Nuclear Power Plant Accident Handbook
A CNSC Emergency Operations Centre Tool

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Abstract

In response to the Fukushima Nuclear Emergency and the subsequent Emergency Operations Centre (EOC) response, the Canadian Nuclear Safety Commission (CNSC) Fukushima Task Force recommended that hardcopy and electronic version reference packages for all Canadian nuclear reactor sites are readily available to the Technical Support Team.

CNSC staff, in a cooperative agreement with Atomic Energy of Canada Limited at Chalk River Laboratories (AECL-CRL), has begun implementing this recommendation through the development of the Nuclear Power Plant (NPP) Accident Handbook. The NPP Accident Handbook will provide readily available reference material for technical staff involved in EOC operations. The NPP Accident Handbook will assist technical staff in finding site-specific and accident-specific details that will help them provide expert advice to the EOC team during a nuclear power plant accident.

1. Introduction

Recent experience by CNSC staff during exercises at the CNSC Headquarters Emergency Operations Centre (EOC) have highlighted the need for readily available information on plant layout, plant operations, accident scenarios and plant response, and anticipated operator actions and their consequences during nuclear accidents. In order to satisfy this need, CNSC staff has identified three independent, yet interlinked projects. The goal of the EOC Technical Support Team Project is to combine these three individual projects under one heading to ensure the EOC Technical Support Team has the required resources to function effectively and efficiently during EOC operations. As well, this umbrella project will reduce the risk of overlapping efforts by the project team members and ensure that all requirements of the Technical Support Team are met.

The three separate projects that will be combined under the “EOC Technical Support Team Project” are the:

1. EOC Technical Support Team Information Project;

2. NPP Accident Handbook; and

3. EOC Source Term Project.

2. CNSC Emergency Operations Centre

2.1 Role of the CNSC

The CNSC emergency organization must be activated for all events which are leading or could lead to significant on-site or off-site consequences, and where the consequences of the event will be strongly affected by the operator's actions [2].

During a nuclear emergency the CNSC's regulatory role is to provide assurance that appropriate actions are taken to limit the risk to health, safety, security and the environment. As such, the CNSC's emergency response objectives, as the federal regulator, are as follows [2]:

(a) Manage the CNSC emergency organization and response;

(b) Assess the safety significance of the emergency, where safety significance refers to the on-site impact, off-site impact and defence-in-depth degradation;

(c) Enforce relevant regulatory and license conditions to reduce the risk to health, safety, security and the environment;

(d) Provide appropriate technical advice and support, as requested or required;

(e) Coordinate and cooperate with licensee, provincial, federal and international response organizations; and

(f) Report to the public, the government and the CNSC organization on the CNSC response.

2.2 Role of the Technical Support Team

The Technical Support Team is a specialized group within the EOC and is comprised of technical specialists in the fields of fuel and physics, thermal hydraulics, containment systems, severe accident progression and mitigation, and radiation protection. The team is designated to meet the requirements of objectives (b) and (d) above. In order to effectively assess the safety significance of the emergency, the Technical Support Team must be fully aware of the emergency scenario, be informed of the actions taken by the operators, and be able to assess the impact of such actions.

Requests for technical advice from on-site licensee staff or the off-site authority are directed to the On-Site and Off-Site CNSC Representatives. The Representative provides the advice or

obtains it from the CNSC EOC. If required, the CNSC provides appropriate advice to other organizations (licensee, provincial, federal or international organizations) without being asked. This happens only when the CNSC has serious concerns about the risk to health, safety, security and the environment. The advice is always provided to the organization that is responsible for the issue or action about which the CNSC is concerned. For example, if the CNSC is concerned about a licensee's recommendation to the off-site authorities, the CNSC provides advice to the licensee, not the off-site authority. Appropriate advice means making the other organization(s) aware of the CNSC's assessment and its concerns.

3. CNSC Fukushima Task Force Recommendations

On March 11, 2011, a magnitude 9.0 earthquake, followed by a devastating tsunami, struck Japan. The combined impact of the earthquake and tsunami on the Fukushima Daiichi nuclear power plant caused a loss of power which led to a severe nuclear accident. The CNSC responded immediately to the accident at Fukushima Daiichi with the following actions:

1. Activation of its Emergency Operations Centre in Ottawa and staffing it 24 hours a day, 7 days a week, to monitor the emergency, assess early reports and provide timely, accurate information to Canadians and to other Canadian government departments and agencies;

2. Requesting licensees of Canadian Class I nuclear facilities, under section 12(2) of the *General Nuclear Safety and Control Regulations*, to review the lessons learned from the Fukushima Daiichi accident;

3. Performing inspections of all NPPs and other nuclear facilities in Canada to assess the readiness of mitigation systems. These inspections covered seismic preparedness, firefighting capability, backup power sources, hydrogen mitigation and irradiated fuel bay cooling; and

4. Establishing a Task Force to evaluate the operational, technical and regulatory implications of the accident and the adequacy of emergency preparedness for NPPs.

In the aftermath of the Fukushima incident, the Emergency Management Programs Division (EMPD) within the CNSC prepared a report [1] with several recommendations. With respect to the EOC Technical Support Team, the following five action items resulted:

1. Action Item 13: Ensure technical applications (e.g. modeling software) can be run from the EOC. All modeling capabilities should be in-house driven and not dependent on external stakeholders;

2. Action Item 16: Prepare hardcopy and e-version reference packages for all Canadian reactor sites. The e-versions should be stand-alone repository available on an external hard drive in the EOC;

3. Action Item 27: Develop a "library" of source term information for Canadian reactors;

4. Action Item 28: Develop the capability to review and validate licensee source term estimates;

5. Action Item 29: Acquire tools and develop and maintain the capability for source term and dispersion modeling, in line with the licensee's, the provincial's and Health Canada's capability.

The Action Items listed above are part of a larger pool of recommendations presented to the commission [1].

4. EOC Technical Team Support Project

In response to the 5 action items, the Reactor Behaviour Division (RBD) within the Directorate of Assessment and Analysis (DAA) initiated the EOC Technical Support Team Project. The project is comprised of three independent yet interlinked projects: EOC Technical Support Team Information Project, NPP Accident Handbook, and EOC Source Term Project.

4.1 EOC Technical Support Team Information Project

Among the lessons learnt from the EOC activity during the Fukushima Accident was the need for essential technical support information to be available to the Technical Support Team. This includes plant layout and drawings, operating parameters and safety analyses for all existing CANDU NPPs and for other nuclear facilities where nuclear accidents may occur. It is expected that the required information would be readily available so that in an event of an incident or exercise no time would be lost searching for documents. The information is to be available in both a hardcopy and a softcopy format.

4.2 NPP Accident Handbook

The Nuclear Power Plant (NPP) Accident Handbook project was initiated to provide easily accessible reference material for technical staff involved in EOC operations. The handbook project takes the results of the EOC Technical Team Information Project and packages the essential information into a user friendly database computer program. Although the information provided to the technical staff through the information project will be complete, it must be recognized that the information will be extensive in volume and arduous to navigate through. The NPP Accident Handbook will allow technical staff to find site-specific and accident-specific details that will allow them to provide expert advice to the EOC team during an accident progression.

4.3 EOC Source Term

The third component of the EOC Technical Team Support Project is the EOC Source Term. The EOC Source Term Project will provide technical staff with the capability of determining, in a short period of time, the radioactive source term and associated dose (both on-site and off-site) for a particular accident scenario at any CANDU facility in Canada. The project requires that two independent tools be employed; one should be from the industry toolset in order to confirm the licensee's predictions, and the second should be a CNSC tool to provide an independent evaluation of dose and source term.

The industry tool for source term calculations is the Canadian code Emergency Response Projection (ERP) developed by AMEC-NSS. ERP is the tool used at all of the Ontario Nuclear Power Plants (NPPs) as well as Emergency Management Ontario. However, an adequate industry independent source term code for CANDU NPPs is not available. As such, the focus of the EOC Source Term Project is to develop an independent source term software tool for CNSC staff.

4.4 Project Integration

Although the three projects are listed as separate entities, they support and compliment each other in achieving the main goal; ensuring the Technical Support Team has the proper tools to fully assist the EOC team during emergency operations. Figure 1 below illustrates the inter-relationship between the three projects.

As can be seen from Figure 1, the EOC Technical Support Team Information Project will firstly provide access to hardcopies and electronic-version reference material for the EOC team. Secondly, it will provide selected key information for inclusion in the NPP Accident Handbook. The EOC Source Term project will satisfy the requirement for a capability to review and validate licensee source term estimates. The dotted line in Figure 1 illustrates a future initiative that would involve using source term estimates in the NPP Accident Handbook, or even linking the two codes. However, that is presently outside the scope of the project.

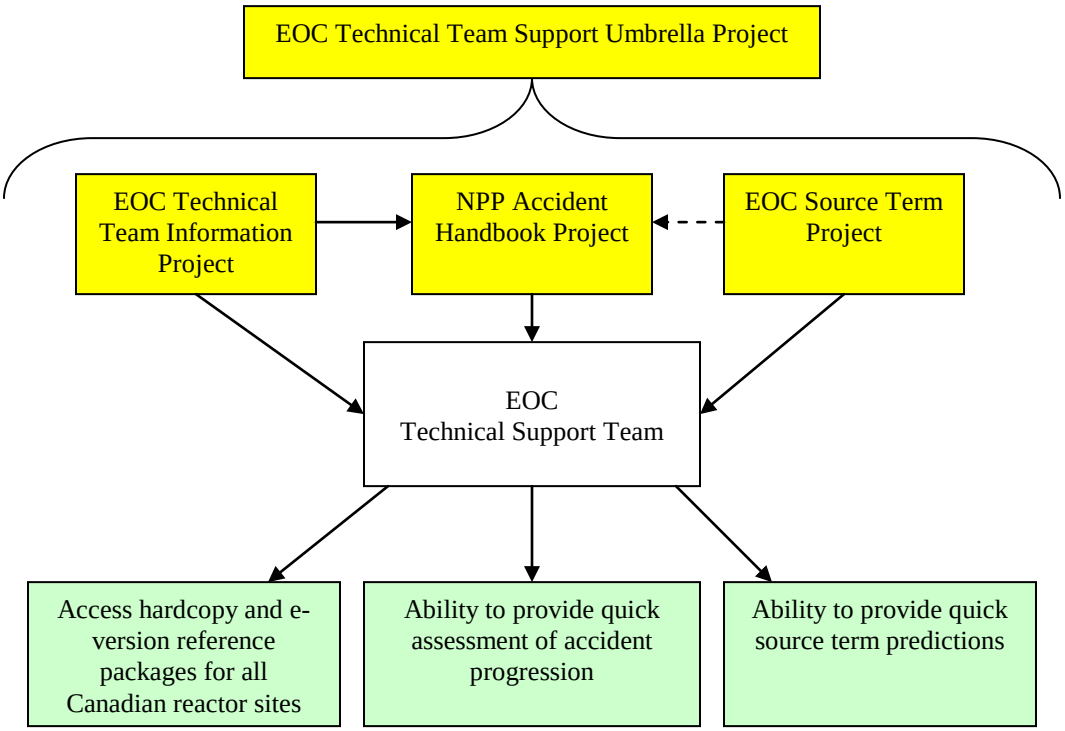

Figure 1 – EOC Project Integration

5. NPP Accident Handbook Prototype

The NPP Accident Handbook Prototype is currently under development at AECL Chalk River Laboratories and CNSC offices in Ottawa. The initial work focuses on the Point Lepreau Generating Station due to the readily available data for that station. New Brunswick Power completed a comprehensive list of analysis of Beyond Design Basis Accidents (BDBA) for PLGS in 2008. These analyses were carried out using the severe accident analysis code MAAP4-CANDU.

The handbook is divided into two components; Plant Layout and Design Information, and Plant Systems Status as illustrated in Figure 2. Upon selecting the desired power plant on the main page, the user then can a) view plant layout and design information or b) search through the database of pre-calculated accident analyses. For example, after selecting the Plant Status Page, the user can choose from a list of accident scenarios. It should be noted that Figure 2 is for illustration purposes and many more accident scenarios will be available. Once the user has selected an accident scenario, a particular system can be explored. In the case shown in Figure 2, the Containment Status has been selected and is showing various system specific parameters that are available for viewing. If the user were to further select the Containment Pressure button, a

graph showing the containment pressure versus time would be displayed, as illustrated in Figure 3.

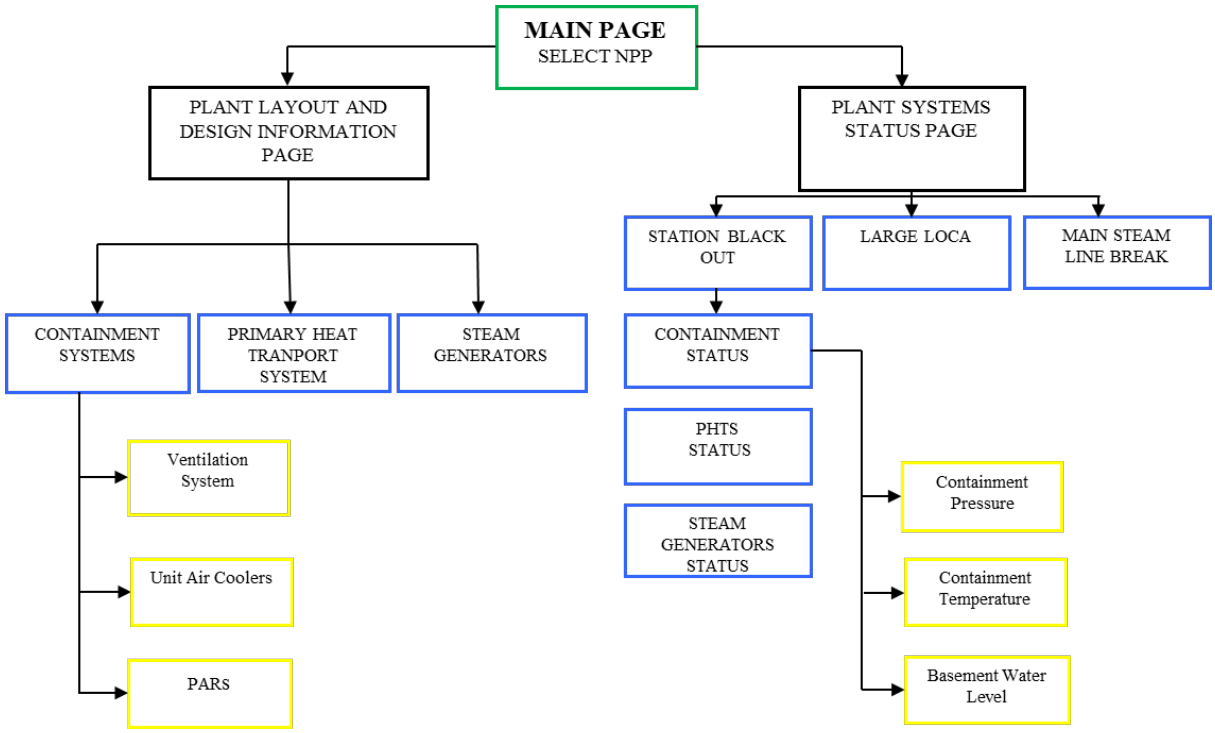

Figure 2 – NPP Accident Handbook Layout

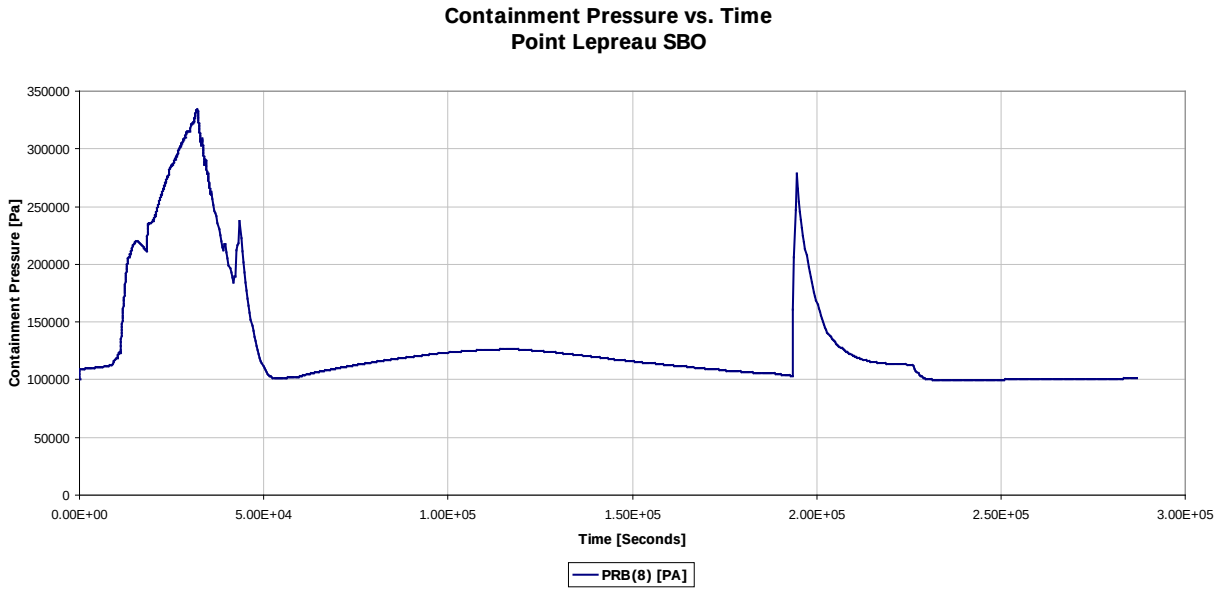

Figure 3 – Typical System Status Data

The Plant Systems Status component has a completed prototype which is presently undergoing review from key stakeholders from within the CNSC and industry. The feedback from this review will assist in defining the look and feel of the final version. Although the prototype has been developed under a simple HTML format, it is anticipated that the final product will be developed under a Graphical User Interface (GUI) software application such as Java. As the software will not perform detailed calculations, there is no requirement to employ a hard engineering code such as FORTRAN or C++. The Handbook will have the feel of an easy to navigate webpage. Behind the GUI will be the necessary drawings, databases and calculations.

If it is desired to know more about a particular system in terms of design and layout, the user would select the Plant Layout and Design button in Figure 2 and then choose the appropriate system. Selection of Containment Systems would bring up the technical specification page on the containment system with options for more details on specific systems within the containment such as the Passive Autocatalytic Recombiners (PARs) or the Unit Air Coolers, as illustrated in Figure 4.

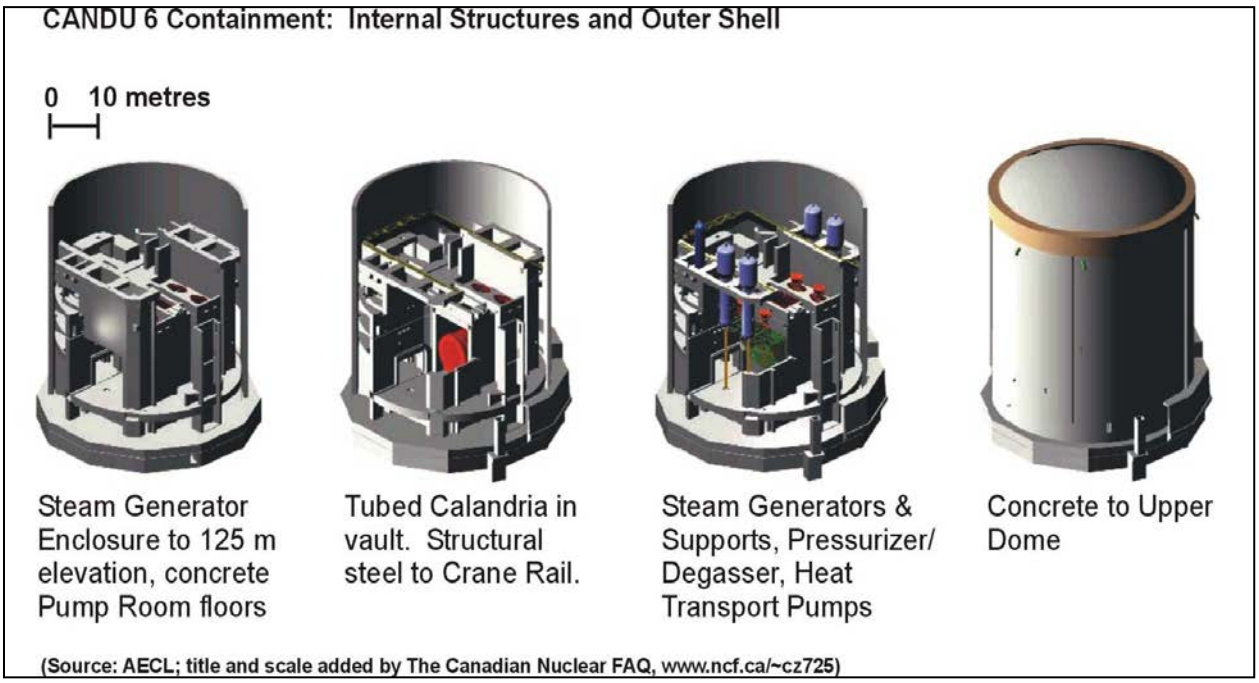

Figure 4 – Typical Plant Layout and Design Information Available

The Plant Layout and Design Information component is being developed through the EOC Technical Support Team Information Project by CNSC staff and will be completed by the fall of 2012.

The Handbook allows the user to select a previously-assessed accident that would closely resemble an actual incident at the plant. As it is impossible to simulate each and every accident scenario a selection of scenarios are made available to the user. The user is then required to have a minimum technical expertise in choosing an appropriate accident case. The user is expected to interpret the results in light of the fact that the selected case may not exactly represent the actual situation. The limitations of the Handbook are overcome through user experience, and the ability of the user to review other similar accident scenarios and interpret the results to the existing situation.

6. Conclusion

The CNSC is committed to the resolution of all actions items recommended by the Fukushima Task Force. In an effort to improve the performance of the EOC technical team during emergency operations, five action items were initiated by the task force. These five action items will be resolved through the EOC Technical Team Support Project. This umbrella project

comprises 3 independent yet interlinked projects that will further improve the technical team's ability to respond to the EOC team's questions effectively and efficiently. One of the main tools being developed within the EOC Technical Team Project is the NPP Accident Handbook (the Handbook). The Handbook is being developed through a cooperative agreement between CNSC and AECL-CRL. The Handbook allows CNSC technical staff to find site-specific and accident-specific details that will assist them in providing expert advice to the EOC team during an accident progression. The program is in the prototype stage and is currently using Point Lepreau Nuclear Generating Station as the trial station.

It is anticipated that the NPP Accident Handbook will, in due course, include all nuclear power plants in Canada, and may eventually include non power reactors as well. During the prototype phase, the CNSC and AECL are encouraging feedback from the industry and key stakeholders. It should be emphasized that the NPP Accident Handbook is intended for CNSC internal use only. However, in order for it to be an effective tool, it must reflect reality and should not contradict tools presently in service in the Canadian nuclear industry.

7. References

[1] CNSC Internal Document, "Fukushima Nuclear Emergency, EOC Improvement Plant", Version 2, July 2011.

[2] CNSC Emergency Response Plan, CAN2-1, Revision 6, December 2010.