FORM-14159 R000*

Periodic Safety Review - Final Document Review Traveler

Bruce Power™

Bruce Power Document #:	Revision:	Information Classification	Usage Classification
NK21-SFR-09701-00003	R000	Internal Use Only	Information
Bruce Power Document Title: Safety Factor 3 – Equipment Qualification			
Bruce Power Contract/Purchase Order: 00193829	Bruce Power Project #: 38180		
Supplier's Name: CANDESCO	Supplier Document #: K-421231-00013	Revision: R00	
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candesco
Division of Kinectrics Inc.

Title: Safety Factor 3 - Equipment Qualification

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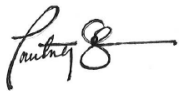
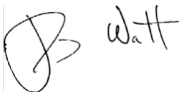
NK21-SFR-09701-00003

A Report Submitted to Bruce Power

June 30, 2015

candesco Division of Kinectrics Inc.	Rev Date: June 30, 2015	Status: Issued
	Subject: Safety Factor 3 - Equipment Qualification	File: K-421231-00013-R00

Issue R00D0	**Reason for Issue:** For first internal Candesco review				
	Author: A. Stretch	Verifier:	Reviewer: G. Archinoff T. Kapaklili	Approver:	Date: Dec 12, 2014
Issue R00D1	**Reason for Issue:** For harmonization, which incorporates internal Candesco review comments				
	Author: A. Stretch	Verifier:	Reviewer: G. Archinoff T. Kapaklili	Approver:	Date: Jan 26. 2015
Issue R00D2	**Reason for Issue:** For final internal Candesco review				
	Author: A. Stretch	Verifier:	Reviewer: G. Archinoff L. Watt	Approver:	Date: Feb 20, 2015
Issue R00D3	**Reason for Issue:** Issued to Bruce Power for review				
	Author: A. Stretch	Verifier: G. Buckley	Reviewer: G. Archinoff L. Watt	Approver:	Date: March 6, 2015

Issue R00D4	**Reason for Issue:** Incorporates changes from Bruce Power review				
	Author: A. Stretch	Verifier: G. Aldev	Reviewer: G. Archinoff L. Watt	Approver:	Date: June 19, 2015
Issue R00	**Reason for Issue:** For use				
	Author: A. Stretch 	Verifier: G. Aldev  C. Stallman 	Reviewer: G. Archinoff  L. Watt 	Approver: L. Watt 	Date: June 30, 2015
Document Classification: Report			Security Classification: Client Proprietary		

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Acronyms and Abbreviations

BP	Bruce Power
BPMS	Bruce Power Management System
CANDU	Canada Deuterium Uranium
CLE	Check Level Earthquake
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
DBE	Design Basis Earthquake
EA	Environmental Assessment
ECC	Engineering Change Control
EM	Environmental Monitoring
EQ	Environmental Qualification
EQA	EQ Assessment
EQD	EQ Dossiers
EQE	EQ Evaluations
EQIS	EQ Information System
EQL	Environmental Qualification List
EQSRCL	EQ Safety Related Components List
ERGM	Engineering Representation of Ground Motion
FASA	Focused Area Self-Assessment
HECL	Harsh Environmental Components List
IAEA	International Atomic Energy Agency
ISR	Integrated Safety Review
LCH	Licence Conditions Handbook
LTEP	Long Term Energy Plan
MCR	Major Component Replacement
NGS	Nuclear Generating Station
NPP	Nuclear Power Plant
NSCA	Nuclear Safety and Control Act

OFI	Opportunities for Improvements
OPG	Ontario Power Generation
PROL	Power Reactor Operating Licence
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
QA	Quality Assurance
RLE	Review Level Earthquake
SBR	Safety Basis Report
SCA	Safety Control Areas
SCR	Station Condition Record
SFR	Safety Factor Report
SIS	Systems Important to Safety
SMA	Seismic Margin Assessment
SME	Subject Matter Expert
SSC	Structures, Systems, and Components
SSCT	Structures, Systems, Components, and Significant Tools
UTC	Uniquely Tracked Commodity

1. Objective and Description

Bruce Power (BP), as an essential part of its operating strategy, is planning to continue operation of Units 3 and 4 as part of its contribution to the Long Term Energy Plan (LTEP) (http://www.energy.gov.on.ca/en/ltep/). Bruce Power has developed plant life integration management plans in support of operation to 247,000 Equivalent Full Power Hours (EFPH). A more intensive Asset Management program is under development, which includes a Major Component Replacement (MCR) approach to replace pressure tubes, feeders and steam generators, so that the units are maintained in a fit for service state over their lifetime. However, due to the unusually long outage and de-fuelled state during pressure tube replacement, there is an opportunity to conduct other work, and some component replacements that could not be done reasonably in a maintenance outage will be scheduled concurrently.

To support the definition and timing of practicable opportunities for enhancing the safety of Units 3 and 4, and the ongoing operation of Units 1 and 2, which have already been refurbished, Bruce Power is conducting a station-wide review of safety for Units 0A and 1-4, to be termed an Integrated Safety Review (ISR) [1]. This ISR supersedes the Bruce A portion of the interim Periodic Safety Review (PSR) that was conducted for the ongoing operation of the Bruce A and B units until 2019 [2]. This ISR is conducted in accordance with the Bruce A ISR Basis Document [1], which states that the ISR will meet or exceed the international guidelines given in International Atomic Energy Agency (IAEA) Guide SSG-25, Periodic Safety Review for Nuclear Power Plants [3]. The ISR envelops the guidelines in Canadian Nuclear Safety Commission (CNSC) Regulatory Document RD-360 [4], Life Extension for Nuclear Power Plants, with the exception of those related to the Environmental Assessment (EA), which has already been completed for Bruce A [5][1].

1.1. Objective

The overall objective of the Bruce A ISR is to conduct a review of Bruce A against modern codes and standards and international safety expectations and provide input to a practicable set of improvements to be conducted during the Major Component Replacement in Units 3 and 4, and during asset management activities to support ongoing operation of all four units, including U0A, that will enhance safety to support long term operation. The look-ahead period will be longer than that in the interim PSR performed for Units 1-8 [2]. It will cover a 10-year period, since there is an expectation that a PSR will be performed on approximately a 10-year cycle, given that all units are expected to be operated well into the future. Nuclear Safety is a primary consideration for Bruce Power and the management system must support the enhancement and improvement of safety culture and the achievement of high levels of safety, as well as reliable and economic performance.

[1] RD-360 [4] was superseded by CNSC REGDOC-2.3.3 [6] in April 2015. REGDOC-2.3.3 was in draft at the time that the ISR Basis Document [1] was prepared. The draft version of REGDOC-2.3.3 stated that it was consistent with SSG-25, and the assessments in the Safety Factor Reports were performed on that basis. The issued version of CNSC REGDOC-2.3.3 also states that it is consistent with SSG-25, and therefore it is considered that the ISR envelops the guidelines in CNSC REGDOC-2.3.3.

The specific objective of the review of this Safety Factor is to determine whether equipment important to safety is qualified (including for environmental conditions) and whether this qualification is being maintained through an adequate program of maintenance, inspection and testing that provides confidence in the delivery of safety functions.

1.2. Description

The review is conducted in accordance with the Bruce A ISR Basis Document [1], which states that the review tasks are as follows:

1. The review of equipment qualification will include an assessment of the effectiveness of the plant's equipment qualification program. This program should ensure that plant equipment (including cables) is capable of fulfilling its safety functions for the period until at least the next ISR. The review will also cover the requirements for performing safety functions while subject to the environmental conditions that could exist during both normal and predicted accident conditions. These include seismic conditions, vibration, temperature, pressure, jet impingement, electromagnetic interference, irradiation, corrosive atmosphere and humidity, fire (for example, a hydrogen fire) and combinations thereof and other anticipated events. The review will also consider the effects of ageing degradation of equipment during service and of possible changes in environmental conditions during normal operation and predicted accident conditions since the program was devised;
2. Although many parties (such as designers, equipment manufacturers and consultants) are involved in the equipment qualification process, the operating organization has the ultimate responsibility for the development and implementation of an adequate plant specific equipment qualification program. The following aspects of implementation of the program will be covered:
    a. Assess if qualification of plant equipment important to safety has been formalized using a process that includes generating, documenting and retaining evidence that equipment can perform its safety functions during its installed service life;
    b. Confirm if this is an ongoing process, from its design through to the end of its service life; and
    c. Assess if the process takes into account plant and equipment ageing and modifications, equipment repairs and refurbishment, equipment failures and replacements, any abnormal operating conditions and changes to the safety analysis.
3. The review of equipment qualification will consider:
    a. Whether installed equipment meets the qualification requirements;
    b. The adequacy of the records of equipment qualification;
    c. Procedures for updating and maintaining qualification throughout the service life of the equipment;

d. Procedures for ensuring that modifications and additions to Structures, Systems and Components (SSCs) important to safety do not compromise their qualification;

e. Surveillance programs and feedback procedures used to ensure that ageing degradation of qualified equipment remains insignificant;

f. Monitoring of actual environmental conditions and identification of 'hot spots' of high activity or temperature; and

g. Protection of qualified equipment from adverse environmental conditions.

2. Methodology of Review

As discussed in the Bruce A ISR Basis Document [1], the methodology for an ISR should include making use of safety reviews that have already been performed for other reasons. Accordingly, the Bruce A ISR makes use of previous reviews that were conducted for the following purposes:

- Return to service of Bruce Units 3 and 4 (circa 2001) [7];
- Life extension of Bruce Units 1 and 2 (circa 2006) [8] [9];
- Proposed refurbishments of Bruce Units 3 and 4 (circa 2008) [10] [11] [12]; and
- Safety Basis Report (SBR) and PSR for Bruce Units 1 to 8 (2013) [2].

These reviews covered many, if not all, of the same Safety Factors that are reviewed in the current ISR. A full chronology of Bruce Power safety reviews is provided in Appendix F of [13].

The Bruce A ISR Safety Factor review process comprises the following steps:

1. **Interpret and confirm review tasks:** As a first step in the Safety Factor review, the Safety Factor Report author(s) confirm the review tasks identified in the ISR Basis and repeated in Section 1.2 to ensure a common understanding of the intent and scope of each task. In some cases, this may lead to elaboration of the review tasks to ensure that the focus is precise and specific. Any changes to the review tasks are identified in Section 5 of the Safety Factor Report (SFR) and a rationale provided.
2. **Confirm the codes and standards to be considered for assessment:** The Safety Factor Report author(s) validates the list of codes and standards presented in the ISR Basis Document against the defined review tasks to ensure that the assessment of each standard will yield sufficient information to complete the review tasks. Additional codes and standards are added if deemed necessary. If no standard can be found that covers the review task, the assessor may have to identify criteria on which the assessment of the review task will be based. The final list of codes and standards considered for this Safety Factor is provided in Section 3.
3. **Determine the type and scope of assessment to be performed:** This step involves confirming or modifying the assessment type for each of the codes and standards and

guidance documents identified for consideration. The ISR Basis Document provides an initial assignment for the assessment type, selecting one of the following review types:

- Programmatic Clause-by-Clause Assessments;
- Plant Clause-by-Clause Assessments;
- High-Level Programmatic Assessments;
- High-Level Plant Assessments;
- Code-to-Code Assessments; or
- Confirm Validity of Previous Assessment.

The final assessment types are identified in Section 3, along with the rationale for any changes relative to the assignment types listed in the ISR Basis Document.

4. **Perform gap assessment against codes and standards:** This step comprises the actual assessment of the Bruce Power programs and the Bruce A plant against the identified codes and standards. In general, this involves determining from available design or programmatic documentation whether the plant's design or programs meet the provisions of the specific clause of the standard or of some other criterion, such as a summary of related clauses. Each individual deviation from the provisions of codes and standards is referred to as a Safety Factor "micro-gap". The assessments, performed in Appendix A and Appendix B, include assessor's arguments conveying reasons why the clause is considered to be met or not met, while citing appropriate references that support this contention.
5. **Assess alignment with the provisions of the review tasks:** The results of the gap assessment against codes and standards are interpreted in the context of the review tasks of the Safety Factor. To this end, each assessment, whether clause-by-clause, high-level or code-to-code, is assigned to one or more of the review tasks (Section 5). Assessment against the provision of the review task involves formulating a summary assessment of the degree to which the plant or program meets the objective and provisions of the particular review task. This assessment may involve consolidation and interpretation of the various compliance assessments to arrive at a single compliance indicator for the objective of the review task as a whole.
6. **Perform program assessments:** The most pertinent self-assessments, audits and regulatory evaluations are assessed, and performance indicators relevant to the Safety Factor identified. The former illustrates that Bruce Power has a comprehensive process of reviewing compliance with Bruce Power processes, identifying gaps, committing to corrective actions, and following up to confirm completion and effectiveness of these actions. The latter demonstrates that there is a metric by which Bruce Power assesses the effectiveness of the programs relevant to the Safety Factor in Section 7. Taken as a whole, these provide a cross section, intended to demonstrate that the processes associated with this Safety Factor are implemented effectively (individual findings notwithstanding). Thus, program effectiveness, if not demonstrated explicitly in the review task assessments in Step 5, can be inferred if Step 5 shows that Bruce Power processes meet the Safety Factor

requirements and if this step shows there are ongoing processes to ensure compliance with Bruce Power processes.

7. **Identification of findings:** This step involves the consolidation of the findings of the assessment against codes and standards and the results of executing the review tasks into a number of definitive statements regarding positive and negative findings of the assessment of the Safety Factor. Positive findings or strengths are only identified if there is clear evidence that the Bruce A plant or programs exceed compliance with the provision of codes and standards or review task objectives. Each individual negative finding or deviation is designated as a Safety Factor micro-gap for tracking purposes. Identical or similar micro-gaps are consolidated into comprehensive statements that describe the deviation known as Safety Factor macro-gaps, which are listed in Section 8 of the Safety Factor Reports, as applicable.

3. Applicable Codes and Standards

This section lists the applicable regulatory requirements, codes and standards considered in the review of this Safety Factor. The list also includes any new codes or standards that came into effect after the completion of the 2013 PSR, as well as those that supersede codes or standards previously assessed. Regulatory codes and standards issued after the code effective date of August 31, 2014 were not considered in the review.

3.1. Acts and Regulations

The *Nuclear Safety and Control Act* (NSCA) [14] establishes the Canadian Nuclear Safety Commission and its authority to regulate nuclear activities in Canada. The NSCA has been amended on July 3, 2013 to provide the CNSC with the authority to establish an administrative monetary penalty system. The Administrative Monetary Penalties Regulations were introduced in 2013, and set out the list of violations that are subject to administrative monetary penalties, as well as the method and criteria for penalties administration. However, these changes do not impact this Safety Factor. Furthermore, following the Fukushima nuclear events of March 2011, the Fukushima Omnibus Amendment Project was undertaken and completed in 2012, and resulted in amendments to regulatory documents to reflect lessons learned from these events. Bruce Power has a process to ensure compliance with the NSCA [14] and its Regulations. Therefore, the NSCA and Regulations were not considered further in this review.

3.2. Power Reactor Operating Licence

The list of codes and standards related to equipment qualification that are referenced in the Bruce Power Reactor Operating Licence (PROL) [15] and Licence Conditions Handbook (LCH)

[16] noted in Table C-1 of the ISR Basis Document [1] are identified in Table 1.[2] The edition dates referenced in the third column of the table are the modern versions used for comparison.

The PROL contains only one condition related to Environmental Qualification. Note that Environmental Qualification is considered to be a subset of Equipment Qualification that focuses on the qualification of equipment under design basis accident conditions. Licence condition 4.5 states that the licensee shall implement and maintain an environmental qualification program in accordance with Canadian Standards Association (CSA) standard N290.13: Environmental Qualification of equipment for Canada Deuterium Uranium (CANDU) Nuclear Power Plants (NPPs).

Table 1: Codes, Standards, and Regulatory Documents Referenced in Bruce A PROL and LCH

Document Number	Document Title	Modern Version Used for ISR Comparison	Type of Review
CNSC S-210	Maintenance Programs for Nuclear Power Plants	RD/GD-210 (2012) [19]	NR
CNSC RD-360 (2008)	Life Extension of Nuclear Power Plants	CNSC RD-360 (2008) [4]	NR
CSA-N286-05 [20]	Management System Requirements for Nuclear Facilities	CSA-N286-12 [21]	NR
CSA N290.13-05	Environmental Qualification of Equipment for CANDU Nuclear Power Plants	CSA N290.13-05 (R2010) [22]	CV
Assessment type: Clause-by-Clause (CBC); Code-to-Code (CTC); High Level (HL); No Assessment Required (NR); Confirm Validity of Previous Assessments (CV)			

CNSC RD/GD-210: CNSC RD/GD-210 [19] is included in the plant licence and is not reviewed further in this document. However, its implementation is briefly discussed in Appendix A (A.3) of this report.

[2] PROL 18.00/2020 [17] and LCH-BNGS-R000 [18] came into effect on June 1, 2015. However, PROL 15.00/2015 [15] and LCH-BNGSA-R8 [16] are the versions referred to in this ISR, as these were in force when the assessments in the Safety Factor Reports were performed.

CNSC RD-360: This ISR is being conducted as part of ongoing operation for Units 1 and 2 and to support Major Component Replacement of Units 3 and 4, so it also envelops the guidelines in RD-360, Life Extension for Nuclear Power Plants, issued February 2008. Therefore, RD-360 [4] *de facto* continues to provide guidance on how this review should be conducted. However, RD-360 [4] was superseded by CNSC REGDOC-2.3.3 [6] in April 2015, which was in draft at the time that the ISR Basis Document [1] was prepared. The draft version of CNSC REGDOC-2.3.3 stated that it was consistent with SSG-25, and the assessments in the Safety Factor Reports were performed on that basis. The issued version of CNSC REGDOC-2.3.3 also states that it is consistent with SSG-25, and therefore it is considered that the ISR envelops the guidelines in CNSC REGDOC-2.3.3.

CSA N286-12: Table C-1 of the ISR Basis Document [1] calls for a code-to-code review against Canadian Standards Association (CSA) standard CSA N286-05, although not for this Safety Factor. However, it is applicable to all Safety Factors, and is addressed herein. CNSC staff have stated that in their view the CSA N286-12 version of CSA N286 “does not represent a fundamental change to the current Bruce Power Management System” and have acknowledged that “the new requirements in CSA N286-12 are already addressed in Bruce Power's program and procedure documentation” [23].

Bruce Power had agreed to perform a Gap Analysis and to prepare a detailed Transition Plan, and to subsequently implement the necessary changes in moving from the CSA N286-05 version of the code to the CSA N286-12 version, during the next licensing period [24]. This timeframe will facilitate the implementation of N286 changes to the management system, and enable the gap analysis results from the large number of new or revised Regulatory Documents or Standards committed in the 2015 operating licence renewal. Bruce Power has also proposed that in the interim, CSA N286-05 be retained in the PROL to enable it to plan the transition to CSA N286-12, and committed to develop the transition plan and communicate the plan to the CNSC by January 30, 2016 [25]. Bruce Power further stated CSA N286-12 does not establish any significant or immediate new safety requirements that would merit a more accelerated implementation. This Safety Factor therefore has not performed a code-to-code assessment between CSA N286-05 and CSA N286-12 and will not be performing a clause-by-clause assessment of CSA N286-05, since it is in the current licence.

CSA N290.13-05: The validity of the previous assessments of CSA N290.13-05 has been further assessed as part of this Safety Factor and the results are presented in Appendix A (A.4) of this report.

3.3. Regulatory Documents

There were no additional Regulatory Documents identified in Table C-1 of the ISR Basis Document [1] considered for application to the review tasks of this Safety Factor beyond those identified in the Bruce Power PROL [15] and the LCH [16].

3.4. CSA Standards

In addition to those identified in the Bruce Power PROL [15] and LCH [16] the CSA standards Identified in Table C-1 of the ISR Basis Document [1] considered for application to review tasks of this Safety Factor are included in Table 2.

Table 2: CSA Standards

Document Number	Document Title	Reference	Type of Review
CSA N289.1-08	General requirements for seismic design and qualification of CANDU nuclear power plants	[26]	HL
CSA N289.2-10	Ground Motion Determination for Seismic Qualification of Nuclear Power Plants	[27]	HL
CSA N289.3-10	Design procedures for seismic qualification of CANDU nuclear power plants	[28]	HL
CSA N289.4-12	Testing Procedures for Seismic Qualification of CANDU Nuclear Power Plants	[29]	HL
CSA N289.5-12	Seismic Instrumentation Requirements for CANDU Nuclear Power Plants	[30]	HL
Assessment type: Clause-by-Clause (CBC); Code-to-Code (CTC); High Level (HL); No Assessment Required (NR); Confirm Validity of Previous Assessments (CV)			

CSA N289.1-08: CSA N289.1-08 [26] defines a seismic success path as the “minimum set of SSCs that can perform the required nuclear safety functions following an earthquake.” It now includes the Seismic Margin Assessment (SMA) as an acceptable qualification methodology. The Bruce 3 and 4 success path was defined in the Seismic Margin Assessment report (NK21-REP-20091-00001) [31] completed in 2002 (and revised in 2003) and accepted by the CNSC in (NK21-CORR-00531-01008) [32]. In late 2006, a Seismic Margin Assessment Report was completed for Bruce Units 1 and 2 (NK21-REP-03611-00005) [33], which was accepted by CNSC (NK21-CORR-00531-06205) [34]. With respect to CSA N289.1-08 [26], the adequacy of the plant design to accommodate seismic events is addressed by both the Seismic Margin Assessment and the seismic Probabilistic Safety Assessment (PSA) addressed in the Safety

Factor 6 report, Probabilistic Safety Analysis. The seismic PSA is being updated to address post-Fukushima action items, as committed in Reference [35]. Table C-1 of the ISR Basis Document [1] calls for a confirmation of the validity of previous assessments. However, to obtain a greater degree of confidence, it was determined that a high level review of the current version of this standard is more appropriate, and this is provided in Appendix A (A.2.1) of this report.

CSA N289.2-10: CSA N289.2-10 [27] describes the investigations required to obtain the seismological and geological information necessary to determine the seismic ground motion that will be used in seismic qualification of safety-related plant structures and systems, and the potential for seismically induced phenomena that can have a direct or indirect effect on plant safety or operation. A high level review of this standard is provided in Appendix A (A.2.2) of this report.

CSA N289.3-10: CSA N289.3-10 [28] applies to SSCs in nuclear power plants that require seismic qualification by analytical methods and specifies the design requirements, criteria, and methods of analysis for determining the engineering representation of ground motion, ground response spectra, and floor response spectra for use in the design and seismic qualification of SSCs and for performing seismic qualification of specified SSCs by analytical methods. Table C-1 of the ISR Basis Document [1] calls for a code-to-code review against an earlier version of this standard. However, since the previous version was not applied to Bruce A, a high level review of the current version of this standard is more appropriate, and this is provided in Appendix A (A.2.3) of this report.

CSA N289.4-12: CSA N289.4-12 [29] provides design requirements and methods for seismic qualification of specific components and systems by testing methods. Table C-1 of the ISR Basis Document [1] calls for a code-to-code review against an earlier version of this standard. However, since the previous version was not applied to Bruce A, a high level review of the current version of this standard is more appropriate, and this is provided in Appendix A (A.2.4) of this report.

CSA N289.5-12: CSA N289.5-12 [30] describes the requirements for seismic instrumentation systems for NPPs and nuclear facilities to monitor site-specific seismic responses. Table C-1 of the ISR Basis Document [1] calls for a code-to-code review against an earlier version of this standard. However, since the previous version was not applied to Bruce A, a high level review of the current version of this standard is more appropriate, and this is provided in Appendix A (A.2.5) of this report.

3.5. International Standards

The international standard listed in Table 3 is relevant to this Safety Factor and was considered for this review.

Table 3: International Standards

Document Number	Document Title	Reference	Type of Review
IAEA SSG-25	Periodic Safety Review For Nuclear Power Plants	[3]	NR
Assessment type: Clause-by-Clause (CBC); Code-to-Code (CTC); High Level (HL); No Assessment Required (NR); Confirm Validity of Previous Assessments (CV)			

IAEA SSG-25: IAEA SSG-25 [3] addresses the periodic safety review of nuclear power plants and is the governing document for the review of the ISR, as identified in the Bruce A ISR Basis Document [1]. It defines the review tasks that should be considered for this Safety Factor. However, no assessment is performed specifically on IAEA SSG-25.

3.6. Other Applicable Codes and Standards

There was no additional international guidance identified for application to review tasks of this Safety Factor identified in Table C-1 of the ISR Basis Document [1]. In an earlier assessment (see below) the Darlington Design guides were reviewed, so the safety guide for Environmental Qualification is listed in this table.

Table 4: Related Documents

Document Number	Document Title	Reference	Type of Review
Darlington DG-38-03650-8	Environmental Qualification of Safety Related Equipment	[36]	NR
Assessment type: Clause-by-Clause (CBC); Code-to-Code (CTC); High Level (HL); No Assessment Required (NR); Confirm Validity of Previous Assessments (CV)			

Darlington Design Guides: Clause-by-clause reviews were conducted against the Darlington Design Guides as part of the Bruce 1 and 2 ISR (NK21-CORR-00531-04059 [8]), which included NK21-REP-03600-00006 (a summary of environmental and seismic qualification) and NK21-REP-03600-00004 (a detailed review against all of the Darlington Design Guides). The report concluded that, although the Bruce A qualification did not strictly meet all of the requirements of the Darlington Design Guides, it is a practicable approach for existing stations and has been previously accepted by the CNSC. The Darlington Design Guides have not been revised since the Bruce 1 and 2 ISR or the Bruce Power 2013 PSR and the results of the

Bruce 1 and 2 reviews remain applicable to Bruce 3 and 4. Therefore, a review against the Darlington Design Guides was not repeated for this Safety Factor.

4. Overview of Applicable Bruce A Station Programs and Processes

The term “Equipment Qualification” is discussed in IAEA SSG-25 [3] as “plant equipment important to safety (that is, SSCs) should be properly qualified to ensure its capability to perform its safety functions under all relevant operational states and accident conditions, including those arising from internal and external events and accidents (such as loss of coolant accidents, high energy line breaks and seismic events or other vibration conditions).” Therefore, equipment qualification includes not only environmental and seismic qualification, but also the conditions that occur in the normal operation of the plant, as well as less frequent internal and external events. Bruce Power documents define “Equipment Qualification” as “verification of equipment design by demonstrating functional capability under anticipated operational stresses and service conditions resulting from normal operation, anticipated operational transients and Design Basis Accidents” (BP-PROC-00261 [37]).

This report focuses on the Environmental and Seismic Qualification aspects, as defined in the Bruce Nuclear Generating Station (NGS) documents, for the harsh environmental conditions resulting from Design Basis Accidents and from earthquake events. Environmental Qualification (EQ) includes the effects of ageing during normal plant operation in the environmental qualification process (i.e., EQ Dossiers), so the procedures used to monitor normal plant conditions are identified below, as these are important to ensure that the equipment qualification is maintained for the life of the plant.

The environmental conditions during normal plant operation (i.e. normal temperature and atmospheric conditions, electromagnetic interference, vibration) are addressed in the Safety Factor 1 report for plant design and the Safety Factor 4 report for ageing aspects. The Safety Factor 1 report includes an assessment of specific requirements that are part of equipment qualification, such as vibration and electromagnetic emissions and qualification. A comprehensive review of the ageing of plant components, monitoring during normal plant operation, and the documentation of ageing is included in the Safety Factor 4 report. These reports are listed in Section 7 of this report as interfacing reports.

The main documents that manage the equipment qualification process are listed in Table 5, and are discussed below. A programmatic assessment of the process is included in Appendix A, which shows that the equipment qualification process is well defined, with a large number of programs, procedures, and supporting documentation covering every phase of the qualified life of equipment, with no gaps identified. These documents are up-to-date and comprehensive, with a robust audit and self-assessment process. This review addressed the main aspects of equipment qualification, and it is recognized that there are many other related procedures, both implementing and interfacing, which play a role in the equipment qualification process. This assessment shows that the quality of the programmatic documents (i.e. programs and procedures) for the equipment qualification process was very good, with interfaces with other

station procedures well identified, recent revisions and updating for most procedures, and incorporation of issues identified in audits and self-assessments.

4.1. Design Basis Management

The Management System Manual, BP-MSM-1 [38] is the top tier management system document that includes policy statements and governs the programs and processes for the Bruce Nuclear Generating Station. It establishes the hierarchy of documents and processes and provides the staff expectations and the management roles and responsibilities for the operation of the nuclear station. It provides the authority for the next lower tier of documents, which includes various programs that implement the management system, including those which implement the equipment qualification process.

The Management System Manual provides the authority for the Plant Design Basis Management program, BP-PROG-10.01 [39], which in turn is implemented by the procedure BP-PROC-00335, Design Management [40], amongst others. The Design Management procedure provides the authority for the primary implementing procedures for Environmental and Seismic Qualification as outlined in 4.2 and 4.3 below.

Other programs that supplement the Plant Design Basis Management Program to sustain the equipment qualification process throughout the life of the plant are:

- BP-PROG-10.02 Engineering Change Control [41]
- BP-PROG-11.01 Equipment Reliability [42] and
- BP-PROG-11.04 Plant Maintenance [43].

4.2. Environmental Qualification

The primary procedure identified in the Management System Manual that implements the environmental qualification process is BP-PROC-00261 Environmental Qualification [37]. This procedure provides a comprehensive description of the environmental qualification process, outlining the role of each of the procedures listed in Table 5 (amongst others), as well as the role of the following basis documents:

1. NK21-EQR-03651-00001 Environmental Qualification Design Guide [44]

   This document defines the plant level EQ requirements, including identification of design related regulations and rulings and applicable codes and standards, identification of the DBAs that result in global harsh environments, the safety related systems and structures that maintain the basic nuclear safety functions when exposed to harsh environments, the system functional requirements necessary to maintain the basic nuclear safety functions when exposed to harsh environments, the EQ conditions and parameters, and the identification of the methods of EQ.

2. NK21-MAN-03651-00001 Room Conditions Manual R003 March 2012 [45]

   This manual provides a single source of the normal service and post-accident environmental conditions for use in establishing and maintaining EQ of essential safety related equipment at Bruce A Nuclear Generating Station. The post-accident room conditions data have been adopted from the Bruce B room conditions data. The thermal hydraulic and radiation analysis for Bruce B have been reviewed and applied to Bruce A. Where differences between stations exist, appropriate changes in the room conditions have been made. The normal service EQ room conditions have also been taken from the Bruce B room conditions.

The procedures applicable to EQ are listed in Table 5 and summarized below in terms of their role in the overall EQ Program:

- SEC-EQD-00007 [46] provides guidelines for the revision of Environmental Qualification Assessments and Environmental Qualification Dossiers (Bruce A).
- SEC-EQD-00012 [47] provides guidelines to define the start of the “qualified life” of equipment for use in EQ documents, including consideration of installations before and after initial criticality and long periods of shutdown.
- SEC-EQD-00013 [48] defines the process for the EQ Environmental Monitoring (EM) Program, which monitors that the actual conditions for environmentally qualified equipment to confirm they are within the range used to establish its qualified life. The main objectives of the EM program are to validate the normal temperature and radiation data in the EQ Room Conditions Manual for selected locations, to identify local hot spots, and to provide justification for extending or limiting the qualified life of equipment based on the collected data. Changes to EQ documentation are addressed in an EQ Evaluation (see SEC-EQD-00032 below).
- SEC-EQD-00015 [49] provides technical guidance for the qualified material, components, and maintenance procedures that may be used for an EQ installation
- SEC-EQD-00017 [50] provides guidance for the use and control of lubricants for environmentally qualified equipment.
- SEC-EQD-00021 [51] defines the process for developing, revising, and cancelling Environmental Qualification Assessments and Environmental Qualification Maintenance Requirements. For Bruce A, the procedure for Environmental Qualification Dossiers (SEC-PROC-00031) is referenced.
- SEC-EQD-00022 [52] describes the process used to develop and maintain the Environmental Qualification List (EQL), including the EQ Safety Related Components List (EQSRCL), and the Harsh Environmental Components List (HECL). This procedure states that the Bruce A information is currently being incorporated into the EQ Information System (EQIS) and that EQIS is not being used for Units 1 and 2, and references SEC-EQD-00031 for the development and maintenance of the EQL. This procedure states that the EQSRCL, the HECL and the EQL are maintained in the EQ Dossiers for Bruce A (see procedure SEC-EQD-00031 below). Components on the EQL

are flagged in PassPort and in Online Wiring so their status is identified for maintenance or monitoring activities.

- SEC-EQD-00030 [53] describes the process used to identify condition monitoring credited in the assessment of qualified life for environmentally qualified components, which are then monitored by the Performance Monitoring Plans outlined in DPT-PE-00008.
- SEC-EQD-00031 [54] describes the process for developing or revising EQ Dossiers (EQD), noting that these documents are used only for Bruce A (the equivalent document for Bruce B is the EQ Assessment (EQA) addressed by SEC-PROC-00021 above). This procedure describes the development and documentation of the EQ List.
- SEC-EQD-00032 [55] describes the process to provide an auditable and documented format for issues arising about the qualification of EQ equipment, in the form of EQ Evaluations (EQE).
- SEC-EQD-00033 [56] describes the process used to verify that EQ equipment and components are installed and configured in accordance with the applicable EQD or EQA, using document reviews or walkdowns. This process is also used to verify assumptions in an EQE.
- SEC-EQD-00034 [57] describes the process used to track the sustainability of EQL components using six different parameters, EQ equipment qualification status, documentation status, installation history, predefined maintenance activity, and new material classifications.
- SEC-EQD-00035 [58] describes the monitoring process used to ensure that maintenance performed on equipment on the EQL is well documented and does not compromise the qualification.
- SEC-EQD-00040 [59] describes the basic steps used to demonstrate and document the EQ of cables at the Bruce Power site.
- SEC-EQD-00049 [60] provides the process and expectation for the EQ Program Health Report, which is produced semi-annually, based on parameters like regulatory reportable events, document production, sustainability, etc.
- SEC-RSA-00001 [61] describes the requirements for the preparation of the EQ Room Conditions Manual, which define the normal and post-accident conditions for rooms which contain special safety and safety related equipment that is required to function in harsh environmental conditions.
- DPT-PDE-00019 [62] identifies the physical barriers that are required to mitigate harsh conditions or maintain mild conditions consistent with EQ assessments and provides requirements for the identification, maintenance, modification and inspection of these barriers.

4.3. Seismic Qualification

The primary procedure identified in the Management System Manual that implements the seismic qualification process is DPT-PDE-00017 Bruce Power Seismic Qualification Standard [63]. This procedure describes the engineering and administrative processes for preserving the seismic qualification of the systems, structures and components. It outlines the basis of qualification of Bruce A, noting that it is qualified using the Review Level Earthquake (RLE) which was developed using the procedures and criteria of EPRI NP-6041, Seismic Margin Assessment [64], and documented in the Bruce A SMA report NK21-REP-20091-00001 Bruce NGS A Seismic Margin Assessment Report [65]. The seismically assessed components are identified in NK21-CALC-20091-002, Success Path and Equipment List [66]. It states that "the seismic qualification of the Bruce A structures, systems, and components will be preserved in accordance with NK21-DG-20091-002, Bruce A Seismic Design Guide.[67] DPT-PDE-00017 states that post-seismic activities, consisting of immediate walkdowns to determine the level of damage will be initiated from the control room after confirmation of the event.

The other main procedure is BP-PROC-00500, Control of Unsecured Equipment in Seismically Qualified Areas [68], which is used during plant operations and maintenance to ensure that any equipment used is properly secured so it would not damage nearby qualified equipment should an earthquake occur.

4.4. Supporting Procedures for Equipment Qualification

A number of supporting procedures are noted in the environmental qualification and seismic qualification procedures, as listed in Table 5[3]. These procedures address the procurement (BP-PROC-00244 [69]), life cycle management (BP-PROC-00400 [70]), maintenance of qualified equipment (BP-PROC-00695 [71]) and monitoring of qualified equipment (BP-PROC-00781 [72], DPT-PE-00008 to 00011 [73][74][75][76]) as required by the equipment qualification procedures and program.

[3] Table 5 lists the key governance documents used to support the assessments of the review tasks for this Safety Factor Report. There is a continual process to update the governance documents; document versions may differ amongst individual Safety Factor Reports depending on the actual assessment review date. A full set of current sub-tier documents is provided within each current PROG document.

Table 5: Key Implementing Documents

First Tier Documents	Second Tier Documents	Third Tier Documents	Fourth Tier Documents
Environmental Qualification			
BP-MSM-1: Management System Manual [38]	BP-PROG-10.01: Plant Design Basis Management [39]	BP-PROC-00261: Environmental Qualification [37] BP-PROC-00335: Design Management [40]	SEC-EQD-00007: Environmental Qualification Assessment and Dossier Revisions [46]
			SEC-EQD-00012: Start of Qualified Life [47]
			SEC-EQD-00013: Environment Monitoring for EQ [48]
			SEC-EQD-00015: Environmental Qualification Installation Standards [49]
			SEC-EQD-00017: EQ and Lubricants [50]
			SEC-EQD-00021: Environmental Qualification Assessments [51]
			SEC-EQD-00022: Development of Environmental Qualification Lists [52]
			SEC-EQD-00030: EQ Equipment Condition Monitoring Procedure [53]

First Tier Documents	Second Tier Documents	Third Tier Documents	Fourth Tier Documents
			SEC-EQD-00031: Preparation of Environmental Qualification Dossiers [54]
			SEC-EQD-00032: Environmental Qualification Evaluations (EQE) [55]
			SEC-EQD-00033: EQ Walkdown and Verification Process [56]
			SEC-EQD-00034: Environmental Qualification Status Index [57]
			SEC-EQD-00035: Environmental Qualification Sustainability Monitoring [58]
			SEC-EQD-00040: Cable Qualification Strategy [59]
			SEC-EQD-00049: Environmental Qualification Health Reporting [60]
			SEC-RSA-00001: Preparation of the EQ Room Conditions Manual [61]

First Tier Documents	Second Tier Documents	Third Tier Documents	Fourth Tier Documents
			DPT-PDE-00019: Steam Protection Barriers [62]
Seismic Qualification			
BP-MSM-1: Management System Manual [38]	BP-PROG-10.01: Plant Design Basis Management [39]	BP-PROC-00335: Design Management [40]	DPT-PDE-00017: Bruce Power Seismic Qualification Standard [63]
			BP-PROC-00500: Control of Unsecured Equipment in Seismically Qualified Areas [68]
Equipment Qualification Supporting Procedures			
BP-MSM-1: Management System Manual [38]	BP-PROG-10.01: Plant Design Basis Management [39]	BP-PROC-00335: Design Management [40]	BP-PROC-00244: Procurement Engineering [69]
			SEC-PE-00001: Item Equivalency Evaluation [77]
	BP-PROG-10.02 Engineering Change Control [41]		
	BP-PROG-11.01: Equipment Reliability [42]	BP-PROC-00400: Life Cycle Management of Critical SSCs [70]	

First Tier Documents	Second Tier Documents	Third Tier Documents	Fourth Tier Documents
			DPT-PE-00008: System and Component Performance Monitoring Plans [73]
			DPT-PE-00009: System and Component Performance Monitoring Walkdowns [74]
			DPT-PE-00010: System Health Reporting [75]
			DPT-PE-00011: Component Program Health Reporting [76]
	BP-PROG-11.04: Plant Maintenance [43]	BP-PROC-00695: Maintenance Program and Activities [71]	BP-PROC-00698 Structures, systems, and Components Monitoring [78]

5. Results of the Review Tasks

The results of the review of this Safety Factor are documented below under headings that correspond to the review tasks listed in Section 1.2 of this document. The review tasks assessed in this section have not changed from those listed in Section 1.2.

5.1. Effectiveness of the Equipment Qualification Program

The review of equipment qualification includes an assessment of the effectiveness of the plant's equipment qualification program to ensure that plant equipment (including cables) is capable of fulfilling its safety functions for the period until at least the next ISR.

The review also covered the requirements for performing safety functions while subject to the environmental conditions that could exist during both normal and predicted accident conditions. These include seismic conditions, vibration, temperature, pressure, jet impingement,

electromagnetic interference, irradiation, corrosive atmosphere and humidity, fire (for example, a hydrogen fire) and combinations thereof and other anticipated events.

The review considered the effects of ageing degradation of equipment during service and of possible changes in environmental conditions during normal operation and predicted accident conditions since the program was devised.

Assessment

The equipment qualification process for Bruce A includes several different programs and procedures that interface with each other. When the plant was originally designed, equipment was specified, and in some cases analyzed or tested, to perform its functions while subjected to defined or assumed ambient conditions of vibration, temperature, humidity, radiation, electromagnetic interference, internal conditions, etc., which collectively constitute equipment qualification. See Section 7.2.1.2 and 7.2.1.3 for an audit description for Environmental Qualification during the restart phase of Units 1 and 2, which provides an example of the processes in place during the original qualification of equipment. During the subsequent plant operation, equipment important to safety was identified and is monitored, maintained, and modified or repaired to maintain its safety functions in the actual ambient conditions that exist at the plant, which may include additional or more severe conditions than assumed in the original design.

The main Bruce A programs and procedures that maintain or enhance the original equipment qualification during normal plant operation, and therefore ensure that the equipment can fulfill its safety functions until the next ISR, are:

- Equipment Reliability, BP-PROG-11.01

  This program employs several procedures to identify critical components, specify preventive maintenance, improve reliability, handling life cycle management, etc. One of the more important procedures for maintaining equipment qualification is BP-PROC-00781 Performance Monitoring, which implements the process for system and component monitoring, and provides the framework for documenting and trending the results of the monitoring in the form of System and Component Health Reports. The monitoring and reporting of the health of systems and components is implemented by procedures DPT-PE-00008, DPT-PE-00009, DPT-PE-00010, and DPT-PE-00011. These procedures are also called up in the EQ Equipment Condition Monitoring procedure SEC-EQD-00030, which implements the condition monitoring process outlined in Section 4.4 of BP-PROC-00261. See Table 5 for a listing of the key procedures for life cycle management and system and component health reporting. This process is addressed in more detail in the SF4 Report, Ageing.

- Plant Maintenance BP-PROG-11.04

  This program evaluates the function and performance of plant equipment against a set of criteria to ensure it continues to operate as per design, and ensures that preventive and corrective maintenance processes are in place to support nuclear safety. The main procedure that implements this program is BP-PROC-00695 Maintenance Program and Activities [71], which is also listed in Table 5.

- Engineering Change Control, BP-PROG-10.02

  This program ensures that design changes and modifications are controlled and documented so that SSCs continue to satisfy the design basis and operate safety. The program is implemented for equipment qualification through the interfacing program BP-PROG-10.01 described below.

- Plant Design Basis Management BP-PROG-10.01.

  This program maintains the design basis to ensure that the plant can operate safety for its design life. The main procedure for implementing this program is BP-PROC-00335 Design Management. As outlined in this procedure (section 4.10), the equipment qualification process for Environmental and Seismic Qualification (i.e., for Design Basis Accidents and external events) is addressed by two primary procedures, BP-PROC-00261 for Environmental Qualification and DPT-PDE-00017 for Seismic Qualification.

The above program documents and their implementing procedures describe a formalized process which requires that qualified structures, systems, and components are identified, that the qualification documentation is produced and maintained for the life of the station, that they have an established qualified life where ageing is a factor, and that the qualification is sustained through control of maintenance and replacement, and through monitoring during their life cycle.

For an assessment of the capability of equipment to withstand the environmental conditions that occur during normal station operation, refer to the reports for Safety Factor 1 “Plant Design”, Safety Factor 2 “Condition Assessment”, and Safety Factor 4, “Ageing”. Although the plant performance monitoring and reporting assessment in the Safety Factor 4 report does not specifically address the Environmental Qualification aspect, the linkage between the EQ process and the plant performance monitoring process is provided through the procedures SEC-EQD-00030, which calls up DPT-PE-00008 and DPT-PE-00009 in section 4.2, and DPT-PE-00008 likewise calls up SEC-EQP-00030 in section 4.1.1.3. The linkage between equipment qualification and performance monitoring, maintenance or modification activities is also provided by the display of the PassPort database (by an information box or “flag”), which is consulted and updated during these activities.

Environmental Qualification

Based on the procedures listed in Table 5, environmentally qualified structures, systems, and components are identified, based on their credited safety functions, using procedures SEC-EQD-00022 and SEC-EQD-00031; the qualification documentation is produced using SEC-EQD-00031, SEC-EQD-00021 (as applicable for Bruce A), SEC-EQD-00040 (for cables), and SEC-EQD-00017 (for lubricants); the qualified life is established using SEC-EQD-00012; maintenance and replacement activities are controlled through SEC-EQD-00015; and qualified components are monitored in accordance with SEC-EQD-00013. These procedures also identify the relevant technical background and information contained in design guides and reports.

Of the above procedures, SEC-EQD-00040 Cable Qualification Strategy is of particular interest, as it describes the steps taken to identify and qualify the cables, which traverse many different rooms and areas of the plant, and are subject to various environmental conditions. The cables originally installed at Bruce A were not qualified to the conditions and with the methodology

currently required, so the steps and methods used to identify and qualify the cables are included in this procedure, and the appendices provide the technical information that supports the qualification.

As described in Section 4.4.16 of the Environmental Qualification procedure BP-PROC-00261, the effectiveness of the EQ program is monitored through the preparation of a semi-annual EQ Program Health Report and is periodically assessed by audits, self-assessments, or independent reviews and/or management oversight,. See Section 7 for a summary of recent audits and self-assessments.

Any changes that may occur in the predicted environmental conditions for accidents are identified in the processes described in the Safety Factor 5 report and would be incorporated into the EQ process through SEC-EQD-00032.

Seismic Qualification

Seismically qualified structures, systems, and components are identified using procedure DPT-PDE-00017, which calls up a number of technical documents, including:

- NK21-DG-20091-001 Seismic Structural Design Guide [79]
- NK21-DG-20091-002 Bruce A Seismic Design Guide [67]
- NK21-CALC-20091-00001 Review Level Earthquake [80]
- NK21-CALC-20091-00002 Success Path and Equipment List [66]
- B-SPEC-01370-00001 Seismic Qualification of Mechanical Equipment [81]
- B-SPEC-01370-00002 Seismic Qualification of Instrumentation and Control Equipment [82]
- NK21-REP-03611-00005 Bruce A Units 1 and 2 Seismic Margin Assessment Report [33]
- NK21-REP-20091-00001 Bruce NGS A Seismic Margin Assessment [31].

These documents provide a comprehensive presentation of the methodology used to identify and qualify the systems and equipment that are part of the seismic success path.

The programs and procedures that were in place for the qualification of equipment important to safety ensured that it was capable of fulfilling its safety functions as installed. Based on the above assessment, it is concluded that processes are in place that will effectively maintain that qualification for the life of the plant, both for conditions that occur during normal operation and those that occur for Design Basis Accidents, and for less frequent internal and external events, such as seismic events.

5.2. Implementation of Equipment Qualification Program

Although many parties (such as designers, equipment manufacturers and consultants) are involved in the equipment qualification process, Bruce Power has the ultimate responsibility for the development and implementation of an adequate plant specific equipment qualification program. The following aspects of implementation of the program were assessed:

1. If qualification of plant equipment important to safety has been formalized using a process that includes generating, documenting and retaining evidence that equipment can perform its safety functions during its installed service life;

   Assessment:

   A formalized process is in place for equipment requiring environmental and seismic qualification, as described in the procedures BP-PROC-00261 Environmental Qualification [37], and DPT-PDE-00017 Bruce Power Seismic Qualification Standard [63], which are given authority through BP-PROC-00335 and BP-PROG-10.01. For other aspects of equipment qualification, a robust process is in place through BP-PROG-11.01 Equipment Reliability [42] to identify and categorize that equipment, and to monitor and maintain it appropriately for the life of the plant. This process is described in more detail in Sections 4 and 5.1 of this report.

   It is concluded that this requirement is satisfied.

2. Confirm if this is an ongoing process, from its design through to the end of its service life;

   Assessment:

   This is an ongoing process, as clearly stated in the programs and procedures that manage equipment qualification as described in Section 4 of this report:

   - BP-PROG-10.01, Plant Design Basis Management, states its purpose to be “to ensure that the plant can operate safely for the full duration of its design life” and calls up BP-PROC-00335 Design Management as an implementing procedure, which in turn calls up BP-PROC-00261 and DPT-PDE-00017. It also calls up the standard CSA N290.13-05 in Section 5.1 as one of the Relevant Statutory Regulatory and Licensing Requirements.
   - BP-PROG-10.02, Engineering Change Control, states its purpose to be “to ensure that design changes and modifications are controlled such that System, Structure, and Component and Significant Tools (SSCTs) continue to meet the design basis and operate safely for the full duration of design life” and calls up various procedures to implement this purpose. This ensures that the equipment qualification requirements are maintained from the original design and installation to the end of the design life of the equipment.
   - BP-PROG-11.01, Equipment Reliability, states (in section 4.0) that its overall objective is “to ensure that all Systems Important to Safety (SIS) shall meet their defined design and performance criteria at defined levels of reliability throughout the life of the NPP” and calls up several implementing procedures (such as BP-PROC-00781 “Performance Monitoring” and BP-PROC-00400 “Life cycle Management for Critical SSCs”. This ensures that the equipment qualification requirements are maintained from the original design and installation to the end of the design life of the equipment.
   - BP-PROG-11.04, Plant Maintenance, states that “the Bruce Power Plant Maintenance program is intended to support the safe and effective achievement of production goals and requirements, both long term and short term, through an effective maintenance strategy’ and calls up implementing procedures and interfacing programs that support

this objective. This ensures that the equipment qualification requirements are maintained from the original design and installation to the end of the design life of the equipment.

The above programs and procedures clearly indicate that equipment qualification is an ongoing process that will be sustained throughout the life of the plant. It is concluded that this requirement is satisfied.

3. Assess if the process takes into account plant and equipment ageing and modifications, equipment repairs and refurbishment, equipment failures and replacements, any abnormal operating conditions and changes to the safety analysis.

   Assessment:

   The process takes this into account, as stated in the procedures described in Section 4 and assessed in Section 5.1 of this report, and through the ageing management process discussed in Section 4.1.1 of the Safety Factor 4 report. Equipment repairs and refurbishment are controlled through the maintenance procedure (BP-PROC-00695 [71]). The Safety Factor 5 report addresses the processes that are followed for changes to the safety analysis.

   It is concluded that this requirement is satisfied.

5.3. Review of Equipment Qualification

The review of equipment qualification considered:

1. Whether installed equipment meets the qualification requirements;

   Assessment:

   Procedures are in place to ensure that installations are done correctly, and these activities are performed under an overall quality assurance (QA) program. For EQ, these are BP-PROC-00261, which includes a requirement in Section 4.3 to verify that installed equipment meets the EQ design and configuration requirements established in the EQ Dossiers, SEC-EQD-00015 [49], which provides technical guidance to ensure that installations meet EQ requirements, and SEC-EQD-00033 [56], which provides requirements for walkdowns and document reviews to ensure that EQ equipment is installed correctly and verified. For seismically qualified components this is addressed through the normal work processes after being identified as being qualified in the Safe Shutdown Equipment List, in Passport, and in Online Wiring. There is an ongoing activity to upgrade certain equipment as a result of the Unit 1 and 2 SMA, which is scheduled to be completed in 2016 [83].

   It is concluded that this requirement is satisfied.

2. The adequacy of the records of equipment qualification;

   Assessment:

   Equipment qualification records are comprehensive and prepared according to procedures and are maintained for the life of the plant (SEC-EQD-00031 Preparation of Environmental Qualification Dossiers [54], SEC-EQD-00032 Environmental Qualification Evaluations

(EQE) [55], and DPT-PDE-00017 Bruce Power Seismic Qualification Standard [63]). The audit reports and self assessments summarized in Section 7 of this report have confirmed the adequacy of these procedures, and a considerable number of improvements have been made in response to the earlier audits. It is noted that many of the procedures have been prepared or revised recently, and have incorporated the recommended changes arising from the audits and self assessments.

It is concluded that this requirement is satisfied.

3. Procedures for updating and maintaining qualification throughout the service life of the equipment;

   Assessment:

   Procedures are in place to update and maintain the qualification of SSCs for the service life of the equipment, and most have been recently revised, including SEC-EQD-00007 Environmental Assessment and Dossier Revisions [46], SEC-EQD-00032 Environmental Qualification Evaluations (EQE) [55] and DPT-PDE-00017 Bruce Power Seismic Qualification Standard [63].

   It is concluded that this requirement is satisfied.

4. Procedures for ensuring that modifications and additions to SSCs important to safety do not compromise their qualification;

   Assessment:

   The programs and procedures that ensure that modifications and additions to SSCs do not compromise their qualification include those addressed by BP-PROG-11.04 “Plant Maintenance, BP-PROG-10.02 Engineering Change Control, SEC-EQD-00032 Environmental Qualification Evaluations (EQE) [55], SEC-EQD-00015, Environmental Qualification Installation Standards [49], and DPT-PDE-00017 Bruce Power Seismic Qualification Standard [63]

   It is concluded that this requirement is satisfied.

5. Surveillance programs and feedback procedures used to ensure that ageing degradation of qualified equipment remains insignificant;

   Assessment:

   Comprehensive surveillance programs and feedback procedures are in place to ensure that ageing degradation of qualified equipment is understood and does not adversely impact performance, which are:

   - SEC-EQD-00013 Environment Monitoring for EQ [48]: This procedure implements the Environmental Qualification environment monitoring program, with the objective of validating the temperature and radiation exposure data included in the Room Condition Manual (RCM), determining local hot spots, and justifying the extension or limitation of qualified life based on this data.
   - SEC-EQD-00030 EQ Equipment Condition Monitoring [53]: This procedure describes the EQ condition monitoring requirements for Bruce A, including the identification of

equipment to be monitored, the review of the implementation of monitoring, and the assessment of the results of monitoring.

- SEC-EQD-00035 Environmental Qualification Sustainability Monitoring [58]: This procedure ensures that maintenance performed on equipment does not adversely affect its qualification, by ensuring that only EQ approved equipment is used and that the work is properly documented.
- SEC-EQD-00049 Environmental Qualification Health Reporting [60]: This procedure provides the requirements for the EQ Program Health Report, which is produced on a semi-annual basis and includes a performance rating system, identifies performance indicators, and identifies future performance objectives.
- BP-PROC-00400 Life Cycle Management of Critical SSCs [70]: This procedure provides the process for the preparation of Life Cycle Management Plans, which includes identification of the age related degradation mechanism, the current condition, and options for repair or replacement in the future, where the costs exceed $10M.
- BP-PROC-00698 Structures, Systems, or Components (SSC) Monitoring [78]: This procedure is related to plant maintenance (i.e. BP-PROG-11.04), and sets the baselines for the measurement and monitoring of the function of structures, systems, and components.
- BP-PROC-00781 Performance Monitoring [72]: This procedure implements the monitoring requirements supporting the Equipment Reliability Program (BP-PROG-11.01) for important structures, systems, critical components, and programs. It is in turn implemented by the following four procedures, amongst others:
    - DPT-PE-00008 System and Component Performance Monitoring Plans [73]
    - DPT-PE-00009, System and Component Performance Monitoring Walkdowns [74]
    - DPT-PE-00010, System Health Reporting [75]
    - DPT-PE-00011, Component Program Health Reporting [76]

It is concluded that the requirement for comprehensive surveillance and feedback procedures is satisfied.

6. Monitoring of actual environmental conditions and identification of ‘hot spots’ of high activity or temperature; and

Assessment:

Actual environmental conditions and identification of “hot spots” of high activity or temperature is done on a selective basis through procedure SEC-EQD-00030 EQ Equipment Condition Monitoring Procedure [53]. This procedure states that where an EQ Dossier “indicates that some specific monitoring activities are necessary, i.e. they are EQ critical and they are credited in the assessment of qualified life”, they must be part of the Performance and Condition Monitoring Activities. The EQ specialist helps to identify the EQ requirements that need to be included in the Performance Monitoring Plans.

It is concluded that this requirement is satisfied.

7. Protection of qualified equipment from adverse environmental conditions.

Assessment:

Qualified equipment is protected from adverse environmental conditions where possible and practical. For example, a substantial amount of equipment is located outside of containment to protect it from radiation during normal plant operation and from adverse environment during accident conditions. In other cases, shielding is provided to reduce the radiation environment for qualified equipment. For the relevant design basis accidents (e.g., steam line breaks) certain identified walls have a function to protect equipment from the harsh steam environment, as required by the procedure DPT-PDE-00019, Steam Protection Barriers [62]. These barriers are subject to certain operating and monitoring requirements, as outlined in the procedure.

It is concluded that this requirement is satisfied.

6. Interfaces with Other Safety Factors

There is some degree of interrelationship among most of the 15 Safety Factors that comprise the Bruce A ISR. The following identifies specific aspects of this Safety Factor that are addressed in, or where more detail is provided in, another Safety Factor Report.

- "Safety Factor 1: Plant Design" in Appendix B.2, addresses several issues related to equipment qualification including maintenance of Equipment Qualification through the Plant Design Basis and Plant Design Basis Management programs and procedures. In Appendix B.1 of "Safety Factor 1" the issue is that the plant design processes can impact equipment qualification for conditions that occur during normal plant operation (e.g. vibration, electromagnetic interference, etc) or the qualification of environmentally qualified or seismically qualified equipment.
- "Safety Factor 2: Actual Conditions of SSCs" in Section 5.7, reviews the documented results of tests which demonstrate functional capability of SSCs to withstand environmental conditions during normal operations.
- "Safety Factor 4: Ageing" in Section 5.8 addresses the review of the ageing management methodology. As well in Section 5.4, the evaluation and documentation of potential ageing degradation that may affect safety functions of SSCs important to safety
- "Safety Factor 5: Deterministic Safety Analysis" in Section 5.2, addresses changes to the safety analysis, for various postulated initiating events leading to predicted accident conditions and associated environmental conditions.
- "Safety Factor 6: Probabilistic Safety Analysis" in Section 5.0 addresses the adequacy of the existing probabilistic risk assessment (PRA) including At Power Seismic PRA.
- "Safety Factor 7: Hazard Analysis" in Sections 5.1 and Section 5.2, respectively, assesses the external and internal hazards that may affect the plant which leads to predicted accident conditions and associated environmental conditions.

7. Program Assessments and Adequacy of Implementation

Section 7 supplements the assessments of the review tasks in Section 5, by providing information on four broad methods used to identify the effectiveness with which programs are implemented, as follows:

- Self-Assessments;
- Internal and External Audits and Reviews;
- Regulatory Evaluations; and
- Performance Indicators.

For the first three methods, the most pertinent self-assessments, audits and regulatory evaluations are assessed. Bruce Power has a comprehensive process of reviewing compliance with Bruce Power processes, identifying gaps, committing to corrective actions, and following up to confirm completion and effectiveness of these actions. While there have been instances of non-compliance with Bruce Power processes, Bruce Power's commitment to continuous improvement is intended to correct any deficiencies.

For the fourth method, the performance indicators relevant to this Safety Factor are provided. These are intended to demonstrate that there is a metric by which Bruce Power assesses the effectiveness of the programs relevant to this Safety Factor.

Taken as a whole, these methods provide a cross section, intended to demonstrate that the processes associated with this Safety Factor are implemented effectively (individual findings notwithstanding). Thus, program effectiveness can be inferred if Bruce Power processes meet the Safety Factor requirements and if there are ongoing processes to ensure compliance with Bruce Power processes. This is the intent of Section 7.

7.1. Self-Assessments

Generally, self-assessments are used by functional areas to assess the adequacy and effective implementation of their programs. The results of the assessment are compared with business needs, the Bruce Power management system, industry standards of excellence and regulatory/statutory or other legal requirements.

The self-assessments:

- Identify internal strengths and best practices;
- Identify performance and/or programmatic gap(s) as compared to targets, governance standards and "best in class";
- Identify gaps in knowledge/skills of staff;
- Identify the extent of adherence to established processes and whether the desired level quality is being achieved;

- Identify adverse conditions and Opportunities for Improvements (OFI); and
- Identify the specific improvement corrective actions to close the performance/programmatic gap.

7.1.1. SA-COM-2014-07 EQ Program Health [84]

This Focused Area Self-Assessment (FASA) reviewed maintenance procedures for compliance with EQ requirements found in EQ documents and for opportunities for enhancement of field verifiable attributes, in response to operating experience reports from Ontario Power Generation (OPG) and CANDU Owners Group (COG) that indicated an opportunity to improve awareness of EQ sustainability requirements within the plant. The plan was to enhance the maintenance procedures so EQ critical steps are reviewed by maintenance personnel during post maintenance activities, to satisfy the objective of periodic validation of installed components.

The FASA identified one gap where a lubricant was missing EQ symbols and instruction, although it was confirmed that the correct lubricant was used and the lube list was correct. The FASA identified opportunities to update maintenance procedures for specific equipment to identify and document additional field verification “As Left” checks.

The SCRs raised to implement the recommendations of this self-assessment were: 28473065, 28473069.

7.1.2. SA-COM-2013-07 EQ Program: Procedure Compliance and Effectiveness [85]

This Focused Area Self-Assessment (FASA) evaluated the compliance with the requirement in BP-PROC-00261 and BP-PROC-00781 to sustain EQ It found good procedural guidance in Plant Engineering procedures, and the inclusion of EQ requirements in DPT-PE-00008 System and Component Performance Monitoring Plan [73]. Four adverse conditions were identified, for which three SCRs were raised:

- System walkdown procedures do not include EQ field verifiable attributes
- There were no systematic walkdown or monitoring of EQ components for the Bruce B Active Drainage System, even though it includes safety related components that have post-accident functional requirements.
- Staff EQ qualification training had expired.
- Station performance monitoring plans had Passed their revision due dates.

An opportunity for improvement was identified, to assist in the development of the COG EQ Field Book, for which an Action Request was raised.

The SCRs raised to implement the recommendations of this self-assessment were: 28403801, 28403832 and 28403839. Station Condition Record (SCR) 28403845 was raised to implement the opportunity for improvement identified to produce an EQ field guide book.

7.1.3. SA-COM-2012-02 EQ Program – Procedure Compliance and Effectiveness [86]

This FASA determined the level of compliance with the requirements of SEC-EQD-00032 Environmental Qualification Evaluations (EQE) [55]. Eleven EQE reports were reviewed for administrative compliance with the procedure (i.e. not for technical content). This FASA concluded that there was general compliance with the procedure, although a number of minor document preparation issues were identified, and three SCRs were raised:

- Interactions between the EQEs and Engineering Change Control were not clearly defined (i.e. EQ components of “equivalent design” type do not clearly require EQ related attributes in PassPort)
- The EQE production checklist is not a controlled document.

Among six identified opportunities for improvement, two were notable for the purposes of this assessment document:

- SEC-EQD-00032 requires several clarifications or corrections.
- Provide a mechanism for oversight of qualified life extensions that reduce the EQ safety margin (i.e. proactively track EQEs where qualified life is extended by reducing one or more of the EQ Safety Factors).

The SCRs raised to implement the recommendations of this self-assessment were: 28319644, 28319648, and 28319661.

7.1.4. SA-COM-2010-02 EQ Program Sustainability [87]

This FASA assessed the compliance and effectiveness of Uniquely Tracked Commodities (UTC) as a key element of EQ Program sustainability. In N290.13-05, maintenance performed on qualified equipment and parts used in the maintenance process are required to be documented and traceable, so a properly completed installation history is required to demonstrate that the station remains EQ qualified after maintenance. Despite several SCRs on the subject since 2005, several non-compliances have been observed in UTC installation history updates in PassPort. The following corrective actions were identified for which one SCR was raised:

- Perform a training needs analysis to ensure maintenance personnel are familiar with the UTC installation process
- Modify maintenance organization metrics to include percentage Work Orders closed with proper UTC fitted into the installation history.

The SCR raised to implement the recommendations of this self-assessment was: 28223262.

7.1.5. SA-PDE-2009-03 EQ Barrier Project – Baseline Complete and Sustained [88]

This FASA assessed the EQ requirements for the Steam Barrier Program to confirm that they are clearly defined and adequately documented, that closeouts for required modifications are complete, and that steam protection requirements are being sustained and satisfied. The assessment found that all field modifications for steam protection barriers were complete, that the main supporting documentation (e.g. procedure DPT-PDE-00019 and supporting GOTHIC analysis models) was complete, and that steam protected room leak tests were complete.

However a number of tasks were not yet completed, and the SCRs raised for these issues were 28184246, 2814247, and 28184276.

7.1.6. SA-PDE-2010-01 Seismic Qualification Procedure Effectiveness and Adherence [89]

This FASA performed an assessment of the application of the seismic procedure DPT-PDE-00017 at Bruce A. It reviewed a number of design change work packages and seismic assessments to determine if the work is meeting the seismic qualification requirements of the procedure and associated procedures. The procedures were found to adequately address the requirements to preserve seismic qualification, but some discrepancy was found in the Engineering Change Control (ECC) process that did not make the review of modifications by Seismic Capability Engineers compulsory, and a lack of complete understanding of the document completion process. Recommendations were made to address these issues through review of the ECC process in PassPort and and for refresher training in the seismic aspects of the ECC process for staff in Plant Design Engineering.

The SCR raised to implement the recommendations of this self-assessment was: 28211050.

7.2. Internal and External Audits and Reviews

The objective of the audit process as stated in BP-PROG-15.01 [90] is threefold:

- To assess the Management System and to determine if it is adequately established, implemented, and controlled;
- To confirm the effectiveness of the Management System in achieving the expected results and that risks are identified and managed; and
- To identify substandard conditions and enhancement opportunities.

The objective is achieved by providing a prescribed method for evaluating established requirements against plant documentation, field conditions and work practices. The process describes the activities associated with audit planning, conducting, reporting, and closing-out. The results of the independent assessments are documented and reported to the level of management having sufficient breadth of responsibility for resolving any identified problems (as stated in Section 5.14.2 of [19]).

7.2.1. Internal Audits and Reviews

Two comprehensive audits were performed by the Bruce Power Audit Department in recent years, with the most recent assessing the sustainability of the EQ Program and its effectiveness within the management system, and the earlier one assessing the work done in the restart phase to confirm that components were properly qualified. An earlier audit was performed in 2008, which addressed issues during early stages of the EQ project phase (Part of the Unit 1 and 2 restart work), which is not relevant to the current plant governance, and is only included here for completeness.

7.2.1.1. AU-2011-00016 EQ Process Audit [91]

This audit was done to assess the completeness, implementation, and compliance to BP-PROC-00261 Environmental Qualification and its effectiveness, and to verify EQ process integration within the Bruce Power Management System (BPMS). The scope included a review of a selection of systems and equipment in Bruce A and Bruce B, a review of preventive maintenance and outage scope deferrals with respect to EQ, a walkdown of selected systems, and a review of EQ Process interfaces and overall integration within the management system.

During the review of the procedures used for EQ, the audit identified a number of problems, such as inadequate identification of interfacing procedures, inadequate referencing of EQ requirements in other procedures (e.g. BP-PROC-00400), etc. The audit did conclude that the EQ Process is supported by quality work being done by knowledgeable staff, but that EQ sustainability is heavily dependent upon the knowledge and capabilities of the staff. It noted that “effective establishment of documented processes and strict adherence to procedures and other instructions by all interfacing organizations is critical to the overall success of EQ sustainability”.

An identified strength was “the rigorous monitoring performed on all EQ related Work Orders and the Focus Area Self Assessments”.

This audit did not identify the SCRs raised to track the implementation of the recommendations, a process that was adopted in later audits. However, an examination of the current procedures indicates that interfacing procedures are well documented and that the processes to sustain the qualifications are well documented.

7.2.1.2. AU-2009-00019 Units 1 and 2 Restart – Environmental Qualification Program [92]

This audit evaluated how effectively the EQ requirements had been established and managed for the Bruce A Unit 1 and 2 Restart to ensure that the required components are environmentally qualified and sustained at this status. The auditors found that the EQ Program, processes, and procedures were generally compliant with CSA N290.13-05, with minor gaps and a number of suggested improvements to the procedures used during the restart phase. A number of EQ Dossiers were reviewed, and were found to be evaluated and documented adequately in accordance with SEC-PROC-00031[54]. A walkdown was performed and it was

observed that good practices were used for equipment identification and the work packages were detailed and provided the necessary information to support the work. It was noted that a lot of the EQ work was in progress and not yet completed. It was concluded that "if compliance to the prescribed requirements continues to occur throughout all phases of EQ, there is a reasonable degree of assurance that EQ related equipment and components will satisfy CSA N290.13-05…"

This audit did not identify the SCRs raised to track the implementation of the recommendations, a process that was adopted in later audits. However, more recent audits and self assessments indicate that the qualification procedures are fully compliant with the requirements.

7.2.1.3. AU-2008-00029 Units 1 and 2 Restart Environmental Qualification Program [93]

This audit evaluated how effectively the Units 1 and 2 Restart Environmental Qualification requirements had been established and managed. The audit noted that a significant effort had been expended to eliminate the EQ Dossier backlog and the development of recovery plans and that the staff could articulate a general awareness and appreciation of EQ. However, several issues were noted, including the adequacy of the project execution plan, the approval of procedures, inadequate scheduling, oversight committee effectiveness, performance of self-assessment audits, and training standards. This audit was applicable to the EQ project that was subject to the project procedures and governance at that time, and is not relevant to the current procedures and governance.

7.2.2. External Audits and Reviews

No external audits and reviews were found beyond the assessment reports referenced elsewhere in this report.

7.3. Regulatory Evaluations and Reviews

After a licence is issued, the CNSC stringently evaluates compliance by the licensee on a regular basis. In addition to having a team of onsite inspectors, CNSC staff with specific technical expertise regularly visit plants to verify that operators are meeting the regulatory requirements and licence conditions. Compliance activities include inspections and other oversight functions that verify a licensee's activities are properly conducted, including planned Type I inspections (detailed audits), Type II inspections (routine inspections), assessments of information submitted by the licensee to demonstrate compliance, and other unplanned inspections in response to special circumstances or events.

Type I inspections are systematic, planned and documented processes to determine whether a licensee program, process or practice complies with regulatory requirements. Type II inspections are planned and documented activities to verify the results of licensee processes and not the processes themselves. They are typically routine inspections of specified

equipment, facility material systems or of discrete records, products or outputs from licensee processes.

The CNSC carefully reviews any items of non-compliance and follows up to ensure all items are quickly corrected.

7.3.1. CNSC Compliance Inspection Report BRPD-R-2012-038 – Environmental Qualification of Bruce A Units 1 and 2 [94]

The CNSC staff conducted an Environmental Qualification (EQ) inspection at Bruce A for Units 1 and 2 to verify that EQ improvements were implemented during Bruce Power refurbishment process and will be sustained in accordance with the relevant licence condition and CSA standard N290.13-05. As a result of the inspection:

"CNSC staff is convinced that Bruce Power has a strong EQ program in place and has implemented improvements to the EQ program according to the licence condition and the CSA standard."

7.3.2. CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013

The CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013 [95] states the following:

"Based on the information assessed, CNSC staff concluded that the physical design SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. The environmental qualification (EQ) program is fully implemented at all Bruce A and B operating units. Bruce Power demonstrated EQ compliance with the related governing document by maintaining adequate EQ program sustainability."

7.3.3. CNSC Field Inspection Reports

A number of quarterly CNSC Field Surveillance Reports were reviewed, with several indicating inspection of environmental qualification or seismic qualification aspects, with no problems noted. The two listed below are typical of these reports:

- NK21-CORR-00531-10731, Field Surveillance Reports April 8, 2013 through July 24, 2013 [96]; and
- NK21-CORR-00531-11551, Field Inspection Report for Q1 of 2014-15 [97].

7.4. Performance Indicators

Performance indicators are defined as data that are sensitive to and/or signals changes in the performance of systems, components, or programs.

Performance indicators reported in the semi-annual EQ Program Health Report, which is produced in accordance with SEC-EQD-00049 [60], include:

EQ Program Compliance

- Regulatory Reportable Events
- Significant Technical Issues

EQ Program Documentation

- EQE Index
- EQ Document Production Index

EQ Program Effectiveness

- Benchmarks/Self-Assessments
- Bruce A EQ Sustainability Index
- Open Action Tracking Items

EQ Program Staffing and Resources

- Primary and Backup EQ Engineer
- Resources
- Training

In addition to the performance indicators monitored by Bruce Power, the CNSC produces an annual report on the safety performance of Canada's NPPs. The report for 2013, CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013, issued in September 2014 [95], summarizes the 2013 ratings for Canada's NPPs in each of the 14 CNSC Safety and Control Areas (SCA), including physical design which encompasses equipment qualification. The equipment qualification rating is based on the performance of the NPP's EQ program. CNSC staff rated Bruce A as "satisfactory" in this area.

8. Summary and Conclusions

The overall objective of the Bruce A ISR is to conduct a review of Bruce A against modern codes and standards and international safety expectations and provide input to a practicable set of improvements to be conducted during the Major Component Replacement in Units 3 and 4, and during asset management activities to support ongoing operation of all four units, that will enhance safety to support long term operation. The specific objective of the review of this Safety Factor is to determine whether equipment important to safety is qualified (including for environmental conditions) and whether this qualification is being maintained through an adequate program of maintenance, inspection and testing that provides confidence in the delivery of safety functions. The conclusions reached during the assessment of each review task show that that this specific objective has been satisfied.

This Safety Factor Assessment included a high level review of the most recent standards applicable to equipment qualification, including CSA N290.13-05, CSA N289 series, and RD/GD-210, and a programmatic review of the main Bruce A programs and procedures that implement and sustain the equipment qualification requirements for the remaining life of the plant (i.e., BP-PROG-10.01, BP-PROG-10.02, BP-PROG-11.01, BP-PROG-11.04, BP-PROC-00335, BP-PROC-00261, and DPT-PDE-00017).

It is noted that Bruce Power has recently sent a request to the CNSC [98] to use the most recent CSA N289 standards and the Design Basis Earthquake (DBE) defined for Bruce B for new systems and modifications to existing systems, but no determination has yet been made by CNSC. If approved, it is expected that the DBE for Bruce B will be used for new systems and major modifications for Bruce A, and that any interfaces between the different methodologies will be handled in an acceptable manner.

In Section 7, the review also examined Audit Reports and self-assessment reports from Bruce Power that showed a robust process in place to identify problem areas and to identify actions to resolve them. The recent CNSC reviews of equipment qualification have found not problems. The review of the reports in Section 7 shows that the current equipment qualification process is effective.

One strength was identified during this review, as follows:

- The quality of the programmatic documents (i.e., programs and procedures) for the equipment qualification process was very good, with interfaces with other station procedures well identified, recent revisions and updating for most procedures, and incorporation of issues identified in audits and self-assessments.

No gaps were identified as a result of this review. The gaps identified in previous reviews [99] against CSA N289.1 [26] and CSA N290.13 [22] as an ‘Acceptable Deviation’ (see Appendix A, Sections A.2.1 and A.4) are now considered to be closed, based on the updated program procedures, and the inclusion of the SMA methodology in CSA N289.1-08 as an acceptable qualification methodology.

Based on this review, it is concluded that Bruce A complies with the requirements of the most recent codes and standards for environmental qualification and seismic qualification, and that the current equipment qualification process can be sustained for the life of the plant.

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[66] NK21-CALC-20091-00002-R06, Success Path and Equipment List, Bruce Power, November 2012

[67] NK21-DG-20091-002-R001, Bruce A Seismic Design Guide Units 034, Bruce Power, February 2004.

[68] BP-PROC-00500-R001, Control of Unsecured Equipment in Seismically Qualified Areas, Bruce Power, December 10, 2008.

[69] BP-PROC-00244-R004, Procurement Engineering, Bruce Power, December 9, 2010.

[70] BP-PROC-00400-R002, Life Cycle Management of Critical SSCs, Bruce Power, July 5, 2013.

[71] BP-PROC-00695-R003, Maintenance Program and Activities, Bruce Power, June 27, 2014.

[72] BP-PROC-00781-R002, Performance Monitoring, Bruce Power, September 22, 2012.

[73] DPT-PE-00008-R005, System and Component Performance Monitoring Plans, Bruce Power, August 21, 2013.

[74] DPT-PE-00009-R001, System and Component Performance Monitoring Walkdowns, Bruce Power, December 18, 2014.

[75] DPT-PE-00010-R006, System Health Reporting, Bruce Power, August 27, 2013.

[76] DPT-PE-00011-R003, Component Health Reporting, Bruce Power, August 23, 2013.

[77] SEC-PE-00001-R012, Item Equivalency Evaluation, Bruce Power, August 21, 2013.

[78] BP-PROC-00698-R001, Structures, Systems, or Components (SSC) Monitoring, Bruce Power, September 1, 2009.

[79] NK21-DG-20091-001-R01, Seismic Structural Design Guide, Bruce Power, February 2, 2005.

[80] NK21-CALC-20091-00001, Review Level Earthquake, Bruce Power, November 28, 2001.

[81] B-SPEC-01370-00001-R002, Seismic Qualification of Mechanical Equipment, Bruce Power, November 25, 2013.

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[87] SA-COM-2010-02, Self Assessment: EQ Program Sustainability, Bruce Power, October 29, 2010.

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[90] BP-PROG-15.01-R004, Nuclear Oversight Management, Bruce Power, December 18, 2013.

[91] AU-2011-00016, Audit Report: EQ Process Audit, Bruce Power, August 2011.

[92] AU-2009-00019, Audit Report: Units 1 and 2 Restart – Environmental Qualification Program, Bruce Power, April 2009.

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[94] NK21-CORR-00531-10094, Bruce A CNSC Compliance Inspection Report BRPD-R-2012-038 – Environmental Qualification of Bruce A Units 1 and 2, Canadian Nuclear Safety Commission, December 2012.

[95] CC171-11-2013-CNSC, CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013, Canadian Nuclear Safety Commission, September 2014.

[96] NK21-CORR-00531-10731, Bruce A and B Quarterly Field Inspection Report for Q1 BRPD-AB-2013-010 - Action Item 1307-4270, (Attachment 1 – Bruce A only), September 3, 2013.

[97] NK21-CORR-00531-11551, Field Inspection Report for Q1 of 2014-15, CNSC Letter, K. Lafrenière to F. Saunders, August 20, 2014.

[98] NK21-CORR-00531-11473, Bruce A Seismic Qualification Standards and Design Basis Earthquake, CNSC Letter, F. Saunders to K. Lafrenière, September 2, 2014.

[99] CPUS 0120-N290.13, Evaluation of the Environmental Qualification Program for Bruce A Units 1 and 2 Against CAN/CSA N290.13-05, April 2008, attachment 1 of NK21-CORR-00531-05735.

[100] NK21-CORR-00531-05973, Bruce A Unit 1 and 2 Return to Service Use of CSA N289 Series, Bruce Power Letter, F. Saunders to P. Elder, June 12, 2008.

[101] NK21-CORR-00531-05840, Bruce A Unit 1 and 2 Return to Service; Modifications to the Instrument Air Supply to the Liquid Injection Shutdown System Isolation Valves, CNSC Letter, P. Elder to F. Saunders, March 17, 2008.

[102] NK21-REP-03600-0012-R00, Bruce NGS A 1 and 2 Return to Service Review Against Design Standards, Bruce Power, July 31, 2006, enclosure 1 to NK21-CORR-00531-04340.

[103] NK21-CORR-00531-04340, Bruce A Units 1 and 2 Return to Service – Review Against Design Standards, Bruce Power Letter, F. Saunders to P. Webster, July 31, 2006.

[104] NK21-CORR-00531-01414, Addendum to Attachment A to Submission #3 (May 15, 2002) in Support of Bruce A Return to Service ("Report 240069-R-001 Rev.1, Bruce NGS A Seismic Margin Assessment, ABS Consulting, October 2002"), Bruce Power Letter, F. Saunders to J. Douglas, January 20, 2003.

[105] EPRI/SQUG Implementation Guidelines for Seismic Qualification of new and Replacement Equipment/Parts Using the Generic Implementation Procedure (GIP), Rev. 5, October 2002.

[106] EPRI NP-7484 Guideline for the Seismic Technical Evaluation of Replacement Items for Nuclear Power Plants, February 1993.

[107] NK21-CORR-00531-05735, Bruce A Units 1 and 2 Return to Service Integrated Safety Review, Bruce Power Letter, F. Saunders to P. Elder, April 30, 2008.

Appendix A – High-Level Assessments Against Relevant Codes and Standards

A.1. Overall Review of Programs and Procedures Against Applicable Standards

A.1.1. Introduction

As summarized in Section 4 of this report, the Bruce A Equipment Qualification process is included in the Plant Design Basis Program (BP-PROG-10.01) [39] and is implemented in the Design Management procedure (BP-PROC-00335) [40]. This program "ensures that the plant design meets safety reliability and regulatory requirements…" [39] and lists CSA N290.13-05 in section 5.1 "Relevant Statutory Regulatory and Licensing Requirements", since this standard is listed in the plant licence. The Plant Design Basis Program interfaces with other programs which have a role in Equipment Qualification, including BP-PROG-10.02 Change Control [41] and BP-PROG-11.01 Equipment Reliability [42]. These programs address the procurement of replacement or new qualified equipment and the monitoring of qualified equipment to preserve the qualification for the life of the station.

The Design Management procedure contains the following clauses to implement the Seismic and Environmental Qualification processes through the use of primary implementing procedures:

> "4.10.1 Seismic Qualification
>
> The implementing procedures necessary to sustain the plants Seismic Qualification status will be governed within the Design Management program. This will establish proof of performance during and after an earthquake and maintain that proof current with the licensing basis, design basis, and operating condition. It will provide assurance that applicable systems, structures and components are designed, purchased, installed and maintained in a manner that preserves their qualified status. Primary implementing procedure is DPT-PDE-00017, Bruce Power Seismic Qualification Standard.
>
> 4.10.2 Environmental Qualification
>
> The implementing procedures necessary to sustain the plants Environmental Qualification status will be governed within the Design Management program. This will establish proof of performance under design basis accident conditions, and maintain that proof current with the plant licensing basis, design basis, service conditions and operating configuration. In addition, it will provide assurance that applicable items are purchased, stored, installed, configured, maintained and replaced in a manner that preserves their qualified status. Primary implementing procedure is BP-PROC-00261, Environmental Qualification."

As described in Section 4 of this report, the above procedures do not address equipment qualification for other environmental conditions that occur during normal operation, which are

addressed by the plant programs and procedures listed in Section 4 (and other implementing and interfacing procedures included in them). Also see the assessment discussion in Section 5.1 of this report for additional detail on this aspect of equipment qualification. The Design Management procedure (BP-PROC-00335) also includes a number of other processes which interface with the Equipment Qualification process, such as BP-PROC-00244 Procurement Engineering, which are identified in each procedure.

The Environmental Qualification and Seismic Qualification processes are implemented by a number of lower tier procedures that are listed in Table 5, with their purpose summarized in Section 4.

A high-level programmatic review of the programs and procedures against applicable standards is provided in Table A1.

Table A1: High-Level Programmatic Review of Programs and Procedures Against Applicable Standards

Bruce Power Programmatic Document	Relevant Regulatory Document Satisfied / Considered	Latest Applicable Regulatory Document or Standard
BP-PROC-00335 Design Management	Satisfies: CSA N290.13-05 clause 8	CSA N290.13-05
Environmental Qualification		
BP-PROC-00261 Environmental Qualification	Satisfies: CSA N290.13-05 all clauses	CSA N290.13-05
SEC-EQD-00007 Environmental Qualification Assessment and Dossier Revisions	Satisfies: CSA N290.13-05 clause 4.5, 4.7, 5.1,	CSA N290.13-05
SEC-EQD-00012 Start of Qualified Life	Satisfies: CSA N290.13-05 clause 4.7(c)	CSA N290.13-05
SEC-EQD-00013 Environment Monitoring for EQ	Satisfies: CSA N290.13-05 clause 4.7(c)	CSA N290.13-05
SEC-EQD-00015 Environmental Qualification Installation Standards	Satisfies: CSA N290.13-05 clause 4.7(b), 6.2	CSA N290.13-05
SEC-EQD-00017 EQ and Lubricants	Satisfies: CSA N290.13-05 clause 5.1	CSA N290.13-05
SEC-EQD-00021 Environmental Qualification Assessments	Satisfies: CSA N290.13-05 clauses 4.5, 4.7, 5.1	CSA N290.13-05

Bruce Power Programmatic Document	Relevant Regulatory Document Satisfied / Considered	Latest Applicable Regulatory Document or Standard
SEC-EQD-00022 Development of Environmental Qualification Lists	Satisfies: CSA N290.13-05 clauses 4.1, 4.6,	CSA N290.13-05
SEC-EQD-00030 EQ Equipment Monitoring Procedure	Satisfies: CSA N290.13-05 clause 6.7	CSA N290.13-05
SEC-EQD-00031 Preparation of Environmental Qualification Dossiers	Satisfies: CSA N290.13-05 clauses 4.5, 4.7,	CSA N290.13-05
SEC-EQD-00032 Environmental Qualification Evaluations (EQE)	Satisfies: CSA N290.13-05 clause 6.1,	CSA N290.13-05
SEC-EQD-00033 EQ Walkdown and Verification Process	Satisfies: CSA N290.13-05 clause 6.2,	CSA N290.13-05
SEC-EQD-00034 Environmental Qualification Status Index	Satisfies: CSA N290.13-05 clause 6.3	CSA N290.13-05
SEC-EQD-00035 Environmental Qualification Sustainability Monitoring	Satisfies: CSA N290.13-05 clause 6.2, 6.7	CSA N290.13-05
SEC-EQD-00040 Cable Qualification Strategy	Satisfies: CSA N290.13-05 clause 5.3, 5.4	CSA N290.13-05
SEC-EQD-00049 Environmental Qualification Health Reporting	Satisfies: CSA N290.13-05 clause 6.1, 6.3	CSA N290.13-05
SEC-RSA-00001 Preparation of the EQ Room Conditions Manual	Satisfies: CSA N290.13-05 clause 4.4.2, 4.4.3,	CSA N290.13-05
DPT-PDE-00019 Steam Protection Barriers	Satisfies: CSA N290.13-05 clause 7	CSA N290.13-05
Seismic Qualification		
DPT-PDE-00017 Bruce Power Seismic Qualification Standard	Satisfies: CSA N289.1-08 all clauses	CSA N289.1-08
BP-PROC-00500 Control of Unsecured Equipment in Seismically Qualified Areas	Satisfies: CSA N289.1-08 Clause 5.3.10(d) and (e)	CSA N289.1-08

Bruce Power Programmatic Document	Relevant Regulatory Document Satisfied / Considered	Latest Applicable Regulatory Document or Standard
Equipment Qualification Supporting Procedures		
BP-PROC-00244 Procurement Engineering	Satisfies: CSA N290.13-05 clause 6.1, 6.4, 6.5 Satisfies: CSA N289.1-08 clause 6.1(g)	CSA N290.13-05 CSA N289.1-08
SEC-PE-00001 Item Equivalency Evaluation	Satisfies: CSA N290.13-05 clause	CSA N290.13-05 CSA N289.1-08
BP-PROC-00400 Life Cycle Management of Critical SSCs	Satisfies: CSA N290.13-05 clause 6.1 Satisfies: CSA N289.1-08	CSA N290.13-05 CSA N289.1-08
BP-PROC-00695 Maintenance Program and Activities	CSA N290.13-05 clause 6.3	CSA N290.13-05 CSA N289.1-08
BP-PROC-00781 Performance Monitoring	Satisfies: CSA N290.13-05 clause 5.7, 6.3.2	CSA N290.13-05 CSA N289.1-08
DPT-PE-00008 System and Component Performance Monitoring Plans	Satisfies: CSA N290.13-05 clause 5.7 Satisfies: CSA N289.1-08	CSA N290.13-05 CSA N289.1-08
DPT-PE-00009 System and Component Performance Monitoring Walkdowns	Satisfies: CSA N290.13-05 clause 6.2	CSA N290.13-05 CSA N289.1-08
DPT-PE-00010 System Health Reporting	Satisfies: CSA N290.13-05 clause 6.3 Satisfies: CSA N289.1-08	CSA N290.13-05 CSA N289.1-08
DPT-PE-00011 Component Program Health Reporting	Satisfies: CSA N290.13-05 clause 6.3 Satisfies: CSA N289.1-08	CSA N290.13-05 CSA N289.1-08

A.1.2. Assessment

The Equipment Qualification process is well defined in a number of procedures and supporting documentation. In each procedure, there are interface links to other supporting station programs and procedures that have an important bearing on preserving the equipment

qualification, such as procurement, engineering change control and condition monitoring. There is a robust self-assessment and audit process to examine the various activities involved in maintaining the equipment qualification for the life of the plant, which have identified meaningful recommendations to improve the procedures and processes. Most of the procedures have been recently revised to implement these recommendations, and it is noted that substantial effort has been spent recently to keep the procedures current and clearly written.

A.2. CSA N289 Series, Seismic Qualification Standards

The nuclear structures of Bruce Nuclear Generating Station A (NSGA) were designed and built to the 1965 National Building Code which required only a static load analysis of the structures and major components. Given that Bruce A was already designed and had operated for some years, Bruce Power opted to pursue an assessment of the seismic capability of the plant using the accepted EPRI NP-6041 Seismic Margin Assessment (SMA) methodology rather than qualifying the plant by design. This was completed for Bruce A Units 3 and 4 in 2003 [8] and for Bruce Units 1 and 2 in 2006 [33].

The use of SMA rather than the CSA N289 series was accepted by the CNSC in 2002 [32] for Bruce Units 3 and 4 and in 2008 [34] for Bruce Units 1 and 2, including for modifications that were part of the Return to Service Project. Bruce Power had noted that the Bruce A facility did not have a defined Design Basis Earthquake (DBE) which limited Bruce Power's ability to utilize the CSA N289 series directly and an equivalent approach needed to be adopted (NK21-CORR-00531-05973 [100]).

Accordingly the SMA approach has been used to identify the Review Level Earthquake (RLE) for the Bruce A facility consistent with EPRI NP-6041 guidelines. This is documented in the Bruce NGS A Seismic Margin Assessment [NK21-REP-20091-00001] [8] and the Bruce A Units 1 and 2 Return to Service: Seismic Margin Assessment [33].

The CNSC reviewed the 2008 submission and concurred with the use of the SMA approach in place of CSA N289 series for the Bruce A Unit 1 and 2 Service Project System modifications [NK21-CORR-00531-06205][34]. However, in an earlier letter, CNSC indicated that the Subject Matter Expert (SME) could be used only for existing systems, and not for modifications (NK21-CORR-00531-05840 [101]).

A.2.1. CSA N289.1-08 (R2013), General Requirements for Seismic Qualification of CANDU Nuclear Power Plants

CSA N289.1-80 was reviewed as part of NK21-REP-03600-00012, Bruce A Units 1 and 2 Return to Service – Review Against Design Standards [102], which was submitted to the CNSC (NK21-CORR-00531-04340) [103]

At that time (2006), because Bruce A was not originally seismically qualified and the Seismic Margin Assessment (SMA) methodology used for seismic qualification was different than that specified in CSA N289.1-80, no clauses were assessed as 'Full compliance'. All clauses were determined to be either 'Complies with intent' or 'Acceptable deviation'. CSA N289.1-80 is now withdrawn and replaced with CSA N289.1-08 (R2013) [26].

The current standard has been substantially expanded in terms of the level of detail, and now includes thirteen pages of requirements, compared with four pages of requirements in the previous edition. A high-level review of the differences between these editions of the standard has been performed and the following changes are noted in the most recent edition:

- The SMA seismic qualification methodology is included in clause 3 (Definitions) and is defined as "an assessment performed to demonstrate sufficient margin over the design

earthquake level to ensure plant safety and to find any weaknesses that might limit the plant capacity to safely shut down after a seismic event exceeding the design earthquake level."

- For use with the SMA methodology, clause 3 also defines the "checking/review level earthquake (CLE)" as "an engineering representation of earthquake ground motion chosen to have a lower probability of exceedance than the design basis earthquake (DBE)."
- Clause 5.2.4 states that "SSCs may also be evaluated and qualified using the seismic margin assessment…or seismic probabilistic assessment…methodologies and the checking/review level earthquake (CLE)."
- Clauses 5.3.5, 5.3.7, and 5.3.8 specifically include the SMA approach for seismic qualification, including EPRI-6041-SLR1 and the SQUG Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment.
- Clause 5.4, "Seismic evaluation of existing plants", states requirements for establishing the ground motion, seismic capacity, and addressed modifications and replacement of seismically qualified SSCs, specifically including the SMA methodology.

In the review of CSA N289.1-80, (NK21-REP-03600-00012) [102], the assessment in section 4.7 indicated that all clauses were either "Compliance with Intent", or "Acceptable Deviations" because of the use of the SMA and SQUG methodologies for qualification, which were deemed to be "an acceptable approach in lieu of seismic design" and were accepted by the regulator. Since the SMA and SQUG methodologies applied to Bruce A are now incorporated into the current standard, the seismic qualification of Bruce A is now in full compliance with CSA N289.1-08 clauses 4 and 5.

Note that clause 5.2.5.2 identifies the Category A and Category B seismic categories whereas the Bruce A approach classifies components as "S" which is equivalent to Category A, and "S, R" which is equivalent to Category B, which is considered to be compliance with this clause, since the Category A and B designation does not appear to be a requirement, based on the current wording (i.e., "The following two seismic categories are used…".

Clause 6 includes responsibilities and duties for the operating plant, including proposing and getting acceptance of the site ground motion (engineering representation of ground motion (ERGM), defining the SSCs needing seismic classification and their seismic categories, ensuring that all SSCs on the safe shutdown equipment list are seismically qualified, implementing controls for design, procurement, operations installation and maintenance to ensure that qualification is maintained for the life of the facility, operator response to seismic events, and post-seismic recovery activities. These requirements are addressed in procedure DPT-PDE-00017 and in related procedures and documents as listed in Sections 4 and 5 of that procedure.

Based on the above, Bruce NGS A now complies with CSA N289.1. However, it is noted that Bruce Power has recently sent a request to the CNSC [98] to use the most recent CSA N289 standards and the DBE defined for Bruce B for new systems and modifications to existing systems, but no determination has yet been made by CNSC.

A.2.2. CSA N289.2-10, Ground Motion Determination for Seismic Qualification of Nuclear Power Plants

CSA N289.2 was not used to develop the ground motion response spectra for Bruce A, although it was used for the Bruce B design. Instead, based on the EPRI guidance for SMA, the Review Level Earthquake for Bruce A was characterized by a Uniform Level Earthquake with a recurrence period of 10,000 years, modified for the Bruce A site, based on the DBE level defined for Bruce B (which was based on published seismic information about the area). With a lower frequency than the DBE, the Review Level Earthquake (RLE) is more conservative than the DBE. The in-structure response spectra corresponding to the RLE were developed by scaling the DBE response spectra from Bruce B [104] [67] [65]. The development of in-structure response spectra is now addressed in NK21-DG-20091-002 [67].

The current version of the standard has been updated to be consistent with CSA N289.1, and to include the latest information for the development of the seismic ground motion for a new or existing site. Since an accepted ground motion has been developed for both Bruce A and Bruce B, as described above, no further review of the requirements in this standard was done.

A.2.3. CSA N289.3-10, Design Procedures for Seismic Qualification of Nuclear Power Plants

CSA N289.3 was not used for SSC qualification at Bruce A. Instead, the EPRI SMA and SQUG methodologies [64][105][106] are used for seismic qualification of existing and replacement SSCs [67].

This standard was updated to be consistent with the content and terminology used in CSA N289.1 (e.g. the Seismic Margin Assessment methodology), and to include more detail for the seismic design of SSCs and for seismic analyses. Since the Bruce A seismic qualification of SSCs was done using the SMA methodology which is now included in CSA N289.1 and which was accepted by the CNSC, no further review of the requirements of this standard was done.

However, as noted above, Bruce Power has recently sent a request to the CNSC [98] to use the most recent CSA N289 standards and the DBE defined for Bruce B for new systems and modifications to existing systems, but no determination has yet been made by CNSC.

A.2.4. CSA N289.4-12, Testing Procedures for Seismic Qualification of Nuclear Power Plants

CSA N289.4 was not used for SSC qualification at Bruce A. Instead, the EPRI SMA and SQUG methodologies [67][64][105][106] are used for seismic qualification of existing and replacement SSCs [67].

As for the above standards, this standard was updated to be consistent with the content and terminology used in CSA N289.1. Since the seismic qualification of the existing SSCs has been completed using the accepted SMA methodology, no further review of the requirements of this

standard was done. See the note above about the proposal for new systems and modifications to existing systems.

A.2.5. CSA N289.5-12, Seismic Instrumentation Requirements for CANDU Nuclear Power Plants

As part of the 2006 Bruce A Units 1 and 2 Return to Service – Systematic Review of Safety (NK21-CORR-00531-04340) [103] Equipment Qualification Review, CSA N289.5-M91 was reviewed at a high level with respect to the seismic monitoring equipment at Bruce A. At that time it was determined that CSA N289.5-M91 did not "explicitly mandate installation at existing Nuclear Power Plants, but rather it is required "where site specific response are required to be determined and recorded. In the case of Bruce A, no such instrumentation has been installed." CSA N289.5-M91 is now withdrawn and replaced with CSA N289.5-12, which includes more detailed requirements for seismic monitoring instrumentation.

In clause 4.1.1.3, it states "to meet the objectives of Clause 1.2, seismic instrumentation systems for existing nuclear power plants and on-site facilities shall include at least one free field triaxial accelerometer (see Clause 4.2.2). Note 2 attached to this clause refers to Table 1, which states that one accelerometer is mandatory for existing plants, but it carries a note (identified by an asterisk) saying "Plants undergoing a life extension follow the requirements established together with the AHJ". Clause 1.2 also contains the wording "Where required to be installed…". Thus, it is concluded that, for the Bruce A plant, which is in the process of life extension, on-site seismic instrumentation is required only if agreed with the authority having jurisdiction (AHJ), which is the CNSC. In the report NK21-REP-03600-0012 [102], it was noted that "Bruce Power is relying on off-site seismic monitoring instrumentation" and that "Bruce Power closed the REGC relating to seismic monitoring instrumentation indicating that off-site monitoring is acceptable and complies with S-99…closure of the AR was based on the judgment that means of monitoring and reporting for seismic activity other than on-site instrumentation was acceptable". The procedure DPT-PDE-0017 "Bruce Power Seismic Qualification Standard" [63] notes in section 4.6 (Post Seismic Response) the notification procedure for an earthquake of magnitude 5 or greater within 500 km of the site.

Based on the above discussion, the current provisions for monitoring, which employs offsite information from the Southern Ontario Seismograph Network, has one monitoring station within 20 km of Bruce A. This has been accepted by the CNSC through the acceptance of the report noted above, which documents this monitoring approach, and satisfies the requirements of this standard, since the requirements that have been established for the Bruce site have been accepted by the CNSC [63] [103] [102].

A.3. CNSC RD/GD-210, Maintenance Programs for Nuclear Power Plants

This CNSC document was issued in 2012 and has been accepted for use by Bruce Power. It is listed in the licence and is not reviewed as part of this report. It was reviewed as part of the 2013 Safety Basis Report as part of the Safety Factor on ageing, but the section on equipment qualification, in clause 3.4.1 Condition Monitoring was not addressed. This clause addresses both environmental and seismic qualification and requires that an equipment list for both aspects is identified, and that maintenance activities do not invalidate the qualification status of the equipment. This is addressed in the Plant Maintenance program, BP-PROG-11.04 [43], which calls up Bruce procedure BP-PROC-00695, Maintenance Program and Activities [71]. BP-PROC-00695 in turn lists DPT-PDE-00017, Bruce Power Seismic Qualification Standard, and BP-PROC-00261, Environmental Qualification as referenced documents under clause 4.2.1, Condition Monitoring. Both the maintenance program and the procedure list RD/GD-210 as a requirement under clause 5.1 "Relevant Statutory, Regulatory and Licensing Requirements", since it is included in the plant licence. This commits Bruce Power to meet the maintenance requirements of RD/GD-210, which is done in the maintenance program. Some of the lower level maintenance procedures are still being updated to recognize this requirement.

A.4. CSA N290.13-05, Environmental Qualification of Equipment for CANDU Nuclear Power Plants

This standard has been previously reviewed in 2008 on a clause-by-clause in document Bruce A Units 1 and 2 Return to Service: Integrated Safety Review [100] and submitted to the CNSC (NK21-CORR-00531-05735 [107]). This review found that "…the EQ processes that are being applied for Units 1 and 2 comply with the requirements of the standard except for two 'Acceptable Deviations'. Both these 'Acceptable Deviations' included references to seismic qualification requirements. The original Bruce A design requirements did not include seismic qualification; however, the recent seismic margin assessment of Units 1 and 2 shows an adequate level of seismic robustness. The non-compliances are thus considered acceptable deviations as they have no significant adverse impact on plant safety."

The clauses noted as 'Acceptable Deviation included:

- Clause 5.2.2 "Equipment qualification requirements: Plant specific technical specifications for environmental qualification shall include the following:…(g)seismic qualification requirements, (h)the required sequence of seismic and harsh environmental condition testing;" the compliance discussion stated that Bruce A does not fully comply because seismic qualification was not an original design requirement, nor is it fully compliant with CSA N289."
- Clause 5.3.2.9 "Seismic testing:…Testing methods shall follow the general requirements of CAN3-N289.4 and the specific requirement defined…as outlined in Clause 5.2.2."

This report was reviewed and the clauses indicating compliance are still valid, although compliance is now achieved through the programs and procedures discussed in Section 4 above, rather than the PMC procedures used at that time for the EQ program. When this review was done, the EQ process was part of the Unit 1 and 2 restart project, subject to the procedures

and governance of that project, but has since transitioned to the plant procedures and governance, most of which have been recently prepared.

For the above clauses, the compliance discussion found the deviation to be acceptable due to the use of the Seismic Margin Assessment methodology, which is now included in CSA N289.1 as an acceptable qualification methodology. Although the EQ documents do not reference the seismic qualification, it is considered that these aspects are sufficiently related through the program and procedure documentation discussed in Section 4 of this report and through Passport that this requirement is effectively satisfied. Since the SMA methodology is now recognized in CSA N289.1-08 [26] as an acceptable qualification methodology (see discussion in Section A.2.1), and can be used instead of seismic testing for existing plants, this “Acceptable Deviation” can now be considered to be “Compliance”.

Appendix B – Clause-By-Clause Assessments Against Relevant Codes and Standards

No codes or standards relevant to Safety Factor 3 were subjected to a clause-by-clause assessment. This Appendix is retained only for consistency with the Appendix numbering scheme in all other Safety Factor Reports.