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**ISLAMIC REPUBLIC OF IRAN**

**IRAN NUCLEAR REGULATORY AUTHORITY**

**NATIONAL NUCLEAR SAFETY DEPARTMENT**

***Report on Review and Assessment of***

***PSAR Chapter 7 (Instrumentation and control) of***

***"Bushehr-2 NPP Unit 2"***

***(Revision B01)***

**Doc. No.: NS-RT-053-21/04-0-Aug.2020**

**Tehran I.R. IRAN**

**فهرست دریافت کنندگان**

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| **ردیف** | **دریافت کننده** |
| **1** | **شركت توليد و توسعه انرژي اتمي** |
| **2** | **دفتر ايمني هسته‌اي** |
| **3** | **گروه ارزيابي ايمني هسته‌اي** |
| **4** | **گروه دفاتر نمایندگی مستقر در تاسیسات هسته‌ای** |
| **5** | **مركز اسناد دفتر ايمني هسته‌اي** |

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1. **INTRODUCTION**

**1.1 Background**

The present report contains the results of review and assessment of chapter 7 of PSAR of Bushehr-2 NPP Unit 2, Revision B01, issued in 2017, which should have been elaborated in accordance with RG 1.70 and recommendations of NNSD. The present report has been prepared by the NNSD experts.

**1.2 Subject of the review**

Chapter 7 of Primary Safety Analysis Report (PSAR) of Bushehr-2 NPP Unit 2, "Instrumentation and control", Revision B.01.

**1.3 Purpose of the review**

Evaluation of format and contents of PSAR Chapter 7, revision B.01, and assessment of its compliance with the regulatory requirements and guides.

**1.4 Basis and references for the review**

Chapter 7 of Primary Safety Analysis Report (PSAR) of Bushehr-2 NPP Unit 2 has been evaluated based on the following documents:

1. US NRC R.G. 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants” (LWR Edition), Rev.3, 2009
2. US NRC NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Report for Nuclear Power Plants” (LWR Edition"), 2007
3. IAEA safety standards No. SSG-39, "Design of instrumentation and control systems for nuclear power plants", 2016
4. STUK Guide-YVL B.1, "Safety Design of Nuclear Power Plant", November 2013
5. STUK Guide-YVL E7, "Electrical and I&C Equipment of a Nuclear Facility"
6. IAEA TECDOC 952, "Advance control systems to improve nuclear power plant reliability and efficiency"
7. IAEA Safety Guide No. NS-G-2.12, "Aging management for nuclear power plant", 2009
8. IAEA Nuclear Security Series No. 17, "Computer security at nuclear facilities"

**List of ABBREVIATIONS**

|  |  |
| --- | --- |
| APCS | Automatic Program Control System |
| NPP | Nuclear Power Plant |
| BNPP | Bushehr Nuclear Power plant |
| PLC | Programmable Logic Controllers |
| I&C | Instrumentation and Control |
| MCR | Main Control Room |
| ULCS | Upper Level Control System |
| ECR | Emergency Control Room |
| NFDC | Neutron Flux Density Conversion Unit |
| VMS | Vibration Monitoring System |
| LPDS | Loose Part Detection System |
| LMS | Leak Monitoring System |
| PHRS | Passive Heat Removal System |
| HELMS | Heat Exchanger loose Monitoring System |
| ICND CS | In-core noise diagnostics Common-use screen |
| ICIS CS | In-core instrumentation system |
| I&C | Instrumentation and control |

**2. COMMENTS**

**2.1 General Comments**

* With respect to the experience of BNPP-1 I&C systems and the revealed faults and failure of equipment and systems, modernization of design hardware equipment and software qualification reliability and response time algorithm set points shall be considered and implemented.
* Aging management in design of I&C systems and its effects on systems and components are important issues to ensure the availability of required safety functions through the service life of the nuclear power plant, and it shall be controlled in the design and operation stages, in monitoring and maintenance of NPP until its decommissioning.
* Due to the environmental conditions of the Bushehr site, the impacts of environmental parameters e.g. temperature, humidity and high-level dust on the Instrumentation and Control systems shall be considered. On the other words, the experiences of BNPP-1 operation and configured installation equipment shall be used in the design of instrumentation and control systems.
* Referring to the cyber-attack on Iranian nuclear facilities by Stuxnet virus in 2010, targeted programmable logic controller (PLC) shall be configured with a high level of cyber security on the I&C systems in Bushehr-2 NPP Unit 2.
* There are some typing and grammatical mistakes in the context of PSAR chapter 7. Whole of the text shall be checked and the mistakes shall be corrected.

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| Issue Title | Requirements for equipment stability to external impacts | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “The dust content in the premises with air-conditioning is not exceed 10E5 pcs/dm3 with particle sizes not more than 3 μm according to requirements of GOST 20397 "Technical facilities for minicomputers. General technical requirements, acceptance, test methods, marking, packaging, transportation and storage, and manufacturer warranties".” | | | |
| *2.2. Comments* | | | |
| C1. On the basis of operation experiences of BNPP-1, the amount of dust in many buildings of BNPP-1 is exceeded from 10E5 pcs/dm3 value. It is necessary to consider an improved air filtering for normalizing status of air in all instrumentation and control systems. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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**2.2 Detailed Comments Related to Each Individual Item**

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| Issue Title | Requirements for equipment stability to external impacts | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.1.1.6.2 Depending on the place of location, the equipment is correspond to operating conditions specified in GOST 15150-69, …” | | | |
| *2.2. Comments* | | | |
| C1. All parameters considered based on GOST 15150-69 are suitable for territory of Russia. Depending on the place for location of installation of I&C equipment, Bushehr environmental conditions are very important for accurate and measurement systems. Standard dust level shall be considered and design of I&C equipment and systems shall be in compliance with Iranian standards and the adapted Russian standards. Russian standard GOST shall be evaluated and adapted for Bushehr-2 NPP Unit 2. | | | |
| *2.3. Recommendations* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Requirements for equipment stability to external impacts | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| 1. Table 7.1.1.2 – Ambient medium parameters in the premises located inside the sealed containment | | | |
| *2.2. Comments* | | | |
| C1. All of the ambient medium parameters inside the sealed containment indicated in table 7.1.1.2 shall be evaluated for Bushehr site. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | Requirements for equipment stability to external impacts | | |
|  | | | |
| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.1.1.6.9 The equipment components located in the controlled access area process rooms outside the sealed containment is operable under the following parameters of radiation effects:   * + the absorbed dose rate (ADR) in periodically attended premises of process equipment equal to 2.8×10-7 Gy/s under normal operation conditions and up to 1 Gy integrally for 10 days in emergency modes;   + the ADR in unattended premises of high-active process equipment equal to 2.8×10-4 Gy/s under normal conditions and up to 1000 Gy integrally during ten days in emergency modes;   − the ADR in the constantly attended premises equal to 9.8×10-13 Gy/s under normal conditions; its value there in accident modes is not standardized.” | | | |
| *2.2. Comments* | | | |
| C1. Standard used for radiation effect on equipment shall be specified. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | System description | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.1.1.7.1.6 …  The scope of monitoring and control that can be performed from the backup area is adopted according to the scope of MCR backup panels in the reference design, which has passed validation at the process I&C test bench and on a full-scale NPP training simulator with participation of the operating company and approved by Rostechnadzor experts.” | | | |
| *2.2. Comments* | | | |
| C1: INRA/NNSD has not taken part in the above-mentioned validation process. Data and records of test bench shall be provided for validation to INRA/NNSD. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | System operation | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.1.1.7.3.5 …  To minimize the consequences from a postulated ULCS failure due to a common cause (e.g., due to an error in the ULCS software or in gateways) and to …" | | | |
| *2.2. Comments* | | | |
| C1. It shall be explained about the deviation and amount of error related to ULCS software.  C2. Detection error like dropped pockets shall be mitigated and compensated by network protocol because, network error leads to performance problem and negatively affects on the network and services. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Page | 65 of Book 1 |
| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Metrological support | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.1.1.14.1 Metrological support (MS) are executed in line with the Federal Law FZ-102 “On Assurance of Measurement Uniformity”, GOST 8.565-2014, “SSEUM. Nuclear Stations Metrological Assurance. Main Provisions”, GOST R 8.596-2002, “SSEUM. Metrological Assurance for Measuring Systems. Main provisions”, STO 1.1.1.01.0678-20015 “Main rules of NPP operation”, requirements of NP-082-07 “NPP reactor plant nuclear safety rules” and other regulatory documents of the JSC “Concern Rosenergoatom” and Rostekhnadzor.” | | | |
| *2.2. Comments* | | | |
| C1. It is necessary to consider Iranian standards for metrological support by Iranian companies. Established licenses are also necessary for them. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Description of safety panels | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “Information from safety panels about possible faults of systems and equipment is very Important for the operator. In this connection, failure (fault) alarms are fulfilled as follows: In the top part of safety panel there is a group of white-colored annunciators releasing summary alarms in response to failures of programmed hardware of control safety systems.” | | | |
| *2.2. Comments* | | | |
| C1. For designing and modification all TPTS and I&C components, Aging Management shall be considered.  C2. In the design criteria, collecting and using all failure data related to I&C systems shall be considered. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Protection from electromagnetic impacts | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| The following measures mitigate electromagnetic impacts as much as possible:   * shielding of MCR and ECR rooms with a special metal mesh inserted inside walls and connected to a grounding loop; * antistatic floors in MCR and ECR with conducting backing connected to a grounding loop; * location of MCR and ECR at a maximum distance form sources of electromagnetic radiation; * selection of equipment with limited electromagnetic radiation (ensuring function quality A as per GOST 32137-2013). | | | |
| *2.2. Comments* | | | |
| C1. It shall be described the level of electromagnetic impacts in the MCR/ECR.  C2. It is necessary to submit more details about type of electromagnetic waves.  C3. It is necessary to calculate impact of mobile frequency. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | Functions implemented in ULCS | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “- Protection against unauthorized access and other cyber threats” | | | |
| *2.2. Comments* | | | |
| C1. The level of protection against cyber threat and cyber security certification and the related requirements shall be described. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Gateway-to-backup server interface | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.5.1.2.2.3.9.1 The gateway-to-backup server interface is implemented similarly with and parallel to the interface with the main server.” | | | |
| *2.2. Comments* | | | |
| C1. More details about file server computer, storage device, connections and traffic transfer data shall be provided. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | Reliability of MCR elements | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “For the modules TPTS-NT, self-diagnosis is provided as by means of the basic functions, as with the use of hardware tools.” | | | |
| *2.2. Comments* | | | |
| C1. In the above phrase, it is not clear that how can fault diagnosis reliability be evaluated? The reliability shall be simulated and evaluated in the operating status. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | Preventive protection system | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.1.1.2 The preventive protection system is classified as follows:   * the equipment has the classification designation 3N according to NP-001-15 and NP-001-15 “General provisions for assurance of nuclear power plant safety;” | | | |
| *2.2. Comments* | | | |
| C1. NP-001-15 shall be corrected as NP-001-99. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Preventive protection system | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “Each of these PP processor cabinets receives signals from their own primary transducers, from discrete signal sensors, and from external systems and transmits them in the digital form for further independent processing via the fiber-optic communication line to the other two PP processor cabinets.” | | | |
| *2.2. Comments* | | | |
| C1. There is no description about the level of existed noise in the transition of the signals from the sensors to the considered cabinet. It shall be explained about the existed noise in detail. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | In-core instrumentation system (ICIS) | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.3.2.3 The ICIS includes the following functional subsystems:  …   * a neutron flux density conversion unit (NFDC) including: …” | | | |
| *2.2. Comments* | | | |
| C1. "NFDC" is not defined in the list of abbreviations of chapter 7. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | In-core instrumentation system (ICIS) | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.3.2.3 The ICIS includes the following functional subsystems: …” | | | |
| *2.2. Comments* | | | |
| C1. For reliability and correctness of data transmission from transducers of neutron flux and temperature, calculations shall be submitted.  C2. There is not any explanation about calibration channel on operation and during reactor shutdown for control flux neuron channel. More details and explanation shall be submitted. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| **1. ISSUE IDENTIFICATION** | | Issue Number | 17 |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Influence function | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| The “influence function” (Figure 7.6.1.3.2.1) is the relation between the decay of neutron flux disturbance and the distance between the center of the FA behaving as the disturbance epicenter and the sensor measuring this disturbance ….” | | | |
| *2.2. Comments* | | | |
| C1. All of the calculations and justifications related to the “influence function” (Figure 7.6.1.3.2.1) shall be provided. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Section Number | 7.6.1.3.5 |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Integrated diagnostics system (IDS) | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.3.5.1 The IDS is designed as a continuously operating automated system that uses its own software and hardware for data processing and display purposes.  The IDS uses the following information as input data:  - data from the VMS, LPDS, LMS, LMS-2, and PHRS HELMS;  - data from the ICND CS;  - data from the ICIS CS and ULCS necessary for diagnostics systems (VMS, LPDS, LMS, LMS-2, PHRS HELMS) …” | | | |
| *2.2. Comments* | | | |
| C1. It is necessary to submit more details about the method of using data and algorithms for data input related different systems. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Section Number | 7.6.1.10 |
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| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Secondary coolant leak monitoring system (LMS-2) | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| "The LMS-2 is supposed to operate in the following modes:   * commissioning; * trial operation; * regular functioning; * Switching the LMS-2 components in/out from operation.   In the startup mode, the power supply is switched on, and the software is downloaded. In so doing, generation of false data is ruled out and, the system is prepared for operation. The mode is Implemented with involvement of the operating personnel." | | | |
| *2.2. Comments* | | | |
| C1. In the list of operation modes of LMS-2, commissioning mode is mentioned but, in the following text startup mode is set forth. It shall be clarified and corrected.  C2. Explanation shall be provided about "commissioning mode" in this sub-section. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| Issue Title | Secondary coolant leak monitoring system (LMS-2) | | |
|  | | | |
| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.10.6 In its regular operation mode, LMS-2 is supposed to automatically perform the following functions on a round-o’clock basis:  - information;  - auxiliary.” | | | |
| *2.2. Comments* | | | |
| C1. Explanation shall be provided about " auxiliary " in this sub-section. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| **ISSUE SHEET** | | | |
| **1. ISSUE IDENTIFICATION** | | Issue Number | 21 |
| Section Number | 7.6.1.10.7 |
| Page | 93 of Book 3 |
| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | General description of the PHRS HELMS | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “The PHRS HELMS ensures coolant leak detection with a leak rate from 19 l/min by steam and more or from 1 l/min and more by condensate with an error of not more than ±50 %. The time taken to produce information on leak detection is not more than 10 min; the time taken to locate the leak place and evaluate its rate is not more than 20 min.” | | | |
| *2.2. Comments* | | | |
| C1. Based on the technical assignment, the leak rate is 1.9 l/min. There is a mismatch between PSAR & APCS TA that shall be corrected. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| **ISSUE SHEET** | | | |
| **1. ISSUE IDENTIFICATION** | | Issue Number | 22 |
| Section Number | 7.6.1.11.2 |
| Page | 96 of Book 3 |
| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | System design | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| “7.6.1.11.2.3 The group controller is physically made as an instrument cabinet. A touch control display is mounted into the front steel door for data monitoring purposes. Two system units (main and backup) are installed in the cabinet.” | | | |
| *2.2. Comments* | | | |
| C1. It shall be submitted the technical specifications and features of the system units (main and backup) which are installed in the cabinet and their functions. | | | |
| *2.3. Recommendations* | | | |
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| *2.4. References* | | | |
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| **ISSUE SHEET** | | | |
| **1. ISSUE IDENTIFICATION** | | Issue Number | 23 |
| Section Number | 7.6.2.4 |
| Page | 112 of Book 3 |
| Facility | BUSHEHR-2 NPP UNIT 2 | | |
| Issue Title | Refueling monitoring system | | |
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| **2. ISSUE CLARIFICATION** | | | |
| *2.1. Issue Description* | | | |
| "Refueling monitoring system analis is provided in i. 7.2.2.3.3.3" | | | |
| *2.2. Comments* | | | |
| C1. Dictation of “analis” shall be corrected.  C2. Sub-section 7.2.2.3.3.3 is missing in chapter 7. Explanations about the refueling /loading machines especially for fuel handling operation, its hardware technology, software and algorithm for increasing level of reliability to ensure low level fault related to instrumentation and control and coordination fuel rods shall be provided in detail. | | | |
| *2.3. Recommendations* | | | |
| R1. On the basis of operating experience of BNPP-1, there were a lot of errors in operation of refueling machine. Therefore, necessary modifications / improvements in the refueling machine should be considered for BUSHEHR-2 NPP Unit 2. | | | |
| *2.4. References* | | | |
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1. **REFERENCES**
2. US NRC R.G. 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants” (LWR Edition), Rev.3, 2009
3. US NRC NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Report for Nuclear Power Plants” (LWR Edition"), 2007
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9. IAEA Nuclear Security Series No. 17, "Computer security at nuclear facilities"