Emergency Support Centre Concept for the Enhanced CANDU 6

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Abstract

In a two-unit Enhanced CANDU 6® (EC6®[1]) design, the overall management of an emergency is by the plant emergency support staff using the Emergency Support Centre (ESC). The ESC is a shared facility between both units and is separate from the plant control rooms. ESC is used to provide support for managing overall emergency response, coordinating radiological and environmental assessments, determining recommended public protective actions, and coordinating emergency response activities with federal, provincial, and municipal agencies. Such a facility provides provisions to protect its occupants from hazards resulting from accident conditions, and applicable natural external hazards.[i]

1. Introduction

In a two-unit EC6 plant, the control centres for each unit consist of the following:

- Main control room (MCR), where the main command and control of the plant occurs, and
- Secondary control room (SCR), where the plant can be shut down and maintained in a safe shutdown state, if the MCR becomes uninhabitable.

The following facilities are available for emergency response:

a) Technical support centre (TSC) – one for each unit near the main control room, where technical support staff gather to support the MCR,

b) Operational support centre (OSC) – one for each unit near the main control room, where operational support staff gather to obtain work orders from the MCR/TSC,

c) Emergency support centre (ESC) – on-site, shared between the two units, but separate from each unit's control rooms, where the emergency support staff gather to manage the overall emergency response.

Following March 2011 and the accident at the Fukushima Daiichi nuclear power plant in Japan, IAEA launched series of investigations on the consequences of that accident on people and the environment. The lessons learned are reflected in some evolving regulations at different levels of authorities such as IAEA, or state regulators such as NRC, and CNSC. This paper describes the regulatory requirements

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and guidelines that drive the design concept for emergency support centres, and how the EC6 ESC complies with these requirements.

This paper is organized as follows. Section 2 discusses the regulatory requirements and regulatory guidelines for the ESC. Section 3 provides an overview of functional and design criteria for the ESC (e.g. structure, size, habitability, communication, power supply, etc.,) which are based on the requirements and guidelines presented in Section 2. Section 4 summarizes the conclusions of this paper.

2. Regulatory Requirements and Regulatory Guidelines

The technical basis for the design of the ESC is:

- Licensing requirements (CNSC RD-337[1], RD-353[2]) – See Section 2.1.
- Other regulatory guidance (CNSC G-306 [3], U.S. NRC NUREG-0696 [4]) – See Section 2.2.

2.1 Licensing Requirement

The following licensing requirements provide the main technical basis for the EC6 ESC design:

1. CNSC Regulatory Document RD-337 [1], Section 8.10.3 and Section 8.10.1.1.
2. CNSC Regulatory Document RD-353 [2], Section 5.1.3.

2.1.1 CNSC Regulatory Document RD-337

The regulatory requirements for the emergency support centre are provided in Section 8.10.3 of CNSC RD-337 [1]:

*"The design of the new power plant shall provide for an **emergency support centre** that is separate from the plant control rooms, for use by the emergency support staff in the event of an emergency.*

The emergency support centre design shall ensure that appropriate lighting levels and thermal environment are maintained, and that noise levels are minimized in accordance with applicable standards and codes.

The emergency support centre shall include a safety parameter display system similar to those in the MCR and in the SCR.

Information about the radiological conditions in the plant and its immediate surroundings, and about meteorological conditions in the vicinity of the plant, is to be accessible from the emergency support centre.

The emergency support centre shall include secure means of communication with the MCR, the SCR, and other important points in the plant, and with onsite and offsite emergency response organizations.

The design shall ensure that the emergency support centre:

1. *includes provisions to protect occupants over protracted periods from the hazards resulting from sever accidents*

2. *is equipped with adequate facilities to allow extended operating periods".*

In addition, Section 8.10.3 of RD-337 [1] requires that *"Information about the radiological conditions in the plant and its immediate surroundings, and about meteorological conditions in the vicinity of the plant, is to be accessible from the emergency support centre."*

Also, Section 8.10.1.1 of RD-337 [1] requires that "*The safety parameter display system is designed and installed such that the same information is made available in a secured manner to the emergency support centre."*

The CNSC has clarified that the EC6 design requires a support centre that can be used to provide support for managing overall licensee emergency response, coordinating radiological and environmental assessments, determining recommended public protective actions, and coordinating emergency response activities with federal, provincial, and municipal agencies. Such a facility must include provisions to protect its occupants from hazards resulting from accident conditions, such as radiological releases (fission products) [1]. The ESC shall also be protected from applicable natural external hazards. Natural external events, as per CNSC Regulatory Document RD-337 [1], Section 7.4.2, and those that are considered for the generic EC6 design are defined as events such as earthquakes, floods, high winds, tornadoes, and extreme meteorological conditions.

2.1.2 CNSC Regulatory Document RD-353

The design of the EC6 emergency support centre supports the effectiveness of the licensee's emergency response framework. As required by CNSC Regulatory Document RD-353 [2] Section 5.1.3, the licensee's emergency response framework is defined as follows:

"*The emergency response framework includes emergency facilities, equipment and documentation. Indicators that demonstrate the effectiveness of these elements include:*

1. *Design and layout of emergency facilities are adequate to support the emergency response and to minimize interference with emergency personnel;*

2. *Emergency equipment and supplies are appropriate, operational, and available in sufficient quantities for an extended response, and are readily accessible during emergency conditions;*

3. *Back-up equipment and facilities are operational and available,*

4. *Emergency operating procedures and associated documentation are current and used by personnel performing emergency tasks, and Suitable and compatible equipment exists for all intervening agencies.*

2.2 Other Regulatory Guidelines

The following regulatory guideline documents also provide input to the technical basis for the EC6 ESC design:

1. CNSC Regulatory Guide G-306 [3], Sections 9.3.1, and 9.3.2.

2. U.S NRC NUREG-0696 [4], Section 4.

2.2.1 CNSC Regulatory Guide G-306

The CNSC Regulatory Guide G-306 [3] provides the guidelines for a severe accident management program for nuclear reactors. For example, Section 9.3.1 recommends that the roles and responsibilities of the participants required for severe accident management be defined. These guidelines are considered in the design of the EC6 control centres so that adequate support for a severe accident management is ensured.

Also, recommendations provided in Section 9.3.2 of the G-306 [3] with regards to the communication interfaces between these participants are taken into consideration.

2.2.2 U.S NRC NUREG 0696

The U.S. NRC NUREG-0696 [4] describes the facilities and systems to be used by nuclear power plant licensees to improve their responses to emergency situations. As described in Section 4 of this regulatory guideline, the function of the Emergency Operations Facility (EOF) is similar to the CNSC expectations of the ESC. The function of the EOF, as discussed in Reference [4], is as follows:

"The emergency operations facility (EOF) is a licensee controlled and operated off-site[2] support center. The EOF will have facilities for:

- *Management of overall licensee emergency response,*
- *Coordination of radiological and environmental assessment,*
- *Determination of recommended public protective actions, and*
- *Coordination of emergency response activities with Federal, State, and local agencies.*

In addition to functionality, NUREG-0696 [4] provides detailed guidelines for location, structure, habitability, size, communication, data systems and equipment.

[2] In the EC6 design, the ESC location is on-site.

3. Functional and Design Criteria for EC6 Emergency Support Centre

In line with CNSC regulatory requirements (mainly RD-337 Section 8.10.3 [1]) and after considering international practices (namely the NUREG-0696 [4]), a set of functional and design criteria were identified for the EC6 ESC. These criteria include function, activation and use, structure, size, habitability, communication, instrumentation and data system equipment, power supplies, technical data system and data sources. The following subsections provide details for these criteria.

3.1 Function and Location

The shared ESC provides overall management of the Licensee's emergency response and provides the following functions for events that may affect one or both units:

- management of overall emergency response
- coordination of radiological and environmental monitoring
- determination of recommended public protective actions
- coordination of emergency response activities with federal, provincial, and municipal agencies [4].

The ESC is located on-site, and separate from both control rooms [1], and is shared between both units. Also, the location of the ESC is such that the functional and reliability characteristics for carrying out its specific functions are ensured.

3.2 Structure and Habitability

The EC6 ESC is well engineered for design life of the plant [4]. In addition, the EC6 ESC is able to provide provisions to protect occupants over protracted periods of time from the hazards resulting from accident conditions, such as radiological releases (fission products) [1]. The ESC is also protected from applicable natural external hazards such as earthquake, flood, high winds, tornado and extreme meteorological conditions.

The ESC design ensures appropriate lighting levels, and thermal environment are maintained, and that noise levels are minimized in accordance with applicable standards and codes [1]. The heating, ventilation, and air conditioning system, as well as the lighting system in the ESC are reliable, and seismically qualified.

Basic essential facilities (e.g. washroom and kitchenette) are also included in the ESC design to allow extended operating periods [1]. First aid equipment and protective clothing is available for the ESC occupants.

3.3 Size

The ESC is large enough to provide working space for the personnel assigned to ESC as per the licensee's emergency plan. In addition, the following items are considered for defining the size of the ESC:

- meeting rooms
- space for data equipment
- sufficient space for maintenance on equipment and displays
- space for ready access to communication equipment
- space for ready access to functional displays
- space for storage of plant records and historical data, necessary to implement emergency preparedness program

3.4 Communication System

The ESC includes reliable and secure means of communication with the MCR, the SCR, TSC and other important points in each unit and with on-site and offsite (local, provincial, and national) emergency response organizations [1].

The ESC includes communication facilities (telephone, fax, photocopy, e-mail, internet, text processing, work management, video, etc.) to ensure that plant and external (local, provincial, national) emergency communication requirements are met.

3.5 Instrumentation, Data System Equipment, and Power Supplies

ESC is provided with necessary equipment for acquisition, display, and evaluation of all radiological, meteorological, and plant system data required to evaluate the magnitude and effects of actual or potential radioactive releases, and to determine offsite protective measures.

The ESC has the seismically qualified safety monitoring system (SMS) workstations with access to safety parameter data including meteorological and radiological monitoring data.

General purpose workstations can be used to access supplemental information from the long-term plant historian, the work management system, and other relevant systems. These general purpose workstations are supplemental and are not essential to the emergency response function, thus they are not seismically qualified.

The ESC also includes paper-based copies of plant records, procedures and documents necessary to implement the plant's emergency preparedness program and the Severe Accident Management Guidelines (SAMG).

ESC is powered from Class IV when available. On Loss of Class IV power, a dedicated diesel generator (DG), and an uninterruptable power supply (UPS) are available. Both the DG and the UPS are protected against external hazards.

4. Conclusions

The EC6 ESC is used as a support facility for emergency response management in events that may affect one or both units in the EC6 plant. This paper presented the design requirements for the ESC that are derived from regulations and international best practices that have evolved in the past few years, especially post Fukushima. The functional requirements of the ESC, as clarified by the CNSC are similar to the functional criteria for the Emergency Operations Facility (EOF), defined in U.S. NRC NUREG-0696 [4]. In cases where the CNSC RD-337 [1] did not provide sufficient details, guidelines for the ESC design were extracted from NUREG-0696 [4]. The paper also provided a description of how the EC6 ESC design meets the identified requirements.

5. References

[1] CNSC, Regulatory Document, RD-337, "Design of New Nuclear Power Plants", November 2008.

[2] CNSC, Regulatory Document, RD-353, "Testing and Implementation of Emergency Measures", October 2008.

[3] CNSC, Regulatory Guide, G-306, "Severe Accident Management Programs for Nuclear Reactors", May 2006.

[4] U.S. NRC, NUREG-0696, "Functional Criteria for Emergency Response Facilities", February 1981.