

UK ABWR

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UK ABWR Generic Design Assessment

Generic PCSR Chapter 30 : Operation



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30.1 Introduction

This chapter describes the approach that will be taken to operate and maintain the UK ABWR.

30.2 Operation

For plant operation, the *UK ABWR GDA: Human Factors Concept of Operations Report* [Ref-1] will be taken into account, and it is operated under the management of appropriate safety. This safety management is applied throughout the plant life cycle of UK ABWR which also the foundation for assuring that the plant will be operated appropriately within the safe operating envelope. The safety of the plant is achieved by the robust design based on the Hitachi-GE's safety and quality policy. Hitachi-GE will share knowledge and information with the Licensee, to provide a safe and high quality nuclear power plant. The details of this safety management are shown in Chapter 4 *Safety Management throughout Plant Lifecycle*.

In order to operate the plant, the principles, procedures and organizational structures required to safely operate the plant will established and fully capable of executing the defined responsibilities during the commissioning of the plant and will continue on through the life of the station.

Operation of nuclear power plant not only covers normal operation, but also the maintainability and inspectability required by the Nuclear Site Licence and health and safety related legislation. This includes periodic reactor shutdowns for the performance of inspections and testing which ensures that the structural integrity and functionality of the reactor, the turbine and their associated support systems are maintained. Organizational functions which help achieve the above will be established in the power station.

Thus, for the operation management of the plant, the following items are mainly considered:

- Management of plant Operations
- Management of the plant during Outages
- Maintenance Management
- Operations Administration

30.2.1 Management of the Plant Operations

All plant operations will be governed and controlled through rigorously prepared and duly authorized operating procedures. The Operating Technical Requirements will be used in the production of the operating procedures to ensure compliance with the requirements prescribed for each operating state.

As described in Chapter 4, the Operating Technical Requirements will be a basic technical guideline for operating, and describes safety limits related to operation of this power station as well as the set points, limiting conditions of operation, and surveillance testing cycles for safeguard systems closely connected to these safety limits.

The operating procedures will govern; the overall control of the plant, the plant start up, the plant shutdown, individual system operation, alarm response, abnormal operation, emergency response and surveillance testing. Basically, the procedures will be provided by Hitachi-GE to the Licensee for operating UK ABWR. These may require modification by the Licensee to incorporate risk assessments for the required tasks and to ensure compliance with applicable UK health and safety legislation.

The operating procedures will be based on the design of systems and components, the operational experience from the existing ABWRs, use of full scope simulators, and BWR preventive maintenance technology centre, together the Operating Technical Requirements. BWR preventive maintenance technology centre is the facility owned by Hitachi-GE equipped with simulated model of actual plant equipment; it enables to carry out the maintenance of reactor pressure vessel and reactor internals, repair, development of replacement technology, handling checks of various equipments, and training for workers. Further validation of the procedures will be achieved by execution on the full scope ABWR Simulator and commissioning.

Prior to the commencement of commercial operation, the commissioning process will test and validate the design functionality of all components and equipment to ensure safe operation. The commissioning is discussed further in details in Chapter 29 *Commissioning*.

In order to make an accurate understanding of the plant operating state of ABWR, is ensured by monitoring operational parameters. All operating parameters required to ensure safe, reliable operation are continuously monitored to ensure that the ABWR is operated within the safe operating envelope. This monitoring is built into the design (instrumentation and control) and will provide sufficient information for the operators to provide early diagnosis of equipment problems and to allow them to take corrective action should an unacceptable parameter deviation occur. This area is discussed in details in Chapter 14 *Control and Instrumentation* and Chapter 21 *Human-Machine Interface*.

Additionally the operability of the safety equipment required to mitigate design basis events will be assured through surveillance testing which will verify equipment functionality and also identify any equipment degradation. This will ensure the early detection and timely response in taking corrective actions prior to the equipment failing to meet its requirements.

The following is the summary of the basic operation management which is implemented at normal operation.

(1) Operation Shift

UK ABWR is mainly operated at the Main Control Room (MCR) in the same way as existing BWR and ABWR. The operation organization of Licensee is responsible for the operation. The control and monitoring of the plant is performed by Control Room Operators. These controls can be carried out by the qualified personnel who have the adequate competence based on the educational programs and training as defined in the Licensee arrangements. Monitoring and control of the plant is performed at post 24 hours a day and seven days a week, using a rotating shift schedule. These teams and support system and their roles and responsibilities are organized based on the *UK ABWR GDA: Human Factors Concept of Operations Report* [Ref-1].

(2) Implementation of Operation

All of the operations use the appropriate procedure which corresponds to the purpose of the operation. As for operation of ABWR, in order to decrease the burden of operators at the normal operation status and an emergency situation, (1) the use of the Wide Display Panel for monitoring the plant as a whole, and (2) automation of the plant level basis are applied. The other work and operations on field are carried out with adequately reciprocal communication between the operators at the main control room and the operators on field, and conduct monitoring of plant parameter for field work in accordance with a situation. The items to be considered related to operation are described in Chapter 21 *Human-Machine Interface* and Chapter 27 *Human Factors*.

(3) Normal Operation of ABWR

In order to start-up the plant, at first, complete the pre-operational checks and confirm that all the requirements are met. After that, control rods are progressively withdrawn to bring the reactor to criticality. After the reactor attains to criticality, the Reactor Pressure Vessel heats up, pressurization and initial power ascension are implemented by continuing to withdraw the control rods. Then, the main turbine is run up and the generator synchronized to the grid, and the first load is applied to the generator. After that, the power ascension is maintained until it reaches to the set condition of control rods position, and then, reactor thermal power is increased by increasing the re-circulation flow rate up to the rated power.

For a plant shut down, decrease the power by the opposite sequence of the start-up. After the control rod is inserted completely, decrease the reactor pressure by the turbine bypass valve. Operate the Residual Heat Removal (RHR) system, eliminate the decay heat, and decrease the water temperature to keep cooling the fuel by next start-up.

In ABWR, it is possible to operate automatically from start-up to rated power and from rated power to shutdown, which reduces the operator burden and supports safe operation. Although the operation and monitoring are supported by automation, the operator also conducts monitoring to make sure that the plant is operated safely by using the Wide Display Panel, Flat Displays, and computer systems, and that contributes to safer operation.

To implement the automatic operation, it is necessary to meet the condition of the logic sequence of automatic operation, and to input the target value and execution command by the operator. These interlock prevents unintended automatic operation. Should the circumstances require the termination of the automatic control, the operator is able to force to switch to manual control.

Also, if particular operation is required due to an occurrence of an abnormal situation during the operation, symptom based procedures are used to diagnose and control the plant. In the unlikely event of an accident, emergency operating procedures are implemented. For emergency situation, overall emergency response is in accordance with the description of Chapter 22 *Emergency Preparedness*. Further, if the design basis accident occurs, basically ABWR is capable of shutting down the reactor automatically and safely without operator's assist.

(4) Surveillance Test

The soundness of the safety equipments that are in standby during operation is confirmed by following the established plan based on the Operating Technical Requirements, implementing surveillance test at designated frequency, and collecting the required data. The surveillance test is performed not only at the normal operation but also during plant start up and includes hold points. If the test result of the surveillance test does not meet the criteria, Start-up operation will be interrupted based on the designated standard until the problem is under control, and the operability of the designated safety equipment is confirmed. If the problem does not resolve within the specified timeline further actions are executed as specified by the controlling procedure, up to and including plant shutdown.

(5) Water Chemistry Management

At the plant operation, the primary system water chemistry and the chemistry of auxiliary systems chemistry are managed. Water chemistry management is discussed more in detail in Chapter 23 *Reactor Chemistry*.

(6) Work Management

Maintenance and testing will be performed during normal plant operation to maintain a high level of reliability and ensure the safety functions, all of which will be procedurally controlled. The Permit to Work System is described in Chapter 4 and the work management process will be aligned to the guidelines contained in the INPO document AP-928.

30.2.2 Management of the Plant during Outages

Rigorous Plant Status Control will be implemented for all plant operating states. In the shutdown state, the Plant Status Control process will ensure that the equipment alignment supports the safety functions required for the shutdown state and will prevent an unplanned loss of the safety function that may be caused by maintenance or inspection activities. The equipment line ups will be established prior to any work being performed to assure that the defined safety functions are maintained through the shutdown period.

The parameter monitoring during the plant shutdown state will be procedurally defined to maintain the safety functions in the same manner as for the normal power operations and similarly the surveillance testing will be tailored to the shutdown state.

The management at shutdown requires a correspondence which considers the fact that fuel is stored in the reactor or the spent fuel pool even when the plant is shutdown.

During this period, for refuelling and inspection purpose, the RPV and RCCV are opened so that there is time for the fuel to transfer between the reactor and spent fuel pool. For example, if trouble occurs during the fuel transfer and there is assumed risk of leakage of radioactive material from the fuel, the safety equipment will be immediately ready for use to ensure the prevention of potential radioactive material discharges to the public environment. In this case, the surveillance test for the Standby Gas Treatment System (SGTS) is required to get ready for such event. (See Chapter 13.2 *Containment system*). Additionally the Emergency Diesel Generators are assured to be available to provide an alternate power supply.

During shutdowns, many inspection and maintenance activities are implemented and rigorous Plant Status Control is established to ensure the appropriate equipment alignment to support the safety measures and minimize human performance errors.

30.2.3 Maintenance Management

In the operation at the nuclear power plant, in order for public safety and function maintenance of the power plant, detailed and extensive inspections, such as an inspection of operation status of equipment and overhaul, are performed on a routine basis. Based on the results of these inspection/examinations, corrective and preventive maintenance will be implemented to ensure a high degree of reliability..

The summary of maintenance is described in Chapter 4 *Safety Management throughout Plant Lifecycle* and Chapter 5.7 *Monitoring, Inspections and Testing*.

The maintenance strategy and management will be implemented in accordance with the significance of the corresponding safety function to achieve high reliability and maintain the functionality of the structures, systems and equipments that composes the UK ABWR, ensuring that the safety functions and process functions of the equipment are maintained throughout the life of the plant.

The Maintenance Program, Preventive Maintenance program and Inspection and Testing Programs will be formulated taking into account of the knowledge of existing ABWR, world wide operating experience, the latest developments within the nuclear industry, and the Operating Technical Requirements.

30.2.4 Plant Operations Administration

All plant operations will be procedurally governed and executed by competent staff trained in the execution of the procedures.

Each of the respective organizations will create and implement programs and procedures to control their respective activities, all of which will be based on the latest developments within the nuclear industry and world wide operating experiences and include inputs from the *UK ABWR GDA: Human Factors Concept of Operations Report* [Ref-1].

Details of the plant operations administration will be provided during the UK ABWR licensing process.

30.3 Conclusion

This chapter described the principles of Operations management for the UK ABWR. The ABWR is already in successful operation and the operating experience is readily available. The use of Operating Technical Requirements together with safety management system will ensure the long term safe operation of the plant.

30.4 References

[Ref-1] UK ABWR GDA: Human Factors Concept of Operations Report, GA91-9201-0001-00034,
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