FORM-14159 R000*

Periodic Safety Review - Final Document Review Traveler

Bruce Power

Bruce Power Document #:	Revision:	Information Classification	Usage Classification
NK29-SFR-09701-00002	R000	Internal Use Only	Information

Bruce Power Document Title:
Safety Factor 2 – Actual Condition of Structures Systems and Components

Bruce Power Contract/Purchase Order:	Bruce Power Project #:
00193829	39075

Supplier's Name:	Supplier Document #:	Revision:
CANDESCO	K-421231-00202	R00

Supplier Document Title:
Safety Factor 2 – Actual Condition of Structures Systems and Components

Accepted for use at Bruce Power by:	Signature:	Date
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Acceptance of this document does not relieve the Supplier of responsibility for any errors or omissions

*Associated with BP-PROC-01024, Periodic Safety Reviews

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NK29-SFR-09701-00002

Title: Safety Factor 2 - Actual Condition of SSCs

File: K-421231-00202-R00

A Report Submitted to Bruce Power

September 20, 2016

Issue	**Reason for Issue:**				
R00D0	For harmonization				
	Author: D. Duncan	Verifier:	Reviewer:	Approver:	Date: Apr 7, 2016
Issue	**Reason for Issue:**				
R00D1	For internal review				
	Author: D. Duncan	Verifier:	Reviewer: L. Watt G. Archinoff	Approver:	Date: Apr 14, 2016
Issue	**Reason for Issue:**				
R00D2	For Bruce Power review				
	Author: D. Duncan	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: June 6, 2016
Issue	**Reason for Issue:**				
R00D3	Addresses Bruce Power review comments and internal verification comments.				
	Author: D. Duncan	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: August 24, 2016

<table>
<tr><td rowspan="2">Issue
R00</td><td colspan="5">Reason for Issue:
For use</td></tr>
<tr><td>Author:
D. Duncan</td><td>Verifier:
G. Buckley</td><td>Reviewer:
L. Watt

G. Archinoff</td><td>Approver:
L. Watt</td><td>Date:
Sept 20, 2016</td></tr>
<tr><td colspan="3">Document Classification:
Report</td><td colspan="3">Security Classification:
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Acronyms and Abbreviations

AIA	Authorized Inspection Agency
ALPO	Asset Life Projections & Options (occasionally seen as ALP&O)
AMOT	Asset Management Options Template
AOP	Ageing and Obsolescence Project
ARDM	Age-Related Degradation Mechanism
ARM	Alarm Response Manual
ASME	American Society of Mechanical Engineers
BDBA	Beyond Design Basis Accident
BDBE	Beyond Design Basis Event
BP	Bruce Power
BPMS	Bruce Power Management System
BPMSM	Bruce Power Management System Manual (commonly referred to as MSM)
CA	Condition Assessment
CANDU	CANada Deuterium Uranium
CAR	Condition Assessment Report
CCS	Concrete Containment Structure
CFAM	Corporate Functional Area Manager
CHR	Component Health Report
CMP	Control Maintenance Procedure
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CPMP	Component Performance Monitoring Plan
CSA	Canadian Standards Association
DBA	Design Basis Accident
DCC	Digital Control Computer
DCR	Document Change Request
DSC	Dry Storage Container
ELCE	Equipment Life Cycle Engineering
EME	Emergency Mitigating Equipment

EOL	End of Life (projection)
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ER	Equipment Reliability
ERCOE	Equipment Reliability Centre of Excellence
ERI	Equipment Reliability Index
FAI	Fukushima Action Item
FASA	Focus Area Self-Assessment
FMEA	Failure Modes & Effects Analysis
HX	Heat Exchanger
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IFB	Irradiated Fuel Bay
IM	Safety Systems Impairments Manual
IMMR	Inspection, Monitoring & Maintenance Review
INPO	Institute of Nuclear Power Operations
ISD	Inspection Services Department
ISR	Integrated Safety Review
IUC	Instrument Uncertainty Calculations
JIT	Just In Time
LCH	Licence Conditions Handbook
LCM	Life Cycle Management
LCMP	Life Cycle Management Plan
LOCA	Loss of Coolant Accident
LTEP	Long Term Energy Plan
M&TE	Measuring & Testing Equipment
MCR	Major Component Replacement
MEL	Master Equipment List
MMP	Mechanical Maintenance Procedure
NBIC	National Board Inspection Code
NPP	Nuclear Power Plant

NSCA	Nuclear Safety and Control Act
NUOG	Nuclear Utility Obsolescence Group
NuSCI	Nuclear Subject Classification Index
OFI	Opportunities for Improvement
OPEX	Operating Experience
OPG	Ontario Power Generation
OSR	Operational Safety Requirements
OVR	Obsolescence Value Ranking
PBQA	Pressure Boundary Quality Assurance
PdM	Predictive Maintenance
PHT	Primary Heat Transport
PIP	Periodic Inspection Program
PM	Preventive Maintenance
PMC	Project Management and Construction (a division of Bruce Power)
PMEL	Performance Monitoring Equipment List
PMPs	Performance Monitoring Plans
POMS	Proactive Obsolescence Management System
PRD	Pressure Relief Device
PROC	Bruce Power Procedure
PROG	Bruce Power Program
PROL	Power Reactor Operating Licence
PSR	Periodic Safety Review
QPM	Quality Program Manual
R&D	Research and Development
RCE	Responsible Component Engineer
RD/GD	Regulatory Document/Guidance Document
RSE	Responsible System Engineer
RV	Relief Valve
SBR	Safety Basis Report
SCA	Safety and Control Area
SCR	Station Condition Record

SFR	Safety Factor Report
SHIP	System Health Improvement Plan
SHR	System Health Report
SIS	Systems Important to Safety
SOE	Safe Operating Envelope
SPHC	Station Plant Health Committee
SPMP	System Performance Monitoring Plan
SPV	Single Point of Vulnerability
SSC	Structure, System and Component
SSMC	Safety System Monitoring Computer
SST	Safety System Testing
TBA	Technical Basis Assessment
TCC	Temporary Configuration Change
TOE	Technical Operability Evaluation
TSSA	Technical Standards and Safety Authority
WANO	World Association of Nuclear Operators
WO	Work Order

1. Objective and Description

Bruce Power (BP), as an essential part of its operating strategy, is planning to continue operation of Bruce B as part of its contribution to the Long Term Energy Plan (LTEP) (http://www.energy.gov.on.ca/en/ltep/). Bruce Power has developed integrated plant life management plans in support of operation to 247,000 Equivalent Full Power Hours in accordance with the Bruce Power Reactor Operating Licence (PROL) [1] and Licence Conditions Handbook (LCH) [2]. A more intensive Asset Management program is under development, which includes a Major Component Replacement (MCR) approach to replacing 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 regular maintenance outage will be scheduled concurrently with MCR. In accordance with Licence Condition 15.2 of the PROL [1], Bruce Power is required to inform the Canadian Nuclear Safety Commission (CNSC) of any plan to refurbish a reactor or replace a major component at the nuclear facilities, and Bruce Power shall:

(i) Prepare and conduct a periodic safety review;

(ii) Implement and maintain a return-to-service plan; and

(iii) Provide periodic updates on progress and proposed changes.

The fifteen reports prepared as part of the Periodic Safety Review (PSR), including this Safety Factor Report (SFR), are intended to satisfy Licence Condition 15.2 (i) as a comprehensive evaluation of the design, condition and operation of the nuclear power plant (NPP). In accordance with Regulatory Document REGDOC-2.3.3 [3], a PSR is an effective way to obtain an overall view of actual plant safety and the quality of safety documentation and determine reasonable and practicable improvements to ensure safety until the next PSR.

Bruce Power has well-established PSR requirements and processes for the conduct of a PSR for the purpose of life-cycle management, which are documented in the procedure Periodic Safety Reviews [4]. This procedure, in combination with the Bruce B Periodic Safety Review Basis Document [5], governs the conduct of the PSR and facilitates its regulatory review to ensure that Bruce Power and the CNSC have the same expectations for scope, methodology and outcome of the PSR.

This PSR supersedes the Bruce B portion of the interim PSR that was conducted in support of the ongoing operation of the Bruce A and Bruce B units until 2019 [6]. Per REGDOC-2.3.3 [3], subsequent PSRs will focus on changes in requirements, facility conditions, operating experience and new information rather than repeating activities of previous reviews.

1.1. Objective

The overall objectives of the Bruce B PSR are to conduct a review of Bruce B against modern codes and standards and international safety expectations, and to provide input to a practicable set of improvements to be conducted during the MCR in Units 5 to 8, and during asset management activities to support ongoing operation of all four units, as well as U0B, that will enhance safety to support long term operation. 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.

The specific objective of the review of this Safety Factor is to determine the actual condition of Systems, Structures and Components (SSCs) important to safety and whether it is adequate for them to meet their design requirements. In addition, the review should confirm that the condition of SSCs is properly documented.

1.2. Description

The review is conducted in accordance with the Bruce B PSR Basis Document [5], which states that the review tasks include examination of the following aspects for the selected SSCs:

1. Existing or anticipated ageing processes;
2. Operational limits and conditions;
3. Current state of the SSC with regard to its obsolescence;
4. Implications of changes to design requirements and standards on the actual condition of the SSC since the plant was designed or since the last PSR (for example, changes to standards on material properties);
5. Plant programs that support ongoing confidence in the condition of the SSC;
6. Significant findings from tests of the functional capability of the SSC;
7. Results of inspections and/or walkdowns of the SSC;
8. Maintenance and validity of records;
9. Evaluation of the operating history of the SSC;
10. Dependence on obsolescent equipment for which no direct substitute is available;
11. Dependence on essential services and/or supplies external to the plant;
12. The condition and operation of spent fuel storage facilities and their effect on the spent fuel storage strategy for the nuclear power plant; and
13. Verification of the actual state of the SSC against the design basis.

As required by the PSR Basis Document, preparation of this Safety Factor Report included an assessment of the review tasks to determine if modifications were appropriate. Any changes to the review tasks described in this section are documented and justified in Section 5. The review task interpretation is based on the following interpretation of the objective of this Safety Factor stated in Section 1.1 above: demonstrate that processes are in place that ensure that the condition of SSCs is known and documented, and whether the condition of SSCs is adequate for them to meet their design requirements.

2. Methodology for Review

As discussed in the Bruce B PSR Basis Document [5], the methodology for a PSR should include making use of safety reviews that have already been performed for other reasons. Accordingly, the Bruce B PSR 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] [10];
- Proposed refurbishments of Bruce Units 3 and 4 (circa 2008) [11] [12] [13] [14] [15];
- Safety Basis Report (SBR) and PSR for Bruce Units 1 to 8 (2013) [6]; and
- Bruce A Integrated Safety Review (ISR) to enhance safety and support long term operation (2015) [16] [17].

These reviews covered many, if not all, of the same Safety Factors that are reviewed in the current PSR. A full chronology of Bruce Power safety reviews up to 2013 is provided in Appendix F of [18].

The Bruce B PSR 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 PSR Basis Document [5] 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 PSR 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 the assessor confirming that the assessment type identified in Appendix C of the Bruce B PSR Basis Document [5] for each of the codes, standards and guidance documents selected for this factor is appropriate based on the guidance provided. The PSR 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 PSR Basis Document.

4. **Perform gap assessment against codes and standards:** This step comprises the actual assessment of the Bruce Power programs and the Bruce B plant against the identified codes and standards. In general, this involves determining from available design or programmatic documentation whether the plant or program 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 the 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 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. The results of this step are documented in Section 5 of each SFR.
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 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 B 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. Table C-1 of the Bruce B PSR Basis Document [5] identifies the codes, standards and guides that are relevant to this PSR. Modern revisions of some codes and standards listed in Table C-1 of the PSR Basis Document [5] have been identified in the licence renewal application and supplementary submissions for the current PROL [19] [20] [21]. Codes, standards and guides issued after the freeze date of December 31, 2015 were not considered in the review [5].

3.1. Acts and Regulations

The *Nuclear Safety and Control Act* (NSCA) [22] establishes the Canadian Nuclear Safety Commission and its authority to regulate nuclear activities in Canada. Bruce Power has a process to ensure compliance with the NSCA [22] 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 SSC condition that are referenced in the PROL [1] and LCH [2], and noted in Table C-1 of the Bruce B PSR Basis Document [5], are identified in Table 1. The edition dates referenced in the third column of the table are the modern versions used for comparison.

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

Document Number	Document Title	Modern Version Used for PSR Comparison	Type of Review
CNSC REGDOC-2.3.3	Periodic Safety Reviews	[3]	NA
CNSC RD/GD-98 (2012)	Reliability Programs for Nuclear Power Plants	[23]	NA

Document Number	Document Title	Modern Version Used for PSR Comparison	Type of Review
CSA-N285.4-05	Periodic Inspection of CANDU Nuclear Power Plant Components	CSA-N285.4-14 [24]	NA
CSA-N286-05 [25]	Management System Requirements for Nuclear Facilities	CSA-N286-12 [26]	NA
CSA N286.7-99	Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants	CSA N286.7-99 (R2012) [28]	NA
CSA N290.13-05	Environmental Qualification of Equipment for CANDU Nuclear Power Plants	CSA N290.13-05 (R2015) [29]	NA
CSA N290.15-10	Requirements for the safe operating envelope of nuclear power plants	CSA N290.15-10 [30]	NA
Assessment type: **NA**: Not Assessed; **CBC**: Clause-by-Clause; **PCBC**: Partial Clause-by-Clause; **CTC**: Code-to-Code; **HL**: High Level; **2SF**: Assessment performed in another SFR; **CV**: Confirm Validity of Previous Assessments			

CNSC REGDOC-2.3.3: This PSR is being conducted in accordance with CNSC REGDOC-2.3.3 per Licence Condition 15.2 (i) [1], and associated compliance verification criteria [2]. Therefore, REGDOC-2.3.3 is not reviewed further in this document.

CNSC RD/GD-98: Table C-1 of the Bruce B PSR Basis Document [5] indicates that an assessment of Regulatory Document RD/GD-98 [23], Reliability Programs for Nuclear Power Plants, is not required. RD/GD-98 [23], which sets out the requirements and guidance of the CNSC for the development and implementation of a reliability program for nuclear power plants in Canada, captures the existing requirements previously found in the eponymous S-98 (Revision 1) [31] and also replaces the latter document. An assessment of the reliability program against S-98 was completed for the Bruce 1 and 2 ISR and submitted to the CNSC. However, RD/GD-98 does not add to the requirements of S-98 [31]. RD/GD-98 continues to be a licence condition, so a line-by-line compliance with this regulatory document is verified on an ongoing basis to ensure compliance with the PROL. Therefore it was not assessed as part of this Safety Factor.

CSA N285.4: CSA-N285.4, Periodic Inspection of CANada Deuterium Uranium (CANDU) Nuclear Power Plant Components is invoked by Condition 6.1, *Fitness for Service*, of the PROL [1]. A new version of this standard was issued in 2009 [32] with an Update in 2011. The 2009 version with the 2011 Update is included in the PROL [1]. Since Bruce Power verifies line-by-line compliance with this standard on an ongoing basis to ensure compliance with the PROL, and since the 2009 version is subject to a transition plan, Table C-1 of the PSR Basis Document [5] indicates that compliance need not be assessed as part of this PSR. However, the latest version of this standard is N285.4-14 [24]. A high level code-to-code comparison between the 2014 and 2009 versions was conducted and the results are presented in Safety Factor 4.

CSA N286-12: CSA N286-05 is noted in the PROL (Licence Condition 1.1 [1]). Per the LCH [2], an implementation strategy for the 2012 version is in progress to be submitted to the CNSC by the end of January 2016. 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" [33].

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 current licensing period [34]. 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 [35]. Bruce Power further stated CSA N286-12 does not establish any significant or immediate new safety requirements that would merit a more accelerated implementation. The gap analysis and the resulting transition plan were submitted to the CNSC [36]. Per [36], the major milestones of the transition plan to N286-12 are as follows:

- 22 January 2016: Discuss all the regulatory actions and the transition plan at the (Corporate Functional Area Manager) CFAM meeting
- 31 December 2016: Revision of CFAM Program Document(s) [with LCH notification requirements to the CNSC] to comply with CSA N286-12 requirements completed.
- 31 March 2017: Revision of CFAM Program Document(s) [that do not have LCH notification requirements to the CNSC] to comply with CSA N286-12 requirements completed
- 31 December 2017: Confirmation that that all impacted documents in the program suite comply with the requirements of CSA N286-12
- 15 September 2018: Verification via a Focus Area Self-Assessments (FASA) that previously identified transition Gaps to meeting the requirements of CSA N286-12 have been addressed and effectively implemented
- 14 December 2018: issue notification to the CNSC regarding state of CSA N286-12 readiness, and, implementation date

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 and there is a transition plan in effect.

CSA N286.7-99: Safety Basis Report Safety Factor 1: Plant Design [6] concluded the Bruce Power Plant Design Basis Management Program [37] satisfied CSA N286.7-99. In addition, CSA N286.7 is included as a requirement in the LCH [2], and therefore subject to an ongoing compliance review. Therefore, further assessment against this standard was not required as part of this Safety Factor.

CSA N290.13-05: CSA N290.13-05 [29] (reaffirmed in 2015) provides environmental qualification requirements for the design of CANada Deuterium Uranium (CANDU) Nuclear Power Plant (NPPs). It is of relevance to deterministic safety analysis, since assumed system credits in safety analysis are supported by environmental qualification. The safety analysis of Design Basis Accidents (DBAs) only credits equipment qualified to withstand the harsh environment resulting from such accidents. This standard that was used for the Bruce 1 and 2 ISR has not been revised and the standard is in the LCH. Table C-1 of the PSR Basis Document [5] indicates that no assessment is required in Safety Factor 2. Given this fact and that CSA N290.13-05 is currently listed in the LCH, and thus subject to ongoing compliance assessment, no further assessment is required.

CSA N290.15-10: CSA N290.15 is included in the current LCH [2] and is therefore part of the current licensing basis. Bruce Power contributed extensively to the formulation of this standard and so the major elements are in place and have been throughout the Unit 1 and 2 and Units 3 and 4 ISR assessments. Given that CSA N290.13-05 is currently listed in the LCH, and thus subject to ongoing compliance assessment, no further assessment is required.

3.3. Regulatory Documents

There were no additional Regulatory Documents identified in Table C-1 of the PSR Basis Document [5] considered for application to the review tasks of this Safety Factor beyond those identified in the Bruce Power PROL [1] and the LCH [2].

3.4. CSA Standards

In addition to those identified in the Bruce Power PROL [1] and LCH [2] the Canadian Standards Association (CSA) standards identified in Table C-1 of the PSR Basis Document [5] 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 B51-14	Boiler, Pressure Vessel, and Pressure Piping Code	[38]	NA
CSA N291-15 (R2013)	Requirements for Safety-Related Structures for CANDU Nuclear Power Plants	[39]	HL
Assessment type: **NA**: Not Assessed; **CBC**: Clause-by-Clause; **PCBC**: Partial Clause-by-Clause; **CTC**: Code-to-Code; **HL**: High Level; **2SF**: Assessment performed in another SFR; **CV**: Confirm Validity of Previous Assessments			

CSA B51-14: Table C-1 of the PSR Basis Document [5] indicates that assessment of CSA B51-14 compliance is not required. CSA B51 is incorporated in the regulatory structure because this standard is called directly by CSA N285, which is in the Bruce PROL and subject to a transition plan. Therefore, no further review of CSA B51 is needed in support of this Safety Factor Report.

CSA N291-15: Table C-1 of the PSR Basis Document [5] calls for a high level assessment of CSA N291-15. Bruce Power's position is that CSA N291-15 largely provides recommendations and guidance [21]. Moreover, many of its requirements would be a backfit that is inconsistent with the already designed, built and operated plant. Notwithstanding this, Bruce Power continues to support the CANDU Owners Group (COG) Research Program on alternative materials (e.g., the COG report on Chemistry, Materials, and Components attached to [40]) that would be acceptable for revitalization or modification of existing structures that might not otherwise comply with the recently issued standard (compared to the original design and construction dates). As such, a high level review of CSA N291-15 is appropriate, and this is provided in Appendix A (A.1).

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	[41]	NA

Document Number	Document Title	Reference	Type of Review
Assessment type: **NA**: Not Assessed; **CBC**: Clause-by-Clause; **PCBC**: Partial Clause-by-Clause; **CTC**: Code-to-Code; **HL**: High Level; **2SF**: Assessment performed in another SFR; **CV**: Confirm Validity of Previous Assessments			

IAEA SSG-25: IAEA SSG-25 [41] addresses the periodic safety review of nuclear power plants. Per the PSR Basis Document [5], this PSR is being conducted in accordance with REGDOC-2.3.3. As stated in REGDOC-2.3.3 [3], this regulatory document is consistent with IAEA SSG-25. The combination of IAEA SSG-25 and REGDOC-2.3.3, define the review tasks that should be considered for the Safety Factor Reports. However, no assessment is performed specifically on IAEA SSG-25.

3.6. Other Applicable Codes and Standards

The codes and standards discussed in the previous sub-sections have been determined to be sufficient for the completion of the review tasks of this Safety Factor. Accordingly, additional codes and standards are not considered in this Safety Factor Report.

4. Overview of Applicable Bruce B Station Programs and Processes

Bruce Power implementation documents related to Condition Assessment, Fitness for Service, System Health Reporting and Life Cycle Management (LCM) have become more detailed and extensive in response to industry and corporate initiatives to better understand and continuously improve. These improvements reflect Bruce Power’s asset management initiatives, as well as alignment with best industry practices and CNSC expectations. The implementing documents relevant to Safety Factor 2 are listed in Table 4[1]. It is recognized there is some overlap with Safety Factor 4 on Ageing, as Asset Management and Ageing Management are integrated. The condition of the SSCs and knowledge of how they change with age is integrated to determine the improvements needed to manage the assets. Reference [42] is a description of the principles of Asset Management as the Asset Management initiative ramped up.

[1] Table 4 lists the key governance documents used to support the assessments of the review tasks for this Safety Factor Report. A full set of current sub-tier documents is provided within each current PROG document. In the list of references, the revision number for the governance documents is the key, unambiguous identifier; the date shown is an indicator of when the document was last updated, and is taken either from PassPort, the header field, or the “Master Created” date in the footer.

Table 4: Implementing Documents

Level 0	Level 1	Level 2	Level 3
BP-MSM-1: Management System Manual [43]	BP-OPP-00001: Operating Policies and Principles – Bruce B [44]		
	BP-PROG-00.04: Pressure Boundary Quality Assurance Program [45]		
	BP-PROG-10.01: Plant Design Basis Management [37]	BP-PROC-00335: Design Management [48]	BP-PROC-00014: Technical Operability Evaluation [49]
			BP-PROC-00261: Environmental Qualification [50]
		BP-PROC-00582: Engineering Fundamentals [51]	
	BP-PROG-10.02: Engineering Change Control [52]		
	BP-PROG-10.03: Configuration Management [53]		
	BP-PROG-11.01: Equipment Reliability [54]	BP-PROC-00383: Performance and Condition Assessment [55]	
		BP-PROC-00778: Scoping and Identification of Critical SSCs [56]	BP-PROC-00666: Component Categorization [57]

Level 0	Level 1	Level 2	Level 3
		BP-PROC-00779: Continuing Equipment Reliability Improvement [58]	BP-PROC-00457: Development and Approval of Predefined [59]
			BP-PROC-00532: Critical and Strategic Spares [60]
			BP-PROC-00534: Technical Basis Assessment [61]
		BP-PROC-00780: Preventive Maintenance Implementation [62]	BP-PROC-00501, Integrated Preventive Maintenance Program, [63]
		BP-PROC-00781: Performance Monitoring [64] [2]	BP-PROC-00267: Management of Steam Generator and Preheater Tube Integrity [65]
			BP-PROC-00268: Safety System Testing (SST) Program Procedure [66]
			BP-PROC-00284: Predictive Maintenance [67]
			BP-PROC-00334: Periodic Inspection [68]

[2] BP-PROC-00382 has been superseded by BP-PROC-00781.

Level 0	Level 1	Level 2	Level 3
			BP-PROC-00361: In-Service Testing and Inspection to Satisfy CSA N287.7-08 Requirements [69]
			BP-PROC-00387: Plant Inspection [70]
			BP-PROC-00825: Buried Pipe Inspection Program [71]
			BP-PROC-00849: Aggregate Risk Assessment and Monitoring [72]
			BP-PROC-00863: Engineering Programs Health Reporting [73]
			BP-PROC-00893: Fuel and Fuel Channel Program [74]
			BP-PROC-00923: Pipe Wall Thinning - FAC Procedure (Replaces SEC-ME-00007 [75]) [76]
			DPT-PE-00008: System and Component Performance Monitoring Plans [77]

Level 0	Level 1	Level 2	Level 3
			DPT-PE-00009: System and Component Performance Monitoring Walkdowns [78]
			DPT-PE-00010: System Health Reporting [79]
			DPT-PE-00011: Component Health Reporting [80]
			SEC-ME-00008: Heat Exchangers [81]
			SEC-ME-00010: Inspection and Monitoring Once-Through Service Water Systems [82]
			SEC-RE-00017: Motor Program [83]
		BP-PROC-00782: Equipment Reliability Problem Identification & Resolution [84]	
		BP-PROC-00783: Long Term Planning & Life Cycle Management [85]	BP-PROC-00400: Life Cycle Management of Aging Components [86]
			BP-PROC-00533: Obsolescence Management [87]

Level 0	Level 1	Level 2	Level 3
	BP-PROG-11.02: On-Line Work Management [88]		
	BP-PROG-11.03: Outage Work Management [89]		
	BP-PROG-11.04: Plant Maintenance [90]	BP-PROC-00695: Maintenance Program and Activities [91]	
		BP-PROC-00699: Maintenance Work [92]	BP-PROC-00694: Maintenance Procedure Development and Revision (Replaces SEC-MSS-00004, [93]), [94]
	BP-PROG-12.01: Conduct of Plant Operations [95]	GRP-OPS-00034, Control of Operator Challenges [96].	
		GRP-OPS-00047: Operator Routines and Inspections - Bruce A and Bruce B [97]	
		BP-PROC-00561: Operations Fundamentals [98]	
	BP-PROG-12.02: Chemistry Management [99]		
	BP-PROG-12.03: Fuel Management [100]		

Level 0	Level 1	Level 2	Level 3
		BP-PROC-00498:[3] Condition Assessment of Generating Units in Support of Life Extension [101]	

BP-MSM-1 [43][4], the Bruce Power Management System Manual (BPMS), describes the way Bruce Power manages the Company. It represents the highest tier document in the governing document structure. It acts as an overall framework to understanding and using the lower tier documents. It establishes the programs that enable the performance of all business activities.

Nuclear Safety is a primary consideration for Bruce Power; therefore the management system supports the enhancement and improvement of safety culture. The BPMS is designed to ensure that the Bruce Power leadership team can consistently deliver expected results and satisfy key stakeholders, such as the regulators, the public, its shareholders and employees. It ensures that Bruce Power meets the stipulations of its operating licences, applicable codes, standards, legal and business requirements.

The BPMS establishes a nuclear safety culture[5] that assures reactor, environmental, industrial and radiological safety. It provides the necessary guidance for making risk-based decisions that satisfy the desired balance between safety, commercial, corporate reputation and other performance requirements. No single element of the BPMS operates independently; all parts of the BPMS are interconnected and interdependent. The BPMS includes ongoing assessment and continuous improvement of system effectiveness.

Bruce Power Programs (PROGs) implement the BPMS and define requirements. They are specific to functional areas and establish measures for compliance and execution. Programs are driven by regulatory and business requirements. They are applicable across Bruce Power.

Bruce Power Procedures and Processes define how work is performed. A procedure resides below the Program level in the document hierarchy and consists of a structured set of activities designed to produce an output or it may be an informational document that establishes a

[3] BP-PROC-00498 Section 5.2 says it is affiliated with BP-Policy-14, which no longer exists, so it would have naturally fallen within BP-PROG-14.01: Project Management and Construction; however it was transferred to BP-PROG-11.01 per Figure 1 of that program document.

[4] Revision 012 of the BPMS contains an important update - the extension of operational safety to both normal operations and extreme events, consistent with WANO SOER-2013-2 (Fukushima Lessons Learned).

[5] In support of the objective of the extension of the BPMS to extreme events, BP-MSM-1 Revision 012 included an amendment to specify (in Section 2.1) that "… nuclear safety culture is applicable to normal operations and extreme events".

standard, expectation or other requirement. Standardization of procedures/processes is required across Bruce Power.

In addition to general procedures, Bruce Power uses station system procedures that require application of a Nuclear Subject Classification Index (NuSCI). Station system procedures, which are principally technical in nature, are intended to facilitate the creation of operating, maintenance, and engineering type procedures requiring alignment to plant structures, systems and components.

The Bruce Power Programs and the procedures supporting them pertinent to Actual Condition of SSCs (where appropriate) are described in the following subsections.

4.1. Pressure Boundary Quality Assurance Program, BP-PROG-00.04

BP-PROG-00.04 [45], Pressure Boundary Quality Assurance Program, describes the Bruce Power program to control the quality of pressure boundary activities at the facilities described in Section A of the Program manual. It complies with the applicable rules and quality assurance requirements contained in CSA Standards: a) N285.0 and supporting codes for Class 1, 1C, 2, 2C, 3, 3C, 4 and 6 systems and components, and b) B51 and supporting codes for Class 6 and unclassified registered systems and components.

Pressure boundary activities at the stations are performed in accordance with the Codes and Standards required by the Bruce B PROL [1] and LCH [2]. Organizations that support pressure boundary work at Bruce A and B comply with the requirements established in the approved Pressure Boundary Quality Assurance (PBQA) Program. BP-PROG-00.04 is relevant to “Safety Factor 1: Plant Design”. In the context of Safety Factor 2, the PBQA Program is the top level governance for inspection activities and therefore relevant to Condition Assessment of SSCs important to safety.

The current revision of BP-PROG-00.04 is R022. The revision reviewed for the interim PSR [6] was R019 and the version reviewed for the Bruce A ISR [17] was R020. Therefore, a review of the changes made to upgrade from R020 to R022 was completed, first examining the changes in R021 and then the changes in R022. An examination of the Revisions block of R021 showed changes related mostly to organizational positions, corrective changes and alignment with NQA-1. The examination of the Revisions block of R022 showed similar types of changes. The changes to both revisions have no impact on condition assessment. Therefore, the previous PSR/ISR reviews of BP-PROG-00.04, which did not identify any gaps, are still valid.

4.2. Plant Design Basis Management Program, BP-PROG-10.01

BP-PROG-10.01 [37], Plant Design Basis Management, defines the overall business need, constituent elements, functional requirements, implementing procedures and key responsibilities associated with the plant's Design Basis.

The overall objective of Plant Design Basis Management is to ensure that the SSCs important to safety have the appropriate characteristics, specifications and material composition to perform their safety functions and that the plant can operate safely and reliably for the duration of its design life[6], with accident prevention and the protection of workers, the public and the environment as prime goals. The objective of this program is to define, document and control changes to the Design Basis to maintain the Design Basis within margins and regulatory requirements and to perform Safety Analysis to show that the plant operation conforms to the Design Basis and Licensing Basis (e.g., requirements, assumptions, regulatory submissions) while remaining within the agreed acceptance criteria and bounds of analyzed conditions and the Safe Operating Envelope (SOE).

The program document specifies requirements as discussed in the following paragraphs.

Plant design of SSCs is in accordance with design requirements and work activities are planned and controlled. Design work activities are authorized and performed using approved processes, documents, materials, parts, tools and practices. Verification of work activities is planned before work activities commence. Verification includes identification of who is to conduct the verification and outlines both the verification method and acceptance criteria. The analysis supporting the design provides a robust demonstration of the fault tolerance, adequacy and effectiveness of the operating and safety systems under the full range of operating and DBA conditions.

The SOE and licensing conditions are defined and managed to provide clear direction to individuals engaged in the design, operation, analysis and licensing of the plant so they understand the operating limits and conditions of the plant that have been analyzed to be safe.

While design basis management is pertinent to condition assessment, the design basis is primarily a topic of “Safety Factor 1: Plant Design”. Therefore, the assessment of the adequacy of BP-PROG-10.01 is addressed in Safety Factor 1.

4.3. Engineering Change Control, BP-PROG-10.02

BP-PROG-10.02 [52], Engineering Change Control, specifies the manner in which design changes and modifications are defined, planned, implemented, and controlled.

The Engineering Change Control (ECC) program objective is to ensure that design changes and modifications are controlled such that System, Structure, Component, and significant Tools (SSCTs) continue to meet the design basis and operate safely for the full duration of design life. It satisfies OP&P Clause 1.6 on Modifications.

This program fosters a healthy nuclear safety culture by defining relevant accountabilities and responsibilities, appropriate management and supervisory oversight, support interfaces, and

[6] The assessment of remaining design life is closely tied to Bruce Power’s Asset Management Program to determine whether the design life can be extended or the component requires replacement (and strategically when, from a schedule and business planning perspective). The program has utilized a wide range of assessments and strategic initiatives, such as AOP (Ageing and Obsolescence Program), ALP&O (Asset Life Projection and Options), AMOT (Asset Management Options Template) culminating in the LCMP (Life Cycle Management Plan). See discussion of BP-PROC-00400 (in Section 4.8).

ensuring that decision-making with respect to design changes and modifications is systematic and rigorous.

Within this program certain identified documents contribute to satisfying pressure boundary quality assurance requirements as described in BP-PROG-00.04, Pressure Boundary Quality Assurance Program.

This program contributes to satisfying the statutory, regulatory and licensing requirements identified in Appendix A, Statutory, Regulatory and Licensing Requirements including CSA N286-05, Management System Requirements for Nuclear Power Plants, CSA N285.0-08 (with Update No. 1, June/09), General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants and CSA N290.15-10, Requirements for the Safe Operating Envelope of Nuclear Power Plants.

While engineering change control is pertinent to condition assessment, the design basis and control of change is primarily a topic of “Safety Factor 1: Plant Design”. Therefore, the assessment of the adequacy of BP-PROG-10.02 is addressed in Safety Factor 1.

4.4. Configuration Management, BP-PROG-10.03

BP-PROG-10.03 [53], Configuration Management, provides an overview of the Configuration Management (CM) Program at Bruce Power and establishes guidance to promote consistent application of the following CM objectives across the site, as follows:

1. Clear definition and communication of CM scope, responsibilities, authorities, principles and interfaces.

2. Design basis and licensing basis requirements, which apply to the plant to be accurately identified, documented, maintained and accessible.

3. The plant’s physical structures, systems and components, and process computer controls to conform to design basis and license basis requirements.

4. Design basis and license basis requirements to be accurately reflected in plant documentation and in processes and procedures for altering, maintaining, testing and operating the plant.

5. Consistency to be maintained among sources of plant information (documents and electronic data) as well as between plant information and the plant’s physical and functional characteristics.

6. Continuous improvement of CM to be achieved by monitoring and assessing CM-related activities and by incorporating feedback of lessons learned from in-house and industry best practices and experience.

This program fosters a healthy nuclear safety culture by:

1. Ensuring changes are made after due consideration of impact on design and operating margins.

2. Ensuring temporary changes undergo independent review to ensure there is no adverse impact on safety or plant design.

Within this program certain identified documents contribute to satisfying pressure boundary quality assurance requirements as described in BP-PROG-00.04, Pressure Boundary Quality Assurance Program [45].

This program contributes to satisfying the following key statutory, regulatory and licensing requirements:

- CSA N285.0-08/N285.6 Series-08 (with Update No. 1, June/09), General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants/Material Standards for Reactor Components for CANDU Nuclear Power Plants
- CSA N286-05, Management System Requirements for Nuclear Power Plants
- CSA N290.15-10, Requirements for Safe Operating Envelope of Nuclear Power Plants
- CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code, Parts 1, 2 and 3.

While configuration management is pertinent to condition assessment, configuration management of the design basis is primarily a topic of “Safety Factor 1: Plant Design”. Therefore, the assessment of the adequacy of BP-PROG-10.03 is addressed in Safety Factor 1.

4.5. Equipment Reliability Program, BP-PROG-11.01

This section describes the Equipment Reliability Program and its supporting procedures pertinent to Condition Assessment. Equipment Reliability has been, and continues to be, a major initiative and priority at Bruce Power.

BP-PROG-11.01 [52], Equipment Reliability, defines the fundamental business need, constituent elements, functional requirements, implementing approaches and key responsibilities associated with the plant's integrated equipment reliability processes. The overall objective of the Equipment Reliability program 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.

Through the procedures described below in this report, BP-PROG-11.01 drives the inspection, testing, surveillance and maintenance activities that provide the information and assessments to understand and document the condition of SSCs Important to Safety. Appendix B of BP-PROG-11.01 is a chart showing the organization of the supporting procedures.

Appendix C of BP-PROG-11.01 contains a useful cross reference matrix of the regulatory requirements and where the requirements are fulfilled in the various sub-tier procedures that support Equipment Reliability (ER) – in effect a mini compliance matrix. It lists the relevant regulatory requirements, identifying which of the six implementing procedures addresses which part of these regulations. A salient comment and solid recognition of management principles included in the first row of the matrix in Appendix D is that “The ER program and its implementing procedures are structured to address the 14 management system principles of N286-05.”

The key driving procedures selected by Engineering in the aforementioned matrix for Equipment Reliability to establish compliance with major regulatory documents are the following:

- BP-PROC-00778, Scoping and Identification of Critical SSCs [56]
- BP-PROC-00779, Continuing Equipment Reliability Improvement [58]
- BP-PROC-00780, Preventative Maintenance Implementation [62]
- BP-PROC-00781, Performance Monitoring [64]
- BP-PROC-00782, Equipment Reliability Problem Identification & Resolution [84]
- BP-PROC-00783, Long Term Planning & Life Cycle Management [85]

4.6. On Line Work Management Program, BP-PROG-11.02

BP-PROG-11.02 [88], the On-Line Work Management Program, defines the fundamental business need, constituent elements, functional requirements, implementing approaches and key responsibilities associated with On-Line Work. Its objective is to provide timely identification, selection, prioritization, approval, scheduling and coordination to allow execution of work necessary to ensure safety and to optimize the availability and reliability of SSCs. The program takes into account the risks associated with conducting work. It identifies the impact of work to the station and to work groups; and protects the station from unanticipated transients due to the execution of work. The On-Line Work Management Program also supports nuclear safety and fosters a nuclear safety culture through the incorporation of the following guiding principles and values:

- Provide timely identification, screening, scoping, planning, scheduling, preparation and execution of work necessary to maximize the availability and reliability of station equipment and systems;
- Manage the risk associated with work through the proactive identification of situations or activities that could jeopardize or adversely impact safety margins and enable the development of mitigation strategies;
- Identify the impact of work to the station and work groups, and protect the station from unanticipated transients that result from work; and
- Maximize the efficiency and effectiveness of station staff and material resources while sustaining safe, reliable and competitive plant operation at optimum cost to Bruce Power.

4.7. Outage Work Management Program, BP-PROG-11.03

BP-PROG-11.03 [89] the Outage Work Management program defines the fundamental business need, constituent elements, functional requirements, and implementing approaches associated with Outage Work Management. The purpose is to ensure work activities are identified and the requirements for the work are understood; the work is sequenced, scheduled, and controlled such that maintenance, inspections, and modifications are performed safely and on the basis of value to maintaining safe, reliable and lowest cost operation. This includes selecting and controlling the scope of work, planning, scheduling, coordinating work execution, and closing out the outage.

4.8. Plant Maintenance Program, BP-PROG-11.04

BP-PROG-11.04 [90], Plant Maintenance Program defines the fundamental business need, constituent elements, functional requirements, implementing approaches and key responsibilities associated with the management of the plant maintenance process. Its objective is to perform the hands-on maintenance of plant SSCs in accordance with approved maintenance strategies, schedules, procedures and practices in a cost effective manner that maximizes the availability and reliability of safety-related and production sensitive equipment, while ensuring the commitment to Nuclear Safety (Reactor, Radiation, Environmental and Industrial Safety) is maintained. It satisfies the requirement of the OP&P Clause 3.1 that a maintenance program exist to ensure that the design degree of system effectiveness is maintained. The focus is on predictive and preventive maintenance to support enhanced equipment reliability and improved operational safety performance. Maintenance strategies are continually refined on the basis of Operating Experience (OPEX), feedback from maintenance activity completion reports, and improved technologies. BP-PROG-11.04 is also relevant to “Safety Factor 4: Ageing”. Ageing is a significant contributor to operability of instrumentation and components and affects their material condition.

The current version of BP-PROG-11.04 responds to the audit AU-2013-00006, Maintenance [see Section 7.2.1.2]. The overall assessment of the revisions is that they do not affect the conclusions of this report.

4.9. Conduct of Plant Operations, BP-PROG-12.01

BP-PROG-12.01 [95], Conduct of Plant Operations program defines the fundamental business need, functional requirements, constituent elements and key responsibilities associated with the conduct of operations at Bruce B. The objective is to safely and reliably operate the station systems within the design basis for which the plants are licensed. Operations conducted in accordance with the standards and expectations defined in this program provide strong support for the four pillars of nuclear safety: reactor safety, industrial safety, radiological safety and environmental safety.

The four operational areas implemented by the Conduct of Plant Operations program are:

- Operations Documentation - Controls the development, review, approval of all procedures, flowsheets, and other documents used by Operations personnel;
- Operator Staffing - Controls the activities to ensure qualified Operations staff complements are acceptable for the safe operation of the reactor units and for the performance of routine and outage activities;

- Plant Operation - Controls the execution of Operator activities in the plants to start-up, operate and shut down the reactor units, to refuel the reactors on an on-going basis, to perform routine operations in support of maintenance activities, and to perform routine surveillance of systems and to respond to unanticipated events. Plant operations shall be conducted in a professional manner to ensure safe and reliable operation of the plant, meeting or exceeding all regulatory requirements, industry standards, and industry good practices. They shall also be conducted within the bounds of the Safe Operating Envelope, licence requirements, and approved plant procedures during normal and abnormal conditions; and
- Work Protection - Controls the development and approval of Work Protection related procedures and oversees the execution of Work Protection related activities to ensure an isolated and de-energized condition exists for the execution of work.

4.10. Chemistry Management Program, BP-PROG-12.02

BP-PROG-12.02 [99], Chemistry Management, defines the fundamental business need, constituent elements, functional requirements, implementing approaches and key responsibilities associated with the management of plant chemistry. Its objective is to establish the optimum conditions for system chemistry and to mitigate conditions that could lead to an adverse effect on nuclear safety, radiological safety, personnel safety, environmental safety or plant condition. The requirements of this program meet the requirements of CSA N286.5-95 [27] for Chemistry Control, Section 7.0. BP-PROG-12.02 is also relevant to “Safety Factor 4: Ageing”.

Optimum chemistry control is maintained during plant states, including start up, operation, shut down and lay up, to minimize material degradation, radiation fields and optimize plant performance and life. Chemistry control is conducted to achieve high standards in the control of plant chemistry, establishing the optimum conditions for system chemistry and mitigating conditions that could lead to an adverse effect on nuclear safety, radiological safety, personnel safety or the environment.

4.11. Fuel Management Program, BP-PROG-12.03

BP-PROG-12.03 [100], Fuel Management, defines the fundamental business needs, constituent elements, functional requirements, implementing approaches and key responsibilities associated with all aspects of fuel management. Its objectives are to:

- Optimize reactor core operation within operating and regulatory limits;
- Operate the reactor with fuel of an approved design, manufactured to strict quality assurance requirements;
- Prevent fuel damage throughout the fuel life cycle and ensure removal of failed fuel from the core;

- Achieve as low as reasonably achievable radiation exposure with fuel and Cobalt 60 activities;
- Fulfill obligations under Canada's Safeguards Agreement;
- Support fuel and fuel channel inspection;
- Implement processes and procedures for activities required for the safe and reliable use of nuclear fuel.

The condition of fuel is reported annually to the CNSC per Section 3.8 of CNSC REGDOC-3.1.1 [102].

4.12. Level 2 and 3 Procedures

BP-PROC-00014 [49], Technical Operability Evaluation, provides a uniform process for identifying and evaluating degraded station conditions when the ability of Structures, Systems or Components (SSC) to carry out their safety-related functions comes into question. It provides a substantiated engineering verification that an SSC is capable of fulfilling its minimum credited safety function(s) or a determination that an SSC is not capable of fulfilling its minimum credited safety function(s). A TOE determination may be used to provide a basis for continued operation of a reactor unit, but the primary objective of performing a TOE is to verify operability of the SSC.

BP-PROC-00261 [50], Environmental Qualification, establishes the authority for the Environmental Qualification (EQ) Process at the Bruce Power site. The EQ Process establishes an integrated and comprehensive set of requirements that provide assurance that credited essential equipment and components can perform their safety related functions if exposed to harsh environmental conditions resulting from DBAs, in accordance with the plant design and licensing basis. This capability is preserved over the life of both stations. The process supports the Plant Design Basis Management program BP-PROG-10.01 [37]. BP-PROC-00261 is relevant to "Safety Factor 3: Equipment Qualification".

BP-PROC-00267 [65], Management of Steam Generator and Preheater Tube Integrity, specifies the requirements for monitoring, integrating and assessing information on steam generator and preheater tubes and tube bundle structures and detailing their documentation requirements. It incorporates the reporting requirements associated with demonstrating compliance with design basis and licensing documentation. The Steam Generator Program Team is a forum for monitoring and evaluation of Steam Generator/Preheater related data, in conjunction with the Station Condition Records (SCRs) and Safety Report Update procedures. The Team is a tool to ensure compliance with design requirements, licensing documents, safety analysis, operational and outage performance targets and business plans.

BP-PROC-00268 [66], Safety System Testing (SST) Program Procedure, defines the Safety Related System Testing program and lists the roles and responsibilities of stakeholders for testing the Safety Related Systems to ensure they remain available.

The SST program has been designed to meet the following primary objectives:

- Demonstrate that the special safety, safety support and standby safety systems meet their design targets for availability and operability to ensure design intent is met to support the Safety Analysis and the LCH [2];
- Ensure that the requirements of Operating Policies and Principles are met;
- Provide information to notify the CNSC, as per the PROL, of Safety Related System component failures and impairments discovered by the testing program in accordance with REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants; and
- Provide meaningful failure rate data on Safety Related System operation.

BP-PROC-00284 [67], Predictive Maintenance, establishes the requirements to implement, maintain, and continuously improve a successful Predictive Maintenance (PdM) Program that integrates various equipment condition monitoring technologies. These activities are performed in accordance with the approved maintenance strategy to assure early detection of deteriorating equipment conditions and to provide meaningful information to determine appropriate maintenance action thereby optimizing the overall component and system health.

The goals of the PdM Program are as follows:

- Provide component health status for all equipment monitored using PdM technologies;
- Prevent equipment failure through accurate analysis and timely corrective action;
- Improve equipment safety, reliability and availability by early detection of equipment degradation and by minimizing unplanned corrective maintenance;
- Where applicable, provide justification for extending the frequency of intrusive preventive maintenance;
- Increase lead time of notification for corrective or preventive maintenance;
- Verify that corrective action has produced the desired effect; and
- Determine optimum scope and frequency of PdM activities.

BP-PROC-00334 [68], Periodic Inspection, is performed to satisfy the requirements of Section 6.1 of the Bruce B PROL and associated LCH. As presently configured, inspections must comply with CSA N285.4-09 (with Updates 1&2, so effectively R2011), and CSA N285.5-08[7]. It describes how the requirements for a Periodic Inspection Program (PIP) of plant SSCs are established and documented through creating, updating and revising the Periodic Inspection Plans and Schedules. It documents the methods for review, evaluation and disposition of periodic inspection findings, as required and identifies the roles and responsibilities for PIP personnel.

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[7] Because N285.4 and N285.5 are included in the PROL, Bruce Power is presently also preparing transition plans to update PIP documents to comply with the CSA standard versions to 2014 and 2013, respectively. Adjustments to the subordinate procedures could ensue from that transition.

The condition assessment review in the interim PSR [6] considered Revision 02 of BP-PROC-00334. In the interim, Revision 03 has been issued [68]. It follows the same general principles, but has been reorganized to considerably strengthen alignment and/or compliance with Bruce Power governing procedures, and to better define roles and accountabilities. It provides a definition of Engineering scope for both CSA N285.4 and N285.5. Overall, there have been no major intent changes negatively affecting the compliance with the N285.4 or N285.5 standards, and therefore the results of assessment are the same or better.

BP-PROC-00361 [69], In-Service Testing and Inspection to satisfy CSA N287.7-08 Requirements [103], satisfies CSA N287.7-96 requirements and provides an outline of the In-Service Inspection, Examination and Testing Program required for monitoring and maintaining the structural integrity of the Bruce A and B Concrete Containment Structures (CCS) and their appurtenances during the operating life of the station.

The two main requirements of the Bruce A and B Containment Envelopes (or structures) are that they must:

- Withstand substantial changes in pressure and retain structural integrity when subjected to the higher of the design pressure or the peak Loss of Coolant Accident (LOCA) pressure; and
- Prevent or minimize radioactive releases out of containment in the event of a DBA.

To ensure that these requirements are met, the leak tightness and integrity of the containment envelope is tested and the containment structures inspected, examined, tested and maintained on a periodic basis. This procedure provides an outline of the In-Service Inspection, Examination and Testing Program required for monitoring and maintaining the structural integrity of the Bruce A and B Concrete Containment Structures and their appurtenances during the operating life of the station.

BP-PROC-00383 [55], Performance and Condition Assessment (CA), provides the basis and expectations for the Performance and CA Process at Bruce Power, which supports the Equipment Reliability Program (BP-PROG-11.01). The scope of SSCs to be included in the CA Process is identified through the LCM Process (BP-PROC-00400), based on the impact of SSC failure on plant safety, reliability or economics. The data and information on plant SSCs, which are evaluated in the CA Process, are collected through the Performance and Condition Monitoring Process (BP-PROC-00781). BP-PROC-00383 is also relevant to “Safety Factor 4: Ageing”.

BP-PROC-00387 [70], Plant Inspection, is an implementing procedure of BP-PROC-00781, Performance Monitoring [64], under the program BP-PROG-11.01, Equipment Reliability [52].

The purpose of this procedure is to ensure that the inspections and associated activities performed by Inspection Services Department (ISD) meet all applicable jurisdictional, regulatory and code requirements and are consistently performed:

- In a safe, controlled, and responsive manner,
- In accordance with approved and demonstrated procedures,
- Using properly maintained and calibrated equipment, and

- By trained and qualified personnel.

This document governs the inspection activities provided by ISD in support of other programs, such as BP-PROC-00893, Fuel and Fuel Channel Program [74], and BP-PROC-00267, Management of Steam Generator and Preheater Tube Integrity [65].

BP-PROC-00400 [56], Life Cycle Management for Critical SSCs, supports the Equipment Reliability Program (BP-PROG-11.01) and enables the development of LCMPs for SSCs. The procedure states that it is consistent with RD-334 [104], Aging Management for Nuclear Power Plants, and the Institute of Nuclear Power Operations (INPO) AP-913, Equipment Reliability [105]. RD-334 has been superseded by REGDOC-2.6.3 [106]. Bruce Power completed a gap assessment of Bruce Power governance against CNSC REGDOC-2.6.3, and submitted a transition plan for CNSC REGDOC-2.6.3 implementation [107]. The gap assessment confirmed that the existing governance largely aligns with the requirements of CNSC REGDOC-2.6.3, and identified some areas requiring clarification, for example, in the requirements for periodic reviews of aggregate effects of ageing, as well as governance considerations for ageing management during all phases of the lifecycle of the plant.

Each LCMP pulls together relevant technical information (e.g., age related degradation mechanisms, replacement and major overhaul tasks/frequencies, current condition) from the Condition Assessment Report(s) (CAR(s)), Technical Basis Assessment(s) (TBA), Component and System Performance Monitoring Plan(s) (CPMP/SPMP), Health Report(s), and uses this information to document the proposed long term mitigation options for the subject SSC. These recommended options are included in the Asset Life Projections & Options (ALPO) documents. Table 5 shows the classes of equipment covered in confidential ALPO reports to date.

Table 5: Equipment Classes Addressed in ALPO Studies To Date

System or Component	System or Component
Motors, Pumps and Compressors	Primary Heat Transport (PHT) Feeders
Pressure Vessels and Tanks	Negative Pressure Containment System Components
Heat Exchangers	Fuel Route
Buried Piping	Turbines and Auxiliaries
Nuclear Piping	Main Generators and Auxiliaries
Secondary Piping	Electrical Systems
Above Ground Service Water Piping	Electrical Cables
Valves	Instrumentation and Control (I and C)
Critical Manual Valves	Computer Systems
Calandria and Shield Tank Assembly	Common Services
Steam Generators and Preheaters	

The ALPO process, outlined in a process chart in Section 4 of BP-PROC-00400 [56], adds key information needed in business strategy decisions to the recommended long term options.

Once the business strategy decisions are made, the approved mitigation option (long term plan) is documented in the LCMP, and the LCMP is issued. BP-PROC-00400 is also relevant to "Safety Factor 4: Ageing". B-REP-00701-31MAY2012 [108] provides insight into the rigour of the review to which the End of Life (EOL) projections are subjected.

BP-PROC-00457 [59], Development and Approval of Predefined, defines the process for developing and approving new preventive maintenance Predefines and defines management controls for changing preventive maintenance Predefines.

BP-PROC-00498 [101], Condition Assessment of Generating Units in Support of Life Extension, takes guidance from CNSC RD-360 [109]. (RD-360 has been superseded by REGDOC-2.3.3 [3]. Its emphasis is on a review of safety and safety related SSCs and design basis, condition of the SSCs, and safety performance and equipment qualification. A CA reviews plant data to establish the physical conditions of SSCs and evaluates their functional capability and remaining service life at a plant level. Both the Safety and Licensing and CA analyses provide the basis for economic and feasibility decisions for Life Extension and for project scope development. Aligned with the transition to implementing the Periodic Safety Review process under REGDOC 2.3.3, this legacy methodology is being reconsidered, given the ongoing, continuous condition assessment processes used to monitor the health of SSCs within the overall BP-PROG-11.01 hierarchy.

BP-PROC-00501 [63][8], Integrated Preventive Maintenance Program, establishes the Bruce Power policy defining the Preventive Maintenance (PM) Program objectives, organization and processes. It discusses the methodology to be used to effectively:

- Specify preventive maintenance activities;
- Achieve "Equipment Reliability" (ER) goals; and
- Continuously improve Bruce Power site PM programs.

The program meets the PM standards for INPO AP-913 ER Process Description [105] elements that support Continuing ER Improvement; Scoping and Identification of Critical Components; Performance Monitoring; and Corrective Actions.

BP-PROC-00532 [60][9], Critical and Strategic Spares, enables the identification of Critical and Strategic Spares through the development of Critical Spare Assessments for components. This process supports BP-PROC-00779, Continuing Equipment Reliability Improvement [58]. The Critical Spare Assessments determine which components are essential to the primary function of the subject equipment, and documents recommended Critical Spare quantities. Critical Spares will ensure that components are available in the event of unexpected equipment failures.

[8] The interim PSR [6] reviews referenced Revision 003 while the current revision is Revision 005. A document compare revealed no substantive differences in intent. The migration from R003 to R005 tightened up some definitions and added cross-references to other PM procedures.

[9] Revision 2 of this procedure was a major rewrite from Revision 001, which was reviewed in the interim PSR [6]. It is now focussed more on Asset Management, but the intent is still the same – to support BP-PROC-00779.

BP-PROC-00533 [87], Obsolescence Management, takes its authority from BP-PROG-11.01, Equipment Reliability [52]. It describes the proactive and reactive processes taken to ensure that equipment obsolescence vulnerabilities critical to equipment reliability and plant availability are identified, prioritized and resolved in short term, long term, and cycle management. This procedure provides an overview and guidance with respect to the processes used to identify, prioritize and resolve obsolescence issues. It is also aligned with INPO AP-913 [105], among others such as Electric Power Research Institute (EPRI) TR1019161 [110] and Nuclear Utility Obsolescence Group (NUOG) NX-1037 [111][10].

BP-PROC-00534 [61], Technical Basis Assessment, enables the development of TBA documents for component types. It is consistent with CNSC direction in RD-334, Aging Management for Nuclear Power Plants, and the recommendations in INPO AP-913, Equipment Reliability Description [105]. (RD-334 has been superseded by REGDOC-2.6.3 [106]. The TBA provides a baseline for the maintenance strategy of the component type and documents this information using a maintenance template. To generate a TBA, a Failure Modes & Effects Analysis (FMEA) is produced. The FMEA lists the degradation mechanisms that cause or influence the failure modes of the component type. Mitigating tasks are identified, up to and including the complete replacement or major overhaul of the component type, and appropriate frequencies for these tasks are populated in the maintenance template.

The maintenance template serves as the baseline for the development and analysis of specific maintenance tasks (e.g., PMs). It is not meant to capture all of the specific condition-based factors that may affect the component type. Additional analysis must occur before applying the maintenance template to specific equipment tags (Maintenance Strategy, as per BP-PROC-00789 Section 4.2.1 [112]). Tasks relating to the end of life of a component, such as replacement or major overhaul, have a recommended implementation plan developed for them in the LCMP process (LCM for Critical SSCs, as per BP-PROC-00400) or the AMOT (Asset Management Options Template) process [113] for those SSCs that do not require a full LCMP.

BP-PROC-00561, Operator Fundamentals, sets forth the expectations for performing, assessing, and reinforcing Operator Fundamentals to ensure Operations activities achieve industry best performance. These operator fundamentals constitute a set of standards and behaviours for the Bruce Power Operations Division of the nuclear stations only.

Appendix A of BP-PROC-00561 lists the fundamental behaviours expected of field operators, Control Room Operators, Control Room Shift Supervisors/Field Shift Operating Supervisors, and Shift Managers. The following table of plant monitoring behaviours extracted from Appendix A demonstrates expectations that directly support condition assessment review tasks:

[10] Distributed by INPO. Nuclear Utility Obsolescence Group (NUOG) is composed of representatives from nuclear utilities, industry organizations (e.g., INPO, EPRI), and selected suppliers.

Field Operators	Control Room Operators	CRSS/FSOS	Shift Manager
• Perform thorough OFIs/Rounds to detect actual or potential problems that could hamper plant operation. • Be attentive to all equipment, not just that listed in OFIs. • Be the eyes and ears of the Station. • Believe your indications and use multiple independent means, if available, to validate parameter status, avoiding undue focus on any single indicator. • Investigate and report all discrepancies to the Control Room. • Own housekeeping.	• Monitor the control room panels and trends at a frequency relative to their importance. • Closely Monitor CSPs/SPs. • Investigate all alarms - it is a messag e from the equipment. • Believe your indications and use multiple independent means to validate parameter status, prior to taking action. • Identify degrading parameter and equipment trends.	• Ensure effective plant monitoring by Operators. • Perform required panel/field walk downs. • Maintain a high degree of professionali sm in the Control Room to minimize distractions to Operators. • Establish increased monitoring for disabled alarm functions or equipment as appropriate.	• Ensure equipment used to monitor plant is functioning properly. • Know the status of the plant, key activities and current risks. • Maintain oversight of plant and crew response during transient and emergency conditions. • Be the voice of the plant.

BP-PROC-00582 [51], Engineering Fundamentals, is crucial in setting expectations for Engineering staff and enumerates fundamental tasks expected as part of every-day job activities. Based on an INPO recommendation, the fundamentals are defined as the essential knowledge, skills, behaviours, and practices personnel need to apply to conduct their work properly. It assists with establishing basic nuclear safety culture among engineering staff. It emphasizes activities that support plant condition and condition assessment.

Appendix A of BP-PROC-00582 lists governing principles for engineers and their managers. The following selected quote extracted from the first of the fourteen categories demonstrates expectations that directly support condition assessment review tasks:

Category	Engineers' Behaviour
Monitor and Evaluate	• Know your equipment. Complete rigorous daily monitoring and ensure aggregate risk is considered for degraded and/or out of service equipment. • Use routine walk downs and interactions with Operations and Maintenance to become familiar with system and component challenges. • Complete and document walk downs as detailed in the performance monitoring plan. • Understand design and operating margin, use established processes to identify and communicate any reduction in margins, including conditional Single Point Vulnerabilities. • Engage operations, maintenance and other stakeholders when assessing system/component/program health and their associated improvement plans. Use the Station Plant Health Committee to identify health threats and solutions. • Proactively identify degraded equipment conditions or repetitive equipment issues through performance monitoring activities and trend analysis. Proactively monitor for and take action on any adverse performance trends. Use the SCR process to document adverse conditions and the Corrective Action Process to document actions to prevent recurrence. • Monitor for and expect material condition excellence. Use the established work management processes to achieve material condition excellence. • Optimize use of Predictive Maintenance techniques to monitor system and component performance.

BP-PROC-00666 [57], Component Categorization, provides the basis for categorizing components (Criticality, duty cycle, Service Condition, Single Point Vulnerability) at Bruce Power. Consistent and accurate categorization of components supports BP-PROC-00778 [56], Scoping and Identification of Critical SSCs, and is fundamental to the successful execution of BP-PROG-11.01 [54], Equipment Reliability Program. This procedure is consistent with the recommendations in INPO AP-913 R004, Equipment Reliability [105].

Specific objectives of this procedure are:

- Categorize the criticality of the component (Critical Category 1 to 4) based on the functional failure effect of the component and value of preventive maintenance;
- Provide the criteria to identify Single Point Vulnerabilities; and
- Populate other component data in PassPort Panel D041 in support of component maintenance strategy development. The data include duty cycle, service condition, and S-98 (now RD/GD-98) equipment importance designation.

BP-PROC-00695 [91], Maintenance Program and Activities, describes the maintenance program for plant equipment, specifying the following elements:

- What maintenance activities are to be performed on given structures, systems, or components (SSCs) and at what frequency/intervals.

- Activities aimed at avoiding, detecting and repairing failures of structures, systems or components (SSCs).
- Monitoring of the SSCs.
- Maintenance program activity optimization.
- Record keeping of maintenance performed.

It is written to align and satisfy the expectations set forth by the CNSC in the S-210 Standard (Maintenance Programs for Nuclear Power Plants) as well as its superseding document RD/GD-210.

BP-PROC-00778 [56], Scoping and Identification of Critical SSCs, is fundamental to the successful execution of BP-PROG-11.01, Equipment Reliability Program. It is consistent with the recommendations in INPO AP-913, Equipment Reliability [105]. It describes the process for identifying SSCs important to maintaining safe, reliable power operation. Aspects of nuclear safety (reactor safety, industrial safety, environmental safety and radiation safety) are addressed.

The procedure provides the basis for developing system and component performance monitoring plans (SPMPs and CPMPs) and PM strategies, or redesign requirements.

BP-PROC-00778 [56] further identifies:

- Scoping criteria;
- Functions of SSCs related to safety and reliability;
- Critical structures and components that support these functions;
- Non-critical components; and
- Run to maintenance components (Category 4).

Systems important to maintaining safe, reliable power operation include those identified in the safety related system list (BP-PROC-00169 [114]) and those identified as systems important to safety (DPT-RS-00012 [115]). Components important to maintaining safe, reliable power operation include components on the master equipment list (MEL) identified as critical or significant to plant operation. These include:

- Components important to safety in systems important to safety; and
- Components that are single points of vulnerability.

Components and structures not in the MEL (such as piping, cables and supports) are reviewed to identify those important to maintaining safe, reliable power operation. SSCs are prioritized to optimize safety, reliability, availability, cost and performance within the regulatory framework.

BP-PROC-00779 [58], Continuing Equipment Reliability Improvement, describes the process for development and optimization of the preventive maintenance technical basis and tasks to support a documented Preventive Maintenance program, for the SSCs identified in BP-PROC-00778, Scoping and Identification of Critical SSCs [56].

Industry templates are available for major component types, and identify failure mechanisms, monitoring and mitigating tasks and task frequencies, based on external OPEX. Selected templates are configured for Bruce Power application through a TBA (BP-PROC-00534, Technical Basis Assessment [61]) using internal and external OPEX, to create a Bruce Power PM Template. The Bruce Power PM Template identifies planned, periodic, and predictive tasks and frequencies, on a structure or component basis for Category 1, 2 or 3 components. The TBA activity is conducted to support development of the PM templates.

The TBA identifies failure and degradation mechanisms, monitoring and mitigation tasks for those mechanisms. The TBA provides a technical basis for the maintenance strategy for this equipment, as implemented by the templates.

BP-PROC-00780 [62], Preventive Maintenance Implementation, describes the process for carrying out preventive maintenance in support of a continuously improving equipment reliability process in support of BP-PROG-11.01, Equipment Reliability [54]. It is implemented by BP-PROC-00284, Predictive Maintenance [67]; SEC-MSS-00004, Proactive Maintenance Processes [93]; BP-PROC-00456, Preventive Maintenance (PM) WO Deferral Process [116]; BP-PROC-00457, Development and Approval of Predefined [59]; BP-PROC-00501, Integrated Preventive Maintenance Program [63]; BP-PROC-00599, Engineering Guidance for Preventive Maintenance [117] and BP-PROC-00603, Preventive Maintenance Program Just in Time (JIT) Review Process [118].

The procedure outlines the interface with the work management system to schedule periodic, predictive and planned maintenance for Structures, Systems, Components (SSCs) on a prioritized/risk informed basis. It also describes the development and use of model work orders as an effective method to define work instructions to carry out preventive maintenance, and the development and use of a standard set of post maintenance tests to verify important SSC functions and the effectiveness of the maintenance performed.

Preventive maintenance covered by this procedure includes periodic, predictive and planned maintenance. It includes preventive maintenance performed during operation and during outages. Preventive maintenance includes tasks scheduled for components on the MEL (such as pumps, motors, tanks, etc.) and inspection programs carried out for components not on the MEL (such as piping, building structures, feeders, etc.). Consideration is also given to equipment listed within the Operational Safety Requirements (OSR) as part of adhering to the licensing requirement CSA N290.15-10, Safe Operating Envelope (SOE) (reference DPT-RS-00015, Safe Operating Envelope Gap Assessment [119]).

BP-PROC-00781 [64], Performance Monitoring, provides the basis and expectations for the Equipment Performance Monitoring Process and supports the ER Program (BP-PROG-11.01).

The scope of the SSCs included in the performance and condition monitoring program is identified by assessing the criticality of the SSC. This is done by applying the appropriate screening criteria to the function of the SSC and assessing the impact of SSC failure on plant safety, reliability or economics via BP-PROC-00778, Scoping and Identification of Critical SSCs [56].

The procedure describes the process for establishing performance criteria and monitoring parameters for important structures, important system functions and critical components and program performance. This procedure describes the:

- Monitoring and trending of system performance;
- Monitoring and trending of component performance;
- Monitoring and trending of program performance;
- Trending of PdM results;
- Use of operator rounds monitoring;
- Monitoring of SST results; and
- Monitoring by RSE/Station Component Engineer walkdowns.

Performance monitoring results are recorded in System Health Reports (SHRs), Component Health Reports (CHRs) or Program Health Reports (see BP-PROC-00863 below). The development and implementation of long term equipment health plans is documented.

BP-PROC-00782 [84], Equipment Reliability Problem Identification & Resolution, describes the problem resolution process, including the interface with the SCR process (BP-PROC-00060) and the Action Tracking Process (BP-PROC-00019). It describes the process to follow when a critical SSC experiences an unplanned failure or when performance is seen, through Performance Monitoring, to have degraded. This element of the ER process corresponds to the Corrective Action component of INPO AP-913 [105]. Required Corrective Maintenance is executed according to the procedures in BP-PROG-11.04, Plant Maintenance Program [90].

For an unplanned critical SSC failure, the relevance to nuclear safety is assessed and either an equipment apparent cause or root cause investigation of the degradation or failure is initiated in accordance with BP-PROC-00060, SCR Process [Corrective Action Program] [120]. Corrective actions are determined, including providing feedback to the Continuing ER Improvement process.

As part of the resolution process, feedback is provided to developing and implementing long term system or component health improvement plans as part of the Performance Monitoring process. Periodic assessments are made of system, component and program health and vulnerabilities in Health Reports. The system or component health improvement plans are a forward looking assessment of current problems and future vulnerabilities, providing direction on system or component performance improvement.

BP-PROC-00783 [85], Long Term Planning & Life Cycle Management, enables the development of LCMPs and the identification and management of obsolescence issues. LCMPs are an input to asset management, and are used as feedback to drive the Continuous ER Improvement process (BP-PROC-00779).

Asset management, as driven by the ALPO studies in Table 5, facilitates business decisions about Capital and Operations & Maintenance investments, long term planning and asset replacement, and maintenance plans and priorities. This drives the following processes:

- Strategic and long range planning;
- Generation planning;
- Project evaluation and ranking;
- Budgeting;
- Plant/Front Line Engineering Emergent (Issues) Team valuation; and
- Ageing management.

BP-PROC-00825 [71], Buried Piping Inspection Program**,** establishes the process and specifies the requirements to detect and assess degradation in buried piping as a result of its ageing and material degradation due to the effects of related degradation mechanisms, and to initiate corrective action at Bruce Power. These activities are performed to maintain buried piping integrity in order to reduce the risk of the potential impacts to the environment and public confidence in the event that unanticipated buried piping failures occur, and to ensure that buried piping systems important to the safe operation of the plant are capable of meeting their design basis requirements until the projected end of life of the generating units/stations.

BP-PROC-00849 [72], Aggregate Risk Assessment and Monitoring, describes a methodology for Engineering staff to assess aggregate risk due to degraded equipment or off normal plant conditions. It helps build a culture where Engineering systematically conducts assessments of system equipment health as a periodic formal review. This aids Station Management and personnel in being aware of the overall risk to operations based on an assessment of the interaction of various risk contributors that impact a system or system reliability, and the subsequent potential for adverse effects on the overall reliability of the Station.

BP-PROC-00863 [73], Engineering Programs Health Reporting, provides the basis and expectations related to the development and generation of Program Health Reports to meet ER goals and continuous improvement. Health Reports are developed for those Engineering Programs that are deemed critical to ensure safe and reliable plant operation.

Engineering Programs are defined as an administratively controlled and ongoing engineering activity that implements regulatory requirements, World Association of Nuclear Operators (WANO) recommendations, plant efficiency and safety improvements, industry OPEX, or management requirements that are non-component specific.

Program Health Reports measure the health of Engineering Program scoping, planning and execution using defined criteria and metrics. The procedure supports BP-PROC-00781, Performance and Condition Monitoring. BP-PROC-00781 in turn supports BP-PROG-11.01, ER and implementation of the INPO AP-913 ER Process [105].

DPT-PE-00008 [77], System and Component Performance Monitoring Plans, provides the basis and expectations for the development, generation and implementation of SPMPs and CPMPs by which engineering continually monitors risk significant systems and component groups.

It directly supports execution of:

- BP-PROC-00781, Performance Monitoring [64];

- DPT-PE-00009, System and Component Performance Monitoring Walkdowns [78];
- DPT-PE-00010, System Health Reporting [79]; and
- DPT-PE-00011, Component Health Reporting [80].

SPMPs and CPMPs contain detailed requirements for System/Component Engineers to use in performance monitoring of their assigned equipment. These requirements include [77]:

- Performance goals;
- Functional failure modes; and
- Identification of equipment (performance monitoring equipment list) and performance indicators to be trended.

DPT-PE-00009 [78], System and Component Performance Monitoring Walkdowns, provides the basis and expectations for the execution of system and component performance monitoring walkdowns. It provides guidance to Plant Engineers for conducting walkdowns on the applicable systems and component types as prescribed in BP-PROC-00781, Performance Monitoring [64].

This procedure defines the scope of performance monitoring walkdowns as follows:

- It defines various types of walkdowns.
- It provides guidelines/specific requirements on when to and how to perform walkdowns and what to look for (Appendix D, System/Component Walkdown Checklist).
- It defines the walkdown documentation requirements.

DPT-PE-00010 [79], System Health Reporting, provides the basis and expectations related to the development and generation of SHRs to meet ER goals and continuous improvement. SHRs are developed for those systems and associated equipment that are deemed critical to ensure safe and reliable plant operation.

The procedure defines the scope and content of SHRs by:

- Providing directions for compiling and evaluating specific system information to determine a graded system health status (e.g., operating status, performance monitoring results and trending, ageing and obsolescence issues, reliability concerns);
- Assessing system “critical” equipment condition by measuring System Performance Monitoring Plan Performance Indicators against a predefined set of criteria;
- Providing for trending of System Health and Performance Indicators over time to discern the direction of system performance and proactively identifying changes needed to improve equipment reliability and system health; and
- Defining the Health Report document and communication requirements to capture and convey the graded system health and identified issues/action plans to Plant Management.

DPT-PE-00011 [80], Component Health Reporting, provides the basis and expectations related to the development and generation of CHRs to meet ER goals and continuous improvement. Health Reports are developed for those Components that are deemed critical to ensure safe and reliable plant operation.

It defines the scope and content of CHRs including:

- Providing directions for compiling and evaluating specific component information such as operating status, performance monitoring results, ageing and obsolescence issues, and reliability concerns, to determine a graded component health status;
- Assessing component condition by measuring the CPMP Performance Indicators against a predefined set of criteria;
- Providing for trending of Component health and Performance Indicators over time to discern the direction of Component performance and proactively identifying changes needed to improve equipment reliability and component health; and
- Defining the Health Report document and communication requirements to capture and convey the graded component health and identified issues/action plans to Plant Management.

BP-PROC-00893 [74], Fuel and Fuel Channel Program, identifies and addresses multidisciplinary parameters to assure safe and reliable operation of Fuel and Fuel Channels. It takes authority from BP-PROC-00781, Performance Monitoring [64] and is part of the ER Integration.

GRP-OPS-00034 [96], Control of Operator Challenges, provides guidance for the definition, identification, prioritization, processing, aggregate assessment and resolution of Operator Challenges, i.e., Operator Work Arounds, Operator Work Burdens, Jumpered Alarms, Main Control Room Deficiencies, and Operator Distractions.

GRP-OPS-00047 [97], Operator Routines and Inspections - Bruce A and Bruce B, defines what Routines and OFIs are, how they are initiated, changed, scheduled, conducted, and documents the process, standards and requirements for their completion. Operator Field Inspections and Routines are key to monitoring and are fundamental in ensuring that process systems and components are operating properly, parameter values are within limits, poised systems are available to operate properly, and overall unit conditions are maintained to a high standard.

In addition to general procedures described above, section procedures based on the application of NuSCI cover a technical process to facilitate the creation of operating, maintenance and engineering type procedures at the equipment and component level. These procedures ensure the condition of components found in multiple systems, such as motors, valves and heat exchangers (HXs), are monitored, reviewed and managed in a common manner. Examples include:

- SEC-RE-00017 [83], Motor Program;
- SEC-ME-00008 [81], Heat Exchangers; and
- SEC-ME-00010 [82], Inspection and Monitoring Once-Through Service Water Systems.

In the Safety Basis Report [6], this list included SEC-MSS-00004 [93], Proactive Maintenance Process, and SEC-ME-00007 [75], Pipe Wall Thinning – FAC. The requirements in these two procedures have been promoted to the BP-PROC series. SEC-MSS-00004 has been superseded by BP-PROC-00694 [94] and SEC-ME-00007 [75] by BP-PROC-00923 [76]. For SEC-ME-00007, a comparison of the two documents reveals large blocks of common text. That is, BP-PROC-000923 appears to be an upgrade of SEC-ME-00007 R003. However, the update does codify the Periodic and In-service Inspection programs as being a continuing requirement of Section 4.3 of the PROL. The new PROC is considerably more prescriptive in terms of consideration of Engineering Analysis and Documentation, on the requirement for FASAs, on training and qualifications of inspection staff, and on review, classification and acceptance of the inspection results. This PROC will be updated to align with N286-12. OPEX plays a role in selection of components for inspection.

5. Results of the Review

The results of the review of this Safety Factor are documented below under headings that correspond to the thirteen review tasks listed in Section 1.2 of this document. First, an amplified discussion of SSCs important to safety (SIS) in Section 5.1 sets the context. With the insertion of the SIS discussion, the subsection numbering corresponds to the list of review tasks, offset by one.

5.1. SSCs Important to Safety and their Classification

To focus the review of the condition of SSCs important to safety as part of this PSR, the initial step was to determine the SSCs that needed to be assessed from a nuclear safety perspective and eliminate those on the CA lists due to their relevance to only operational or production significance (e.g., the Main Generator).

The Safety Factor 2 review [13] for Units 3 and 4 utilized a screening and grouping of equipment and components for CAs based on a review of the entire SSC identification list (formerly called the Universal Subject Index; now called the NuSCI) [121]. This index includes both safety and non-safety related equipment and components, and subject disciplines (e.g., Regulatory correspondence (00531)). This screening and grouping was used to determine which SSCs needed to have CAs (CA Summary Report [122] [11] and [123]) as fewer CAs existed and the process and procedures to determine the appropriate systems were in their infancy. In the 7 or 8 years since that time, the process and procedures to determine which SSCs require CAs has significantly evolved. BP-PROC-00781 [64] Appendices B and C, identify the increased number

[11] The interim PSR report [6] referred to the initial U34 refurbishment document [124] for guidance on how various review tasks could be addressed in response to the IAEA guidelines. These concepts are now included in improved quarterly SHRs, the key enhanced input for the review. Repeat references to the initial refurbishment assessment report throughout Section 5 should be interpreted in this context; i.e., when Reference [124] is invoked, it should be understood that information on system condition in the SHRs is also being invoked.

of systems and components where CAs have been performed based on their importance to safety, importance to generation and asset preservation, and general significance (rotating equipment, valves, Instrumentation and Control (I&C) general, or based on engineering programs) for all of Bruce 014 and 058. Before the migration from producing CARs in favour of utilizing existing System Health Reports[12], there were approximately 200 CARs produced for Bruce A and B encompassing more than 200 systems, auxiliary systems, subsystems and components as CARs tended to include groups of NuSCIs. The original CARs provide a baseline and are referenced in the formulation of ALPO and AMOTs, which are precursors to finalized LCMPs (see Section 5.2).

This complete list of CARs was compared to the probabilistic risk assessment [124] systems important to safety which complies with Regulatory Document S-98, plus the priority 1 and 2 systems requiring an OSR (Table 1 in [125], also reproduced as Table 6 in Section 5.3 below). (S-98 has been superseded by RD/GD-98; however, RD/GD-98 does not add to the requirements of S-98.) These SSCs have been reflected in the Equipment Reliability Program [54]. Items were added (NuSCI 24100, 24400, 24500 and 34400) per Section 1.2, due in part to the events in Fukushima. These system lists compare favourably with the systems identified in the Risk Significant Systems list [115] for decision making purposes and the Safety Related System List, BP-PROC-00169 [114] which was used in the Bruce 3 and 4 assessment and discussed in the CA Summary Report [122] (see footnote 11). The listing in Appendix D herein provides the list of Tier 1 and Tier 2 system SHRs, as defined in Section 4.1 of BP-PROC-00781 [64].

Items relevant to production (e.g., Main Generator) were excluded for the CA assessment for the interim PSR, and items that would not be expected to degrade during the next 10-year period were not assessed (e.g., concrete, large vessels).

This Safety Factor Report uses the following explanation multiple times throughout Section 5, so it is appropriate to mention it at this stage to avoid repetition. A detailed review and status [126] for the SSCs important to safety[13] was conducted in late 2013 and it shows overall good to excellent performance for systems and components, trending upwards, as Bruce Power continues to focus on improving equipment reliability to achieve safe, reliable, and economic production. The assessment systematically reviewed and calculated numerical performance indicators, augmented by day-to-day detailed assessments from Responsible System Engineers (RSEs) and Responsible Component Engineers (RCEs). The report provides summary histograms of the performance indicators for Bruce B showing steady progress to 2012. It reviews the measures to improve performance and programs to bring systems and components requiring improvement to satisfactory or excellent ratings and concludes they are effective. Also, it reviewed the plans in place to improve the systems and components within the next licensing period to ensure that those systems and components receive effective support. The

[12] Bruce Power stopped producing CARs in early April 2012. There was significant overlap among the various health reports, CARs, SHRs, and SPMPs, all with a slightly different format, purpose, and official records status.

[13] The review also included Tier 2 systems [92] supporting production, so it is more comprehensive than required for the present assessment.

two “Red” systems (Fuel Handling Inverters and Water Treatment Plant) are shown to progress to Yellow and White, respectively, as system improvements are completed. A summary of the states of health of the same systems in 2014 was submitted to the CNSC [127]. Section 1.1.3 of this summary shows that the Water Treatment Plant health had progressed to White in 2014. Based on the continued emphasis on equipment reliability and monitoring, and a comparison of the 2013 states of health with the 2014 states of health, which shows a continuing upward trend in system health, it is a reasonable extension that no cliff edge deterioration in system reliability will have occurred, and thus the 2014 submission continues to be a valid representation of system health for the purposes of this Safety Factor Report.

The expectation that SSC performance is being monitored and thereby improved will be limited by age-related degradation mechanisms (ARDMs) that limit the life of SSCs, ultimately having an impact on SSC performance. Bruce Power continues to determine the condition of SSCs by classifying them based on their importance to various parameters (e.g., safety, operability, single point vulnerability) and conducting regular reviews in the form of System Health Reports and Life Cycle Management Plan effectiveness assessments.

5.2. Existing or Anticipated Ageing Processes

This section addresses review task 1. This review task overlaps extensively with Safety Factor 4, which programmatically would satisfy a significant part of this review task.

LCM is the integration of ageing management and economic planning adopted by Bruce Power to optimize the operation, maintenance, and service life of SSCs, maintain an acceptable level of safety and performance, and maximize return of investment over the service life of the plant (INPO AP-913 [105]). The Bruce Power LCMPs compile technical information from the original Condition Assessments, Technical Basis Assessments, Performance Monitoring Plans (PMPs), SHRs, and other data sources such as SCRs, Technical Operability Evaluations (TOEs) and Engineering Evaluations and use this information to document the recommended long term mitigation options for the subject SSC [56]. A key item from this compilation is an understanding of the age-related degradation mechanisms for the SSCs. These age-related degradation mechanisms are used as inputs to the ALPO and AMOT documents.

The LCMP mandate and organization are described in BP-MSM-1 Sheet 0002, MSM - Approved Reference Chart Authorities and Responsibilities [43]. Two relevant roles for Vice President, Corporate Strategy & Business Development, from that mandate that provide the essence of the structured process are:

- Manage the process to select and approve Asset Management options to achieve a resource leveled, integrated Asset Management Plan that will provide safe, reliable long term operation in alignment with corporate strategic and business planning objectives; and
- Monitor the quality of ALPOs, LCMP development and implementation, outage preparation and execution, MCR preparations, Project Management and Construction (PMC) execution, analysis and online inspections and maintenance as they pertain to execution of the Asset Management Plan.

Implementation of the LCMPs is the responsibility of Component and Program Engineering (CAPE), Department Manager, stated in the BPMSM as follows:

- Provide Engineering Governance, Oversight and Support for the following Asset Management Programs; Ice Plugs, Welding/Brazing, Metallurgical/Material Science, Cranes/Rigging, Parts Manufacturing/Reverse Engineering support, Measurement & Test Equipment support, Asset Management (Single Point of Vulnerability (SPV), Ageing and Obsolescence, LCMP, Critical/strategic spares).

Section 4.3 of the LCMP Procedure [86] requires Data Gathering and Review to focus on obtaining information externally from available industry sources and internally from Bruce Power sources on the SSCs in the area of potential failures, repairs/corrective strategies, ageing degradation, failure modes, and obsolescence. Lower tier Section procedures have been developed to assist the RSEs in particular disciplines to better understand and address the gamut of degradation mechanisms. For example, Inspection and Monitoring of Once-Through Service Water Systems discusses flow-related, biological and infrequent mechanisms to be considered when looking at 15 service water systems and systems that utilize service water at Bruce B (Appendices C and D of [82]).

A list of LCMP summaries submitted to the CNSC identifies 32 plans. Each LCMP, from which the summary is derived, reviews existing failure modes and ageing processes to better understand the remaining service life of the SSCs and to determine what steps are required for their replacement, and when.

Part of the implementation of the LCMP involves the preparation of AMOTs (Section 4.4.1 of [113]) to assist with the decision for the best available option to manage the SSC's end of life strategy. These are presented to an Asset Management Option Selection Committee composed of Bruce Power Vice Presidents. The selected option becomes part of the LCMP and is integrated into the overall Lifetime Asset Management Plan for the site.

Therefore, Bruce Power meets the requirements of this review task.

5.3. Operational Limits and Conditions

This section addresses review task 2, and demonstrates that the reactor has Operational Limits and Conditions appropriate for systems important to safety to ensure safe operation. Sections 5.6 to 5.8 describe measures to demonstrate compliance with these limits, given SSC aging and condition.

Condition G.1 of the PROL [1] requires that operation of the plant shall conform with the licensing basis (and hence the safety analyses (Safety Report)), and so the underlying assumptions become a key element of the essential requirements for safe plant operation. The limits and conditions associated with these essential safety requirements form the SOE and are addressed in this section.

The requirement for design, analysis, operation and maintenance within the SOE is a fundamental requirement in the CSA standard N286-05 [25], Section 6.3, Safe Operating Envelope (SOE) to which Bruce Power is currently licensed.

The COG document Principles and Guidelines for SOE [128], expands on these requirements and provides guidelines for implementation. These guidelines had a pseudo-licensing status during the development of the SOE Program at Bruce given that Bruce Power had committed to the CNSC to have a program that is consistent with this COG document. This COG document has been superseded by CSA standard N290.15-10 [30], Requirements for the Safe Operating Envelope of Nuclear Power Plants. The requirement for operation within a well-documented SOE is also imbedded in Section 3.1 of the LCH for Bruce A and B [2]. Compliance with N290.15-10 is achieved by ensuring plant operations are controlled to OP&P and Impairment Manual and Operating Manual limits and constraints. Compliance is assured through the licensing processes and, therefore, is not addressed further here (see Safety Factor 5).

In a process similar to all Canadian CANDU utilities, Bruce Power implements the requirement by first extracting the limits from existing licensing analysis to an Operational Safety Requirements (OSR) document for each safety related system (DPT-NSAS-00012 [124]), and applies instrument uncertainty values to establish the limits of the envelope in operating space[14]. To ensure station compliance, the Reactor Safety Support Department performs a gap assessment [119] against operating procedures and confirms with stakeholders, such as Design and Plant Engineering, to ensure that the OSR limits with indication uncertainty bound the operating envelope. The process is complete for all Priority 1 and 2 systems for Bruce B (Table 6) listed in Table 1 of [124]. The OSR limits are subject to ongoing review and revision for sustainability [119].

The gap assessment also includes a review of the limits in the Impairments Manual (IM) used by Operations. The IM provides direction to Operations staff on what actions must be taken in what time frames if, during regular surveillance, a safety-related system is found to be operating outside the conservative values included in the IM. The time frame for action depends on whether the system would be able to meet its full or partial safety function. The loss of full function (e.g., no redundancy) demands prompt action, whereas systems with sufficient redundancy can be repaired in an orderly manner, although still within defined time frames.

Compliance with the SOE is continuously confirmed by a comprehensive set of operator and maintenance actions such as calibration of measuring equipment and tracking results, provision of alarms (visual, electronic, or digital), routine mandatory functional testing, formal panel checks, and operator field surveillances; see Sections 5.7 and 5.8.

These actions are performed at defined intervals consistent with the past performance of the system to meet reliability targets.

[14] Instrument Uncertainty Calculations (IUC) result in a formal Controlled Document NK29-CALC series report; generally one IUC report for each SOE system.

Table 6: Systems Requiring an OSR

Priority	Bruce B System
1a	SDS1
	SDS2
	ECI
	Containment
	Fuel and Reactor Physics
1b	Heat Transport System
	Moderator System
	Shutdown Cooling and Maintenance Cooling Systems
	Main Steam Supply System
	Feedwater and Condensate System
	Emergency Water System
	Service Water Systems
	Powerhouse Emergency Venting System
	Emergency Power Supply
	Electrical Systems
	Reactor Regulating System
2	Fuel Handling Systems
	End Shield Cooling System
	Annulus Gas System
	Critical Safety Parameter Monitoring
	Confinement

Table 6 includes only systems requiring an OSR from the SIS list, most of which are common to the S-98 (now RD/GD-98) SIS list, per [129]. For these systems, test acceptance criteria are defined explicitly to stay within the licensing safety analysis.

In addition, every system has operating limits provided in its Operating Manual. Most systems, and especially all SIS, have SSTs with limits for reporting and follow-up. The performance (availability) of all SIS is tracked and reported to the CNSC in the Annual Reliability Report [129]. Many systems have hard wired alarms or control-computer-generated alarms at specific values (limits); for each alarm there is a one or two page instruction (alarm response manual) on how the operator is expected to respond.

In addition to these surveillances, there are operator field routines, where operators check the state of operating systems.

These surveillances are specified in the suite of Operating documentation for each system. Section 4 of BP-PROG-12.01 [130] sets Operations' expectations and documentation requirements. BP-PROG-11.01, Equipment Reliability [52], provides the authority for monitoring. BP-PROC-00781, Performance and Condition Monitoring [64], which takes its authority from BP-PROG-11.01, defines the activity of Performance Monitoring as "To regularly check on identified parameters, which measure equipment and process performance in order to control that performance within acceptable and specified limits. Methods of monitoring can include such activities as time based trending of parameter levels, simple parameter level checks against a pre-set limit, observational results of walk downs, review of plant information trends/data, operational, shift logs, …" (Section 3.1.9). Appendix B of BP-PROC-00781 lists the importance of systems to be tested, with the S-98 (now RD/GD-98) SIS list as Tier 1. Implementing procedures DPT-PE-00008 [77], -00009 [78], -00010 [79] and -00011 [80] cover the range of components and systems to be tested, and the means by which the testing is to be performed.

In addition, Bruce B has implemented a pattern recognition scheme, SmartSignal™ that is designed to notify Plant Engineering staff when any of thousands of parameters is outside its expected range for any given plant state. See Section 5.7 for more detail.

Bruce Power meets the requirement for a controlled set of Operating Limits and Conditions.

5.4. Current State of SSCs with Regard to Obsolescence

This section addresses review task 3.

Obsolescence is a fundamental element of the assessment and decisions made in the Asset Management process. It has received significant scrutiny since the introduction of Equipment Reliability and the related Asset Management activities.

Obsolescence is more pertinent to components, but it is a required input for both Component (DPT-PE-00011 [80]) and System (DPT-PE-00010 [79]) Health Reporting. Both procedures provide "directions for compiling and evaluating specific Component [System] information such as operating status, … aging & obsolescence issues, …, etc., to determine a graded Component [System] health status". Systems comprise an assembly of components and so obsolescence of components is directly included in the performance calculation arriving at the System Health colour-coded index, that is, Green, White, Yellow or Red.

BP-PROC-00533 [87], Obsolescence Management, defines the methodology for, and outputs from, obsolescence assessment. Section 4 herein describes the methodology with the summary of BP-PROC-00533. The output is stored in the Site Obsolescence List, or the Living List in the Obsolescence Manager of the commercial Proactive Obsolescence Management System (POMS) software package, and is accessible via the Bruce Power intranet. It includes a database with obsolescence evaluations of thousands of components, from which the most important obsolescent items can be obtained (e.g., Top 10 or Top 100 lists can be extracted). Components are classified by their importance and whether they are a Single Point of

Vulnerability[15] (SPV); i.e., importance to safety and/or vulnerability (e.g., loss of redundancy) put the component in the highest vulnerability classification. Obsolescence Value Ranking (OVR)[16] is a weighted numerical index using such inputs as safety classification, spare parts availability, number of spares in stores, maintenance work order history, number of end uses, required lead time, and SPV.

As noted, obsolescence is a topic covered in the SHRs [79]. The states of health of the systems important to safety are listed in [127] along with summaries of the health of the systems with a Red or Yellow status. The summaries note obsolescence issues that contribute to the low health rating. These are listed in Table 7 along with the strategies in place to circumvent the obsolescence issues until the issues can be resolved. As noted in Section 4.8 herein, the SHRs are also a source of information for the LCMPs. Consequently, the list of LCMPs in place at the end of 2015 [131] also identifies components that are obsolete and have required a bridging strategy [127]. These components are also found in Table 7.

Table 7: Strategies for Obsolete Components in Bruce B

Component	Bridging Strategy
Safety System Monitoring Computers	Replacement of obsolete components with emulators. (Total hardware replacement nearing completion.)
Instrument and Service Air Compressors	Replace components as they fail with existing spare parts.
Pressure Transmitters	A last-time purchase from the supplier.
Relief Valves (RVs)	PMs used to replace RVs. Catalog of obsolete parts updated to flag obsolescence in a more timely manner.
Small pump/motor sets	Motor test program in place.
EIM motor operated valve operators	Replacing with Limitorque
Isolated Phase Bus fans, control and	Maintained through a preventive maintenance program.

[15] The SPV designation identifies critical components that, due to a lack of redundancy, are especially important to the nuclear power plant An SPV is an SSC whose failure results in a Reactor Trip, Turbine Trip or Derate of >10% (BP-PROC-00666 [57]).

[16] This score is an indicator (not absolute). The outcome depends on the algorithm and on the fidelity of the available inputs. The Obsolescence Program Coordinator can edit this list to adjust the rankings based on engineering considerations not calculated by the algorithm.

Component	Bridging Strategy
instrumentation	
13.8 kV and 4.16 kV Type DHP breakers	Actively being replaced
250 Vdc breakers	Actively being replaced
Klockner-Moeller Motor Control Centres	Actively being replaced.

The preceding discussion shows that Bruce Power has a system for identifying, predicting, and managing obsolescent components. Therefore, Bruce Power meets the requirements of this review task.

5.5. Implications of Changes to Design Requirements and Standards on Actual Condition of SSCs

This section addresses review task 4.

In addition to the regular enhancement of standards, advances in technology (e.g., computer codes, solid state instrumentation), OPEX on materials performance (e.g., hydrogen uptake in pressure tubes, or FAC impact on feeders), operations observations (e.g., acoustic vibrations, concrete cracking) or significant events (e.g., Fukushima) are typical of factors that can lead to changes in standards and hence design requirements, some more precipitously than others. Some are needed to enhance safety, some to enhance production, some both.

There are at least four mechanisms by which a station faced with changes in standards can adapt. They are: a) design changes and associated equipment changes, b) engineering or nuclear safety analysis refinements, c) requests for deviation from the standard (e.g., either grandfathering or code cases), and d) operating envelope changes (most often more restrictive, but not always). Bruce Power has a full array of procedures to accommodate changes, a strong safety analysis capability, and a developed Engineering Change Control process to ensure compliance with the standards. The design process is more fully described in the report for Safety Factor 1, Plant Design; the analysis processes to maintain and enhance safety are described in the reports for Safety Factors 5 and 6.

BP-PROG-10.01, Plant Design Basis Management [37], leads to BP-PROC-00335, Design Management [48] (interfacing document) and BP-PROC-00363, Nuclear Safety Assessment [132]. The exchange between the two procedures is a fundamentally iterative process that provides assurance that the plant Design Basis, as described in design documentation and the safety analysis, as described in the Safety Report, provide a mutually consistent basis for safe operation. This iterative process continues until a design solution has been reached that meets all safety requirements, including those that may evolve during the course of design.

Bruce Power maintains Engineering and active Research and Development programs to anticipate and accommodate evolutions in standards. Ageing is one area where changes in standards could impact safety and/or operation. Through active participation in COG, Bruce Power contributes to programs such as Pressure Tube Life, fracture toughness, channel diametral creep and elongation, cable ageing (Power and I&C), Fibre Reinforced Plastic (accommodates N291 standard for refurbishment and modifications), computer code development and validation, chemistry and materials, hydrogen in containment, and studies on instrument survivability following a Severe Accident. Bruce Power participates in the CSA and American Society of Mechanical Engineers (ASME) organizations where nuclear and pressure boundary standards are set and modified. The following table, extracted from [40], demonstrates the extent of topics covered in these multidisciplinary studies.

Table 8: COG Major Research and Development (R&D) Programs, 2015/2016

Number	Title	Areas[17]	#WP[18]
COG 15-9105	Fuel Channels R&D Program, 2015/2016 Operational Plan	7	56
COG 15-9205	Safety and Licensing R&D Program 2015/2016 Operational Plan	13	70
COG 15-9405	Chemistry, Materials and Components R&D Program, 2015/2016 Operational Plan	8	77
COG 15-9505	Industry Standard Toolset Program, 2015/2016 Operational Plan	20[19]	64
COG 15-9305	Health, Safety & Environment R&D Program, 2015/2016 Operational Plan	10	34

In addition to the Programs listed in Table 8 above for Fuel Channels, there are parallel Joint Projects, COG JP 4452 and JP 4491, on Fuel Channel Life Management Program which produce supplementary R&D results.

Through a balanced approach among Engineering, R&D, Analysis and Operations, Bruce Power adapts to changing standards to accommodate plant conditions. Therefore, Bruce Power meets the requirements of this review task.

[17] Project Areas, or Disciplines.

[18] Active Work Packages per 2015/2016 Plan.

[19] 18 codes divided into 4 major disciplines: a) Containment and Severe Accident, b) Thermal hydraulics, c) Physics, and d) Fuel and Fuel Channels.

5.6. Plant Programs that Support Ongoing Confidence in Condition of the SSCs

This section addresses review task 5.

The Ageing and Obsolescence Project (AOP) was an Equipment Reliability (ER) improvement initiative launched a few years ago to raise the Bruce A and B station equipment reliability and was a key component of Bruce Power's Business Plan. The AOP was fashioned based on an understanding of the Regulatory expectations (RD-334 [104], superseded by REGDOC-2.6.3 [106], and S-210 [133], superseded by RD/GD-210 [134]), and international guidance (INPO AP-913, Equipment Reliability Process Description Rev 3 [105]; NEI AP-940, Nuclear Asset Management (NAM) Process Model [135]; and the Nuclear Utility Obsolescence Group (NUOG) NX-1037, Obsolescence Program Guideline Rev 1 [111]). The AOP evolved into the existing programs and initiatives in effect today – Obsolescence, PM Basis Reviews, and Asset Management.

The objective of the AOP project is to improve plant equipment reliability through the optimization of:

- Equipment Preventive Maintenance (PM);
- Available critical spares; and
- Short-term mitigation of high risk, low reliability components through enhanced maintenance while awaiting long-term corrective fixes (usually design changes).

The scope of the project included:

- Development of Fuel Handling LCMPs for reactor area bridges plus completion of the outstanding Fuel Handling system critical component basis assessments to align these systems with Bruce Power's ER initiative;
- Provision of Critical Spares Assessments; and
- Acceptance of the AOP Critical Category 1 assessment documentation.

At the time of application for licence renewal in October 2013, as a station-wide program listed in Attachment I of [136], AOP had completed:

- Critical[20] Category 1 (including SPV[21]), non-Fuel Handling component assessments for both stations;

[20] Critical Component - Is a component whose function is essential to system operation and/or operability (Criticality Category 1 & 2). Critical Components are listed on the Performance Monitoring Equipment List (PMEL) within the approved System Performance Monitoring Plan (SPMP) and Component Performance Monitoring Plan (CPMP) (DPT-PE-00008/-00009/-00010) and meet criteria specified in INPO AP-913. Cat 1 is the highest importance component and Cat 4 is the lowest (full definition Appendix D of BP-PROC-00584 [137])

- All Category 2 components on four systems/
- Some select Category 3 and 4 components based on plant data reviews; and
- Assessments of 6 selected Fuel Handling systems at both stations.

These assessments included estimates of remaining life, verification of criticality, determination and rationale for repair/replace strategies, review of and improvement to preventive maintenance strategies, and determination of stocking quantities for critical spares.

The project concentrates on three fundamental deliverables, specifically [136]:

- Update of the outstanding high safety and high generation importance, critical component PM strategies to reflect the recently developed and approved Bruce Power PM Templates. These updates are expected to ensure best practice PM strategies consistent across similar components in both stations, including a critical review of the PM frequency appropriate to the condition of those components.
- Field implementation of the documented high importance PM strategies. Field implementation of the recognized and approved best practice PM strategies.
- Enhancement of the PM strategies associated with high risk/low reliability, aged and obsolete SPVs awaiting permanent design fixes or other long term obsolescence corrective measures. Enhanced PM strategy implementation will limit the unplanned outage risk that each of these SPVs poses to the maximum extent possible.

In 2008, an initiative to improve equipment reliability resulted in the creation of the Equipment Reliability Centre of Excellence (ERCOE) [138] organizational model. The overall goal of the ERCOE is to significantly improve equipment reliability at Bruce Power to support improved plant performance, focusing Station Engineering resources on the implementation of INPO AP-913 and NEI AP-940. The ERCOE model, in addition to establishing the basis for developing and implementing an Equipment Reliability Program based on best industry practices, leverages the many equipment reliability improvement initiatives currently underway at Bruce Power, including the Asset Management, Critical Spares, and Obsolescence strategies development. A self assessment of the effectiveness of the ERCOE is discussed in Section 7.1.1.1.

The deployment of the AOP and ultimately the Asset Management approach that incorporates elements of internationally recognized CA principles and attention to the associated remedial actions, and the commitment to excellence through the ERCOE, shows that Bruce Power meets the requirements of this review task.

5.7. Significant Findings from Tests of Functional Capability of SSCs

This section addresses review task 6.

[21] The SPV designation identifies critical components that due to a lack of redundancy are especially important to the nuclear power plant An SPV is an SSC whose failure results in a Reactor Trip, Turbine Trip or Derate of >10% (BP-PROC-00666 [57]).

As indicated in the preceding sections, the documentation reviewed as part of the CA effort included reports that document results of tests that demonstrate functional capability, such as Health Reports - Inspections and Testing Status ([79] Section 4.11).

A detailed review [126] summarizing the status for systems important to safety and production shows overall good and upward trending performance (see Section 5.1). Comparison of the states of the systems in this report against the states in the 2014 submission to the CNSC [127] shows that, in general terms, the upward trend is continuing.

As well, Bruce B has a full range of functional and performance tests driven by OP&P Clause 3.5 on Testing, referred to as SSTs, that demonstrate the continuing availability of SIS. The results of testing are compiled in both the SHRs and the Annual Reliability Report [129]. The statistics demonstrate that reliability targets are being met or identify systems needing remedial attention. From the Executive Summary of the 2014 Report:

> *"In 2014, none of the twelve Systems Important to Safety exceeded their Predicted Future Unavailability (PFU) targets.*
>
> *The Standby Class III system that was over target in 2013 showed a considerable improvement in the system PFU due to the update of component restoration times. The restoration time update resulted in the PFU being below the target. The PFU decreased further when the model was updated with the 2014 observed failure data.*
>
> *In 2014, Actual Past Unavailability (APU) was observed for four out of twelve Systems Important to Safety. The four systems were Emergency Coolant Injection System, Emergency Power System, Shutdown System One and Shutdown System Two. The APU for Emergency Coolant Injection System was above its target. Events that caused the APU have been addressed through Bruce Power's corrective action process. The APU for Emergency Water System is under review."*

Operating staff perform the SSTs at a frequency consistent with the reliability target for the system. There are two categories of SSTs - static and dynamic. Static tests involve no change of state of the system, for example panel meter readings that are recorded, compared against expected ranges, and archived for access by such staff as Performance Engineering, or Reactor Safety Support staff for assessment. Operator field inspections and maintenance predefines (e.g., lubricant analysis) are two more examples of static testing. Dynamic SSTs involve de-energization of signals or the injection of a transient test signal to an instrumentation loop, such that parts of the system change state (activate) and the value of the actuation setpoint or time of actuation can be determined either from panel readings or using a digital comparator such as the Safety System Monitoring Computer (SSMC). The goal of the dynamic SSTs is to functionally test the normally poised systems via defined test signals to ensure availability. In most the cases, the test cannot check the calibration of the loop components. That is, the functional testing assumes that all the loop components have been calibrated. In both static and dynamic SSTs, then, calibration of the circuit elements plays a pivotal role. Calibration must be performed with a specified frequency and performance statistics must be tracked to support the instrument uncertainty calculations mentioned in Section 5.3.

Should testing determine that there is doubt in the operability of an SSC, but there is high expectation that it can perform its minimum safety function, a TOE is initiated (BP-PROC-00014

[49]) to determine what corrective action, if any, is required. As discussed in Section 5.2 above, TOEs are considered in LCMPs and as discussed in Section 5.10 below, TOEs are considered in the compilation of SHRs.

In the case of Special Safety Systems and Safety Related Systems, there are usually two acceptance criteria for testing of any parameter - action levels and impairment levels. The action level is set such that an operator can intervene in a system with deteriorating health before the impairment level is reached and so an operating margin is available. The setpoints include a statistically calculated allowance for indication uncertainties (e.g., instrumentation loop or loop timing uncertainties), such that the indicated value leads to intervention before the actual process value becomes impaired.

For process systems, the monitoring can be more automated, with data collection for the SST performed using the DCCs (digital control computers), for example, for valve stroke timing, or running currents of pump motors, which are indicative of their health.

There is a natural extension of the collection of data and monitoring digital signals using computers and mathematical algorithms (such as pattern recognition) to continuously monitor and cross-correlate a large number of plant variables to assess whether any parameter is trending outside its normal range for the plant operating state. If detected, the computer can generate an alert to staff to examine and correct the anomaly. Digital monitoring is a mature technology and has been deployed in nuclear plants world-wide with varying degrees of success for more than 25 years. Bruce Power has utilized several schemes of this type over the years and is presently using a commercial product called SmartSignal™. Bruce B was fully implemented in the fall of 2012 and Bruce A was fully implemented by the end of 2013.

Should degraded or degrading operating conditions discovered during testing or data monitoring or during normal equipment operation that require operator workarounds or operator work burdens, the condition is identified as an operator challenge and added to a list of operator challenges to determine if, in aggregate, the operator challenges create an obstacle to safe operation. The conditions listed according to this process described in GRP-OPS-00034, Control of Operator Challenges [96], are an input to the SHRs, as noted in Section 5.10 below.

If in the above processes, any critical parameter is found outside the allowable value, operators are required to take action to restore it to within safe operating limits. In the case of Special Safety Systems, the required actions are ultimately defined in the Safety Systems Impairment Manual [139], as described in Section 5.3. Limits and corresponding actions for systems not included in the Impairments Manual are included in other operating manuals, such as the System OM, Alarm Response Manuals (ARMs), or Operator Field Routines.

Testing on all systems, impairments or not, are tracked by the RSE and reported in the equivalent SHRs (and previously in the CARs) [79].

Any test evoking the Impairment Manual gets immediate follow-up attention from the RSE and shortly after from the Reactor Safety Engineering staff. The results of these investigations for SIS are incorporated in the system's actual unavailability reports and reported annually in the Reliability Report [129].

In summary, the results from SSTs, maintenance, routine call ups (predefines), calibration, operator observation, and field routines provide a supportable and robust means of monitoring and trending the operability of systems and components to support the conclusion that Bruce Power programs meet the requirements of this review task.

5.8. Results of Inspections and/or Walkdowns of SSCs

This section addresses review task 7.

In addition to reviewing the results of routine inspections, Section 4.1.3.2, "Walkdown", of the CA Summary Report [122] (see footnote 11) revealed that a walkdown was conducted for each SSC group. Significant observations were recorded photographically for follow-up with the RSE and inclusion in the CAR. This process and the lessons learned were fed back and included in the revised CAR procedure [101]. This improved procedure was then used in the walkdowns of the Unit 058 units. The results are captured in the CAR reports identified in Appendix C.

Also, RSEs are required to record observations of walkdowns, performed according to DPT-PE-00009 [78], in the SHRs under Inspections and Testing Status and Field Walkdown Highlights (see Section 4.11.5 in [79]).

The operational status of Units 058 prevented a comprehensive CAR walkdown in controlled access areas (e.g., reactor vault, boiler rooms) [6]. However, for critical SSCs, opportunities do arise for RSEs to walk down their systems during outages recognizing system conditions and configuration do restrict some systems from being fully inspected (e.g., where insulation covers piping). In these situations, susceptibility reviews are employed to determine those areas most impacted by degradation mechanisms associated with pipe wall thinning (e.g., [82] Section 4.1) and corrosion. This improves program effectiveness by ensuring resources are focussed on key areas. As appropriate, non-destructive means are employed to assist the collection of inspection data for these hard to access areas. The non-destructive examination specialists provide the results to the RSEs so they can be captured in the SHRs (e.g., Section 4.5.1 and Appendix D of [82]; Sections 4.9.1.4 and 4.9.1.5 of [76][22]).

Another special type of walkdown occurs while members of a dedicated group in Bruce Power conduct Periodic Inspections according to the plans required by CSA standards N285.4, N285.5 and N287.7. These inspections take place in diverse locations throughout the units. The inspectors have formal qualifications and provide a continuous set of snapshots of the status of components in the station. The components have specific acceptance criteria. The reports are approved by qualified inspectors and filed formally in their own sub-type category in Controlled Documents.

Other mechanisms to invoke walkdowns are commissioning (or recommissioning) of systems following maintenance or design change implementation. BP-PROC-00539, Design Change Package [140], requires walkdowns, not only prior to preparation of the design change as part of the constructability review (Section 4.4.1), but for installation completion assurance (Section 4.5.3). Special requests for walkdowns may originate from regulatory bodies, such as the CNSC or Bruce Power's Authorized Inspection Agency (AIA, i.e., TSSA (Technical

[22] This procedure supersedes the previous SEC-ME-00007. The revision does not require a walkdown, but counts on the provision of results of inspections through reports.

Standards and Safety Authority)). For example, there was an extensive series of walkdowns following the Fukushima event, and more recently, there was an extensive set of walkdowns with the CNSC to support Bruce Power's S-294 submission (Attachments 5, 6, and 11 of [141]).

System inspections are performed routinely by Operations according to GRP-OPS-00047, Operator Routines and Inspections - Bruce A and Bruce B [97], as required by BP-PROC-00561, Operations Fundamentals [98]. Operator Field Inspections are guided by inspection sheets listing checks, readings, and activities and are performed on a regular scheduled basis to record system parameters and ensure that systems and components are operating properly. Findings are documented on the sheets and on work requests, when the findings are abnormal.

In addition to these considerations, Section 7 summarizes a selection of Self Assessments and Internal/External Audits and Inspections. In particular, Section 7.3 discusses formal CNSC Inspections of the condition assessment process, as well as the regulatory inspection of equipment installed to mitigate Beyond Design Basis Accident (BDBA) events in response to the Fukushima event.

A detailed review [126] summarizing the status for systems important to safety and production shows overall good and upward trending performance (see Section 5.1). Comparison of the states of the systems in this report against the states in the 2014 submission to the CNSC [127] shows that, in general terms, the upward trend is continuing.

Bruce Power programs meet the requirements of this review task.

5.9. Maintenance and Validity of Records

This section addresses review task 8.

Generically, Bruce Power maintains an extensive and comprehensive documentation system stored digitally with hard copy records in some cases to satisfy OP&P Clause 4.1 on Operating Records. Procedural Controlled Documents are under continuous review and periodic revision as described in BP-PROC-00098 [46]. Table 9 illustrates some of the topics covered in companion procedures and the extent of attention to records.

Table 9: Sample of Records Procedures

Document #	Title	Rev #
BP-PROC-00068	Controlled Document Life Cycle Management	023
BP-PROC-00098	Records Management	015
BP-PROC-00238	Retention Process for Bruce Power Records	011
BP-PROC-00358	Software Records	005
SEC-DOCM-00023	Controlled Documents	025
SEC-DOCM-00029	Records Retention Authorizations and Destructions	009
BP-PROC-00972	Records Retrieval and Secure Storage	000

Document #	Title	Rev #
SEC-DOCM-00053	Processing and Microfilming Records	007
SEC-DOCM-00056	Records Indexing	006

For items such as routine maintenance and monitoring records, and SSTs, Bruce Power maintains hard copies and digital copies of such documents as completed Control Maintenance Procedures (CMPs), Mechanical Maintenance Procedures (MMPs), SSTs, and Operator Field Inspections to name a few. The Operations and maintenance and I&C technicians return mark-ups of completed procedures to the main control room, where they receive an initial screening. They are then sent to a data centre on the 6th floor near the Plant Engineers (System Engineers) for immediate reference, electronic cataloguing (completion, success/failure) and eventual transmission in batches to the Bruce Power Records Department where they are scanned and filed in the vault. The electronic cataloguing allows functional groups, such as Reactor Safety Support, to review regularly scheduled testing and request a copy from Records of items of interest (e.g., failed SSTs).

Records have a retention period defined based on their importance to plant operation.

As noted in the previous section, formal Periodic Inspections, e.g., as required by the N285 and N287 series standards, are recorded in the Controlled Document System in their own report series category (e.g., NK29-IR-NuSCI-serial).

In addition to a formal Controlled Documentation system, Bruce Power (and before that OPG) has scanned and indexed much of the Bruce legacy design, correspondence, reports, procurement, commissioning, and operations information. This information is available for any authorized computer user in Bruce Power to search and analyze.

In the context of Condition Assessment and as described throughout this report, Bruce Power has embarked on a systematic process to examine, characterize, assess, and maintain or rejuvenate the equipment to meet the mutually consistent objectives of safe operation, assurance of stable production to meet commercial targets, and protection of the long term investment. Broadly speaking, this process is called Asset Management. Significant effort has been applied to formally record and trend the condition of systems important to safety in CARs, and SHRs, and to record measures in ALPO documents and to update and upgrade systems requiring attention in LCMPs.

The Maintenance Program Document BP-PROG-11.04 [90] (in Section 4.1) subscribes to the importance of record keeping:

> "*Records are kept to track equipment inspections, monitoring, repairs, failure information, including specific component, cause of failure and actions taken to correct, and equipment condition post repair. BP-PROC-00695 [Maintenance Program and Activities] describes this process and ties to other programs needed to maintain this element of the maintenance program.* "

BP-PROC-00695 [91] provides a systematic approach towards identifying what maintenance activities are to be performed on given SSCs and at what frequency/intervals, as described in Section 4 above.

BP-PROC-00694 [94], Maintenance Procedure Development and Revision, establishes the requirements for initiation, development, review, verification, approval, and validation of Maintenance Procedures used to perform maintenance on a facility SSC.

Maintenance Records

As indicated in the preceding sections, and based on the procedures described in Section 4 and the documentation reviewed as part of the CA process, this review task requires consideration of maintenance records for Bruce 058 systems. This section provides two examples of many, where specific programs define requirements for maintaining records:

- The Inspection, Monitoring and Maintenance Review (IMMR) on HXs describes the process for determining and documenting the existing degradation mechanisms, inspection methods, and maintenance and monitoring activities that assure design basis characteristics are met. The required document format and review and approval steps for IMMRs are described in B-STM-04660-10000, HX IMMR ([81] Section 4.6).
- The Motor Program [83] highlights the need to capture feedback from internal and external motor experience and implementing enhancements is critical for improving the Motor Program and equipment reliability. It defines the formal PM feedback process that captures as-found equipment condition. It promotes a questioning attitude and identification of alternative strategies, improved testing and monitoring, and optimized PM tasks and frequencies based on station component operating and maintenance experience. PdM results reside in a computerized database Plant IQ. The trades staff enters the data and comments; the PdM program owner reviews that data and provides a report to the Responsible Component Engineer (RCE). The RCE then provides the engineering decision for the paths forward and, where useful, a benefit-cost analysis. The final report is issued to the affected RSE(s) for information and tracking ([83], Section 4.4.4).

The maintenance records are typically produced during the assessment, scheduling, and execution of work requests through the work management process. While the work management process is not an integral component of condition assessment, it plays a supporting role.

As described in this section, Bruce Power has processes for recording formal documents (Controlled Document) and records of routine operation of the station such as maintenance and testing. Therefore, Bruce Power meets the requirements of this review task.

5.10. Evaluation of the Operating History of SSCs

This section addresses review task 9.

The condition assessment procedure [101] states that the system condition assessor is expected to refer to documents as far back as is relevant and meaningful. Section 4.4.2 of

[101], “Information Gathering”, lists the sources that may be used, namely, System Health Reports, open work orders, temporary and permanent configuration changes, maintenance and inspection records, SCRs, OPEX, and other programs that may be relevant to aging and life cycle management. In the subsequent section, the procedure stipulates that interviews with subject matter experts will cover inspection history, maintenance history, performance monitoring history, and condition monitoring history.

The more recent SHRs are standardized to identify items, such as occurrences of Functional Failures, high maintenance backlogs, SCRs, S-99 (now REGDOC-3.1.1) reports, operator challenges and TOEs. Functional Failure for System Health reporting is defined as any change in a component that would result in the system being unable to perform its minimum intended function or to operate within specification. The functions include those related to safety, e.g., shutoff rod falling in core is failing safe. The SHRs are heavily weighted to flag these situations with a 25% weight[23] ([79] Appendix E).

The SHRs show the extent of compliance and discuss potential improvements. These reviews confirm the extent of compliance against this element. A detailed review [126] summarizing the status for systems important to safety and production shows overall good and upward trending performance (see Section 5.1 herein). Comparison of the states of the systems in this report against the states in the 2014 report [127] shows that, in general terms, the upward trend is continuing.

In addition, the ALPO/LCMP process (using CARs and SHRs) has reviewed operating history to provide an estimate of the remaining reliable operating life.

Therefore, Bruce Power meets the requirements of this review task, recognizing that improvements in documentation occur as SSCs are modified, as required by BP-PROG-10.02 [52].

5.11. Dependence on Obsolescent Equipment for which No Direct Substitute is Available

This section addresses review task 10.

Bruce Power’s Asset Management Program is about predicting component life and planning for its replacement in a systematic strategy combining safety, operating efficiencies, and revenue projections (see Section 5.6). Obsolescence management is a key component of the program.

When a component is not available or the supply line is threatened, a search for a suitable replacement follows. As discussed in Section 4, BP-PROC-00533 [87], Obsolescence Management is a framework for predicting and addressing obsolescence issues. The procedure suggests many options for addressing obsolescent components – repairs, cannibalisation, surplus market, and redesign/replacement are among the obvious. This is an ongoing and systematic process, especially in the context of Asset Management.

[23] Weighting is used to give prominence to one aspect or another to produce a higher or lower score, which determines the “colour” of the assessment.

Over the years, there have been high profile cases of obsolescence that have been accommodated for long periods of time through workarounds. The obsolescence of the DCCs, comprised of Varian™ computers, the CAE input/output interfaces, and Ramtek human/machine interfaces, is one such case that has been known for at least 30 years. Replacement of the obsolete components is expensive both in terms of capital cost, outage costs, documentation costs (far reaching ripple effects) and engineering "software" (e.g., software quality assurance for the replacement machines). The inevitable has been delayed by developing emulators (other processors that adequately replicate the Varian computers and the Ramtek display drivers), buying up parts from other industries abandoning the Varian equipment (e.g., US Navy), and adding supplementary peripherals. The AMOT process (see Section 5.2) has produced assessments of the DCCs with one option for replacement in the time frame of this PSR.

Another example of obsolete equipment with no direct substitute is the Safety System Monitoring Computer. This system is more than 30 years old, so the equipment itself, as well as the electronics within the equipment is obsolete, as is common with the rapid changes in electronic technology. The lack of spare parts would be potential threat to reactor fuelling, since fuelling will not proceed without the ability of the operators to see the Neutron-Overpower margins to trip, a function provided by the SSMC. Much of the system has been replaced with emulators to circumvent obsolescence. The SSMCs are in the process of being totally replaced with Invensys hardware, with a target completion of 2017.

Therefore, Bruce Power meets the requirements of this review task, recognizing that obsolescence management is a key component of Bruce Power's Asset Management Program.

5.12. Dependence on Essential Services and/or Supplies External to Plant

This section addresses review task 11.

Off-site support is available from manufacturers and construction companies in Canada and overseas. Bruce Power Supply Chain and Procurement Engineering maintains an ongoing relationship with its major suppliers.

On-site support includes the following facilities:

- Large Bore Facility. The Large Bore facility consists of three shops: the Plate Shop, the Pipe Fabrication Shop, and the Hand Rail shop. These shops can fabricate a wide range of items required, such as: piping systems (1" to 66" inch piping), instrumentation panels, steel platforms, bridges, beams, columns, and handrails. Moreover, they can handle all welding and cutting of steel (including stainless, carbon steels) and aluminum.
- Paint and Sand Blast Shop. The Paint and Sand Blast Shop can handle large objects that require painting. The shop has a sandblasting area and a paint shop area (both primer and finishing coats).

- Central Maintenance and Laundry Facility. The Central Maintenance and Laundry Facility is an ISO 9001 qualified shop that provides a complete range of machining services.
- Measuring & Testing Equipment (M&TE) Lab. The M&TE Lab calibrates Electrical, I&C and Mechanical Dimensional M&TE for the Bruce Site. Calibrations are performed to traceable standards. Calibrations are documented and reports are generated for follow-up actions in the event M&TE is found out of calibration. In addition, inspections in support of site manufacturing are performed.
- Portable Radiation Instrument Shop. The Portable Radiation Instrument Shop performs calibration and service for a variety of portable instrumentation used for measuring hazards such as gamma radiation, beta radiation, alpha radiation, tritium in air, airborne contamination, toxic gases, and oxygen levels. The shop supplies technical support for radiation detection equipment permanently installed in the stations.
- Breaker/Starter Shops. The breaker/starter shops provide testing and refurbishment of a range of breakers and motor starter cells.

A detailed review [126] summarizing the status for systems important to safety and production in 2013, as well as comparison of these states to the states of health in 2014 [127], shows overall good and upward trending performance (see Section 5.1), suggesting that reliance on these facilities and external support is effective.

Given the support of suppliers and contractors plus the availability of a range of on-site maintenance facilities, the conclusion is that Bruce Power meets the requirements of this review task.

5.13. Condition and Operation of Spent Fuel Storage Facilities

This section addresses review task 12. As part of the commercial agreement between Bruce Power and Ontario Power Generation, OPG is responsible for the storage of spent fuel once it leaves the station(s)[24]. This section describes the Bruce Power activities at the Bruce B station.

The key Bruce Station SSCs that form the used fuel storage facilities include the following:

- Primary and Secondary Irradiated Fuel Storage Bay Structures (NuSCI 24100 (Central Fuelling Area) and 24500 (East Service Area), and 24400 (Ancillary Services Building) respectively);
- Irradiated Fuel Bays System including the Primary (34410) and Secondary (34420) Irradiated Fuel Cooling and Purification Systems (NuSCI 34400 and 63440); and
- Used Fuel Dry Storage SSCs (NuSCIs 35300 (Fuel Transfer and Storage) and 63530).

[24] The physical and administrative transfer of the Spent Fuel occurs at the Auxiliary Services Building door where Bruce Power presents the loaded Dry Fuel Storage Container (cask), OPG personnel accept the cask, and OPG's transporter delivers it to the Waste Management Facility.

The condition of aforementioned SSCs has been reviewed and assessed, and is documented in [142][143][144][145]. Furthermore, as part of the SHR process, the SHRs for these systems are regularly issued, ensuring that the state of their condition and operation is fully updated at least annually.

Leakage from the bays is monitored and when practicable stopped. When it cannot be eliminated, it is stabilized, and maintained at acceptable levels. It is collected by designed drainage systems and transferred to the liquid waste handling area (Section 1.3.3 of [144]) and the design of the bays allows inspection of the concrete (Section 1.3.9 of [144]).

For the period Q1 2015 to Q4 2015, the SHRs [146][147] show the Bruce B Used Fuel Dry Storage improved from White to Green, while the Bruce B Irradiated Fuel Bays and Systems [148][149] was rated White throughout 2015.

The Dry Storage Container (DSC) loading bay is used in the shipment of the used fuel bundles, and does not typically contain fuel, unless it contains a DSC.

There has been a continuing priority on ensuring that sufficient fuel is shipped to maintain adequate spare capacity in the bays to receive irradiated fuel from the reactors. As reported in the interim PSR [6], in 2014 Bruce B had completed 55 DSC shipments, the target for that year. Sixty-five DSC shipments are expected to be completed by the end of 2015 [147]. Functional failures have remained at one since the last reporting period; the corrective maintenance backlog continues to be low and under control.

In terms of performance, a strategic action plan includes improvements for dry fuel storage [147], although the current system health is Green. The Irradiated Fuel Cooling and Purification Systems are performing well [149].

The LCMP for civil structures, B-PLAN-20000-00001 [150], describes industry best practices for understanding ageing degradation of civil structures and components. It includes the management for ageing and degradation of the Used Fuel Storage Bays (Section 4).

Bruce Power is routinely able to transfer spent fuel canisters to OPG to manage the spent fuel inventory in the bays. The condition and operation of the used fuel storage facilities are routinely reviewed and monitored. Therefore, Bruce Power meets the requirements of this review task.

5.14. Verification of Actual State of SSCs against Design Basis

This section addresses review task 13.

Bruce Power has extensive programs that support this activity, some of which have been in place since the plant began operation, but most of which have been enhanced since the focused review on asset management (life cycle management) was initiated.

As stated in Section 1.1 of BP-PROG-10.01, Plant Design Basis Management [37], “The scope of the plant design basis management program is to provide the necessary processes required to document and manage the plant design basis and plant design.” BP-PROG-10.01 lists its implementing procedures, including BP-PROC-00335, Design Management [48], and BP-PROC-00363, Nuclear Safety Assessment [132]. It also defines Design Basis as “The range of conditions and events taken explicitly into account in the design of a facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits by the planned operation of safety systems. [IAEA Safety Glossary, 2007 Edition, Page 51]" (Section 3.1.3).

BP-PROC-00498, Condition Assessment of Generating Units in Support of Life Extension [101], Section 4.5, states that the assessor will consider the design basis in the SSC assessment that is recorded in the CAR. The CARs listed in Appendix C contain an overview of the design basis, typically in the system description in Section 1 of each CAR. BP-PROC-00778, Scoping and Identification of Critical SSCs [56], Section 1, requires that SSC functions that are important to providing safe, reliable, affordable and environmentally sound electricity be determined by examination of the system design basis (e.g., functions defined in the Safety Analysis and the System Design Manuals, EQ requirements, and functions cited in the OSRs). Apart from using the lists of functions to determine the SSCs that are important to maintaining safe, reliable power operation, the lists are used to establish the System Performance Monitoring Plans developed under DPT-PE-00008, System/Component Performance Monitoring Plans [77]. The data from the SPMP provide input to the System Health Reports, thus providing the basis for measuring system health (see Section 4.10 of [79]). System performance against the design basis, although not explicitly mentioned, is inherent in the SHRs listed in Appendix D. In the context of Condition Assessments and Design Basis, the programs mentioned in the preceding sections also have elements of design basis associated with them. Testing and monitoring functions such as Periodic Inspection Programs, SSTs, Calibrations, and Component and System Monitoring Programs have acceptance criteria based on the components' or systems' design basis. In the Asset Management environment, data and trends from these programs contribute to the LCMPs, which apply an additional layer of review of design basis in establishing continued fitness for service and estimating remaining life. The projected end of life dates, the points in time at which the SSCs may begin to exhibit indications of reduced reliability, that fall within the 10-year period covered by this PSR may be found in the LCMP summary report in Reference [131].

In addition to the above programmatic statement, the following items are typical of the integrated and component tests (SSTs discussed in Section 5.7) that are periodically performed to verify that equipment continues to meet the minimum requirements of the design:

- A trip test is performed at the start of a scheduled outage every two years either using SDS1 or SDS2. In addition to verifying that the SDS meets the minimum negative reactivity insertion rate, the test also provides information to verify that the prompt fraction of in-core flux detectors still meets the minimum standards.
- An SST for Emergency Water System verifies that the system pumps start and are able to deliver lake water to the discharge duct via a bypass line.
- The single and full rod drop tests for shutoff rods demonstrate that the speed of insertion of the Shut-Off Rods continues to bound the analysis assumptions.
- The SDS2 channel trip tests verify that the Quick Acting Valves operate in time to pressurize the helium header for SDS2 injection.

- Air holding tests verify that the instrument air receivers are capable of operating the supplied loads.

Further, BP-PROC-12.01, Conduct of Plant Operations [95], requires that Operations perform routine surveillance of the systems. Subordinate procedure GRP-OPS-0047 identifies the checks to be included in the Operator Field Inspection sheets for specific types of equipment. It states that instrument ranges noted on the inspection sheets are the normal operating ranges that should be observed on the instruments. These routine inspections will identify pending or current system operation outside of the design basis.

Bruce Power meets the requirements of this review task.

6. Interfaces with Other Safety Factors

There is some degree of interrelationship among most of the 15 Safety Factors that comprise the Bruce B PSR. 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 Section 5.4, addresses the design process and programmatic review of Bruce Power Program documents, including BP-PROG-10.01. Pressure Boundary Quality Assurance Program (BP-PROG-00.04) is reviewed in Section 4.1 in terms of adequacy as it relates to plant design.
- "Safety Factor 3: Equipment Qualification" in Section 5.1 addresses the effectiveness of the equipment qualification process for SSCs. In Section 4.2 a programmatic review is performed of BP-PROC-00261 in terms of adequacy as it relates to environmental qualification.
- "Safety Factor 4: Ageing" in Section 4.0, addresses the programmatic review of BP-PROG-11.04, BP-PROG-12.02, BP-PROC-00781, BP PROC-00383 and BP-PROC-00400 in terms of adequacy as they relate to ageing. A high level code-to-code comparison between the 2014 and 2009 versions of CSA N285.4 is presented in Appendix A (Section A.1) of Safety Factor 4.
- "Safety Factor 5: Deterministic Safety Analysis" in Sections 5.2 and 5.3, addresses the design analysis process to maintain and enhance safety and in Section 5.4 addresses the implementation of a Safe Operating Envelope Program which provides a comprehensive identification of all operating limits and conditions in compliance with the requirements of CSA N290.15.
- "Safety Factor 6: Probabilistic Safety Analysis" in Appendix B.1 performs a detailed assessment of CNSC REGDOC-2.4.2 to review the sufficiency of scope including updates to incorporate significant changes stemming from design, operational, maintenance, and analysis to keep consistent with the as built and as operated state of the plant.

7. Program Assessment 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 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 each assessment are compared with business needs, the Bruce Power management system, industry standards of excellence and regulatory/statutory or other legal requirements. Where gaps are identified, corrective actions are identified and implemented.

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.

Focus Area Self-Assessments (FASAs) relating to CA that were conducted since 2010 are listed in Appendix E. The most pertinent ones are discussed in the following sections.

7.1.1. FASA Results

7.1.1.1. SA-ERI-2013-08, Effectiveness of ERCOE Implementation on Reducing Equipment Failures

This FASA examined a number of specific long-standing equipment issues related to equipment condition. It analyzes the success of the Equipment Reliability Centre of Excellence (ERCOE) by comparing the number of repeat equipment failures within time periods to determine if the number of repeats decreased after ERCOE was implemented.

The Station Engineering Division developed the ERCOE initiative to focus on establishing clear processes, authorities, responsibilities, and expectations. The ERCOE is based on the EPRI Standard Nuclear Performance Model, INPO/WANO guidelines (AP-913) [105], as well as industry best practices. In addition, during the development of ERCOE, key stakeholders in the equipment reliability process, such as Operations, Maintenance, Work Management, Nuclear-Operations-Support (NOS) Maintenance Support, Supply Chain, and others participated and provided input into the development. The primary ERCOE implementation activities were executed around April, 2011, using the Management of Change Process.

The FASA concluded that the ERCOE was successful in reducing long-standing equipment reliability issues and that further improvement should be observed when the ERCOE positions vacant at the time of the FASA are filled. It also noted three adverse conditions, as follows:

- Long-standing equipment reliability issues still exist, some of which are high risk issues.
- ERCOE does not extend sufficiently to Engineering Programs. Station engineers were only assigned to a couple of programs, so, for the most part, only corporate engineers exist.
- Implementation of ERCOE is less than sufficient to ensure sustainable performance. To complete the implementation, as a minimum, a significant number of document revisions are required and further turnover between Components and Programs Engineering and Plant Engineering is required.

SCR 28408050 was raised to address the adverse conditions, which has since been closed.

7.1.1.2. SA-ERI-2014-02, Asset Management Program Assessment

This FASA focused on a review of the current status of the Asset Management Planning processes at Bruce Power to assess the initial alignment with the Bruce Power Management System and to review the current state against the requirements of the Asset Management Standard, ISO 55000 [151], specifically ISO 55001 and ISO 55002.

The assessment considered procedures and processes identified as the core governance of the Bruce Power Asset Management Planning activities included the following:

- BP-PROC-00783 Long Term Planning and Life Cycle Management [85]
- BP-PROC-00936 Asset Management Planning [113]
- BP-PROC-00899 Asset Life Projections and Options [152]
- BP-PROC-00400 Life Cycle Management [56]
- BP-PROC-00534 Technical Basis Assessments [61]
- BP-PROC-00533 Obsolescence Management [87]
- BP-PROC-00666 Component Categorization [57]

The assessment noted many areas where the program has been effective in progressing towards a mature integrated Asset Management Program, as well as identifying areas for improved governance clarity and integration, and opportunities to better align with the requirements of ISO 55000. SCR 28477152 was created to address the improvements recorded in this FASA. Two of six assignments have been completed on this SCR.

7.1.1.3. SA-ERI-2014-07, Quality of System Health Reporting

This FASA is important to Condition Assessment because it impacts the efficiency of the process and thus on the effectiveness of the SHRs and upgrades to systems resulting from it.

The scope of this FASA included:

- Assessing the quality of the SHRs, with respect to DPT-PE-00010, System Health Reporting [79] and identifying gaps to excellence and opportunities for improvement; and
- Assessing how effectively the content of the SHRs is communicated to influence decision making, with respect to the reporting requirements of DPT-PE-00010, System Health Reporting and identifying gaps to excellence and opportunities for improvement.

The findings of the FASA concluded a need to strengthen communications and line of responsibility in procedures governing the SHRs (e.g., advancing items to the SPHC for resolution). Although there was a general understanding that the SHR System Health Improvement Plans (SHIPs) should be presented to the SPHC for endorsement, RSEs were unsure exactly which SHIPs needed to be presented to SPHC (all or only certain overall health colours). As a result, it was determined that few RSEs are making this presentation which is resulting in other important non-project SHIP work orders (WOs) not getting proper SPHC endorsement to help drive them through the Work Management Process with better success of completion.

Implementation of the recommended actions from this FASA would result in:

- improved quality of SHRs by enhancing the System Health Reporting procedure (DPT-PE-00010 [79]) with identified opportunities for improvement to clarify and consolidate error-likely sections (SCR 28452107, which is complete); and
- improved Equipment Health by enhancing the integration of System Health Reporting (DPT-PE-00010) and Station Plant Health Committee (BP-PROC-00559 [153]) procedures to provide clearer procedural guidance for the appropriate communication of System Health Report content to decision makers, to assign appropriate priority (endorsement) on the appropriate work to maximize the effectiveness of the Work Management process (SCR 28452101, which is complete).

7.1.1.4. SA-ERI-2015-08, Inspection Services Department Governance Review

This FASA was performed to evaluate the adequacy of Inspection Services Department (ISD) governance's interactions and interfaces with other referenced procedures, the alignment of personnel responsibilities with Pressure Boundary Quality Assurance Program, the Equipment Reliability program, and the implementation of corrective actions from last year's FASA. It concluded that:

- The majority of current ISD governance requires update or revision to meet the requirements for categorizing references (i.e., Governing, Implementing, Interfacing, or Other) as specified in BP-PROC-00166 R024, General Procedure and Process Requirements. Many of the procedures also contain overdue Action Requests and Document Change Requests (DCRs) that need to be addressed.
- ISD top level governance, BP-PROC-00387-R001 Plant Inspection [70], has in general addressed the responsibilities, expectations and requirements as defined in BP-PROG-00.04 R022, Pressure Boundary Quality Assurance Program [45].
- ISD top level governance also meets or exceeds the responsibility expectations in BP-PROC-00781, Performance Monitoring [64], which supports the Equipment Reliability program and is the governing document for ISD top level governance, BP-PROC-00387 [70].
- Corrective Actions from last year's FASA, SA-ERI-2014-05, had been completed. The review indicates that all expected deliverables have been produced and are practical and implementable to improve ISD governance structure and alignment with other procedures/programs.

Two SCRs were raised, as follows:

- SCR 28504163 - Section 4 of "PROC" type procedures are not adequately grouped and listed under the correct category to meet the requirement specified in BP-PROC-00166 [47], General Procedure and Process Requirements.
- SCR 28504168 - Most of the ISD Field Inspection procedures contain overdue or soon-to-be overdue Action Requests/DCRs.

These SCRs are not due until December, 2016.

7.1.1.5. SA-ERI-2015-13, Evaluating Pipe Support Inspection Scope and Resourcing

This FASA evaluated the Pipe Support Inspection Process (BP-PROC-00480 R001 [154]) against industry practices with regards to program scope and budget. A review of OPG's pipe support inspection program was conducted through conversations with a member of OPG's Corporate Engineering Program Integration group. In addition, OPG had recently completed benchmarking of several nuclear facilities in the U.S. and these findings were discussed.

Review of OPG's pipe support inspection program and benchmarking in the U.S. completed by OPG shows that industry best practice for completing pipe support inspections is for regulatory required inspections to be completed as part of the Periodic Inspection Program (PIP) and for routine inspections and monitoring to be completed by system engineers as part of their routine walkdowns. At Bruce Power, regulatory required inspections of pipe supports are being completed as part of the CSA N285.4 and N285.5 Periodic Inspection Program (BP-PROC-00334 [68]) and routine inspections of pipe supports are completed during system engineer walkdowns in accordance with DPT-PE-00008 [77] and DPT-PE-00009 [78]. In addition, the corporate pipe support specialist completes visual inspections of accessible pipe supports in eight systems per year; however, this is redundant since visual inspections are completed by system engineers. The FASA recommended that Bruce Power adopt the OPG methodology to align with industry best practice and to eliminate redundancies with the current process.

The FASA noted that snubbers in the Primary Heat Transport System, Maintenance Cooling System and Emergency Cooling Injection System are visually inspected as part of the CSA N285.4 Periodic Inspection Program (BP-PROC-00334 [68]). However, there is no defined test program for snubbers nor are pre-defines set-up to complete testing of all snubbers on a routine basis. The functional testing of some snubbers is being completed on an ad-hoc basis based on work requests that have been input by the RSE or pipe support specialist, and in addition, a small number of snubbers have pre-defines. OPEX has indicated that snubbers degrade over time and industry best practice is to complete routine testing and maintenance of snubbers, and therefore, the FASA recommended that a snubber maintenance and test program be developed.

Two SCRs, 28525689 and 28525691, were raised to address the recommendations noted above. These SCRs are not due until later in 2016, so are still open.

7.1.1.6. SA-ERI-2015-15, RV Quality Evaluation Program

This FASA is important to Condition Assessment because of the impact of relief valves (RVs) on equipment integrity, as well as personnel safety. Also, periodic RV testing/calibration is a code requirement and, thus, is important to operating licence compliance.

The objective of this FASA was Pressure Relief Device (PRD) Program Evaluation with respect to nuclear class relief valve testing frequency in compliance to ASME-OM Code Mandatory Appendix I. Plant Engineering staff had recognized that work management was sometimes not able to execute work which is critical to maintain code compliance. Deferrals had started to surface that were recommended for approval, which is not allowed by code.

This FASA identified a potential gap in the RV Quality Program Manual with respect to use of the deferral process which is planned to be addressed in the next revision of the manual. The FASA also found a potential gap in the deferral process governance as well as work management process with respect to PRDs.

The FASA concluded that PRD specialists and system engineers are exhibiting many positive attributes associated with the rigor and regulation of relief valves. It is also concluded that engineers are rigorously following established processes and procedures to conduct their required activities. The FASA identified a number of opportunities for improvement, including a recommendation that the preventive maintenance process should be updated to prevent deferral of Nuclear Class 1, 2, and 3 RV PMs. Most notably, the FASA recommended that the FASA be discussed with members of the ASME OM Code Committee to determine if further corrective actions are required and, thus, further improve deferral process governance.

7.2. Internal and External Audits and Reviews

The objective of the audit process as stated in BP-PROG-15.01 [155] 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 [25]).

This section addresses audits related to Condition Assessment. Internal audits are conducted by the Bruce Power Corporate Risk Oversight and Audit Division. External audits are conducted by independent third parties, excluding the regulatory authority for the purposes of this section.

7.2.1. Internal Audits

This section contains information on internal audits related to procedures and performance experience related to Condition Assessment. Audits relating to Condition Assessment that were conducted since 2010 are listed in Appendix E.

7.2.1.1. AU-2012-00006, Equipment Reliability

This audit of the Equipment Reliability functional area assessed the draft BP-PROG-11.01 R003 [R004][25] Equipment Reliability program and implementing procedures for completeness and implementation against the requirements in the following documents:

- BP-MSM-1 R010 [R012] Management System Manual
- BP-PROC-00774 R002 [R002] Program Requirements
- BP-PROC-00166 R021 [R023] General Procedure and Process Requirements
- BP-PROC-00068 R018 [R021] Controlled Document Life Cycle Management
- BP-PROC-00138 R002 [R002] Regulatory Requirements

At the request of the Department Manager, Component and Program Engineering a review was conducted of the following procedures against the industry best practice INPO AP-913 Rev 3 Equipment Reliability Process Description.

- BP-PROC-00666 R000 [R003] Component Categorization
- BP-PROC-00534 R001 [R002] Technical Basis Assessment (draft)

This audit did not include Pressure Boundary elements that exist under the Equipment Reliability functional area because compliance to Pressure Boundary elements is covered in the annual Pressure Boundary audit.

The audit had the following observations and conclusions:

- Upgrades to the program document and some implementing procedures will make them compliant with the standard format as required by Bruce Power's Management System.
- The Program's processes for SPV and Technical Basis were observed to be in good alignment with INPO AP-913 R003.
- Equipment Life Cycle Engineering (ELCE) Management (now Component and Program Engineering, or CAPE) has performed well in identifying program issues through 17 FASAs completed within the last 3 years. However, more effective use of the SCR and corrective action tools will improve compliance for some of these identified issues.

[25] Revision numbers in square brackets indicate the present revision of the document.

- Equipment Reliability Integration Managers were aware that the current program document BP-PROG-11.01 R002 Plant Reliability Integration[26] is out of date so R003 draft was used for the Audit.
- The audit concluded that staff do not always create or revise procedures and programs following the requirements outlined in BP-MSM-1 and associated procedures. Improving performance in getting the updates created and issued will avoid delays and re-work.
- The Duke Energy Technical Specialist noted 2 opportunities for improvement associated with BP-PROC-00666 R000 Component Categorization. The SPV procedure is not aligned with INPO AP-913 and INPO 01-004 Achieving High Equipment Reliability - A Leadership Perspective in regard to the elimination of design vulnerabilities as an SPV management/mitigation strategy. Also awareness of SPVs needs to be incorporated when considering preventive maintenance work orders for deferral and when scheduling first time Preventive Maintenance Work Orders.

Three adverse conditions and two opportunities for improvement were generated based on the above observations. Five SCRs, namely 28331980, 28331982, 28331983, 28331984, and 28331985, were opened to track the resolution of adverse conditions and opportunities in a managed process. All five SCRs have been completed.

7.2.1.2. AU-2013-00006, Maintenance

Maintenance is the foundation of maintaining the actual state of SSCs in operable condition. The PROL requires that Bruce Power implements and maintains a maintenance program in accordance with CNSC S-210 (now RD/GD-210). This audit found that program document BP-PROG-11.04 Plant Maintenance is structured to match the sections of S-210 and that all major components and the majority of all the specific requirements of S-210 are covered. However, the audit found that BP-PROG-11.04 Plant Maintenance is not fully complete and is not fully implemented in documentation.

The audit observed that maintenance groups required significant upgrades to formal qualifications.

The audit recorded a strength in that Maintenance Peer Group meetings are held regularly. Meetings include maintenance representatives from across site and meaningful metrics are reviewed and discussed. This provides the Maintenance Corporate Functional Area Manager with good information regarding the effectiveness of the Program.

Overall, this audit identified five adverse conditions and two opportunities for improvement. These findings resulted in seven SCRs, namely, 28367179, 28367181, 28367185, 28367187, 28367192, 28367193, and 28367195, for follow-up in a managed process, six of which have been completed.

[26] Renamed Equipment Reliability at R003. R005 is presently issued.

7.2.1.3. AU-2014-00006, RV Program and Field Maintenance

Relief valves support the operating limits for systems and are therefore pertinent to Condition Assessment. See review task 2, Section 5.3.

This audit supports BP-PROG-11.01 Plant Reliability Integration[27] and meets the requirements of ANSI NB-23 National Board Inspection Code to evaluate Relief Valve (RV) field repair activities each year. In addition to this, the Program Document is reviewed at an audit cycle of every 3 years in the year prior to AIA re-certification. In this case, AIA re-certification was due in June 2015.

The Bruce PROL requires the implementation and maintenance of a pressure boundary program in accordance with the requirements of CSA N285.0. In turn, N285 requires the servicing of pressure-relief valves (Class 1, 2 & 3) to be based on ANSI/NBBI National Board Inspection Code (NBIC). NBIC Part 3 specifies Audit Requirements as: Upon issuance of a Certificate of Authorization, provided field repairs are performed, annual audits of the work carried out in the field shall be performed. The audit shall verify compliance with quality program requirements and performance criteria and it will determine the effectiveness of the quality program.

The pressure relief valve program, accepted by the AIA, is required by CSA N285.0, as well as the station's Operating Policies and Principles. The program accepted by the TSSA is BP-PROC-00078, Quality Program Manual for Testing and Repair of Pressure Relief Valves [156], which requires annual audit of field repairs. “Field repair” is any repair conducted outside of the fixed repair shop location. The program also states that additional audits of testing and repair activities shall be conducted periodically.

The audit evaluated both nuclear and non-nuclear pressure relief valve program related activities at both stations. The audit included, but was not limited to, performance testing of valves, in accordance with NBIC Part 3, that were repaired in the field. Reviews were conducted specific to testing and repair activities of Relief Valve Field Repairs. Observations included sampling of completed, ongoing and planned work, and records initiated after November 1, 2013. The audit encompassed a selection of work scheduled by the Passport work management process at Bruce A and B during the audit's conduct period.

The overall conclusion of the audit is that although some deficiencies were identified, staff are generally compliant with the requirements of Quality Program Manual (QPM) BP-PROC-00078 R006 Relief Valve Program and Field Repairs. The RV Quality Program was determined to be effective in establishing the requirements related to field activities, and performance criteria, although some non-compliances and misalignments, were identified. The QPM was also found not to be fully effective at achieving its stated purpose of conforming to requirements of ANSI/NB-23 National Board Inspection Code latest edition. Deficiencies identified with respect to BP-PROC-00078 R006 were as follows:

- RV Quality Program Documentation Inadequacies

[27] Renamed, Equipment Reliability at Revision 003.

- Unclear RV Assessor Qualification Requirements
- Ineffective Corrective Actions to identified problems
- RV Uniquely-Tracked-Commodity (UTC) Trace Information Misalignments.
- OFI - Coordination of Audit Field Observations with scheduled in-situ RV activities
- OFI - Establishment of PRD Program Health Reporting Requirements.

The audit team initiated six SCRs, namely, 28477801, 28477807, 28478477, 28477816, 28477825, and 28477833, for follow-up in a managed process. Four of these SCRs have been completed, with the remainder being tracked via the managed process.

7.2.1.4. AU-2014-00010, Control of System Chemistry

This audit evaluated the completeness of, and the compliance to, DPT-CHM-00003 R006, Control of Chemistry [157]. It is discussed in this Safety Factor Report because of its direct bearing on system condition.

The scope of this audit included an evaluation of compliance to system chemistry control requirements. Chemistry specifications, procedures, databases, forms, calculations, reports, records and other documentation associated with controlling system chemistry were reviewed for completeness and compliance to Chemistry Control requirements where applicable. This included a review of the alignment of Chemistry Control parameter values in the suite of chemistry documentation and a review of responses to Chemistry Control Action Level events. Interviews were conducted with Chemistry and Environment Department Managers (Bruce A, Bruce B and Programs), Responsible System Chemists, Chemistry Lab personnel and Documentation Clerks to verify responsibilities, alignment of qualifications and confirm implementation and compliance of Chemistry Control requirements.

Limited field observations were conducted to confirm the availability of online instrumentation.

The status and effectiveness of corrective actions taken in response to two audits, AU-2011-00024 and AU-2011-00026, and a FASA, SA-CHM-2012-01, were reviewed and assessed as part of this audit.

DPT-CHM-00003 requirements were generally found to be complete, established and implemented in general accordance with its own requirements and the Bruce Power Management System. Inconsistencies were found in the implementation of chemistry control parameters and non-compliance and inadequacies were found in the Control of Chemistry Program. No immediate negative consequences were identified. Despite the large volume of control parameters that exist and the complexity of their implementation, few significant gaps in the program were found.

Six adverse conditions, documented in 16 SCRs, and three opportunities for improvement (SCRs 28439145, 28439146, and 28439147) were identified.

7.2.1.5. AU-2015-00018, Temporary Configuration Change Management

This audit is presented in this Safety Factor Report because of the impact of Temporary Configuration Change (TCC) Management on design basis management, described in Section 4.2 herein, and, hence, control of system condition. The audit evaluated the completeness of, and compliance to, BP-PROC-00638, Temporary Configuration Change Management procedure [158].

The scope of the audit included the objectives described in Section 4.7, Temporary Configuration Change Management, of BP-PROG-10.03, Configuration Management [53], and the requirements implemented in BP-PROC-00638, Temporary Configuration Change Management, to meet those objectives. The audit was performed on Temporary Configuration Change Management activities from March 2013 through March 2015 and conditions found in the field at Bruce A and Bruce B during the conduct of the audit.

The audit found that the Temporary Configuration Change Management process is incomplete but generally effective in meeting the objectives and purpose of BP-PROC-00638. There are weaknesses in the process and non-compliances to the procedure which have resulted in some undocumented configuration management issues and discrepancies between station documentation and field equipment.

Non-compliances were found to exist in the areas of Engineering Technical Verification (FORM-13096), Emergency TCCs & TMODs, Chrono Logs, RSE Walkdowns, SCR initiation, Installation and Removal WO tasks, tagging and other miscellaneous instructions.

BP-PROC-00638 did not adequately specify the applicable TCC records requirements to ensure documentary evidence exists to demonstrate that TCCs meet specified requirements for tracking temporary plant configuration changes from design basis. The procedure was also found to have inaccuracies, missing and out-of-date instructions.

Finally, some personnel were found to be performing Peer Verification without holding the required qualification (QUAL 18516) Temporary Configuration Change (TCC).

Five SCRs, namely, 28506621, 28506629, 28506636, 28506641, and 28506643, were raised to address the adverse conditions/error likely situations. All the assignments in three of the five SCRs are complete; the remaining two assignments will be completed in August 2016.

7.2.2. External Audits and Reviews

To support the return to service of Bruce Units 1&2, Bruce Power hired a consultant to perform a systematic review of safety based on IAEA NS-G-2.10 [159]. Since the findings of that review with respect to CA were specific to the condition of Bruce Units 1 and 2, they do not necessarily apply to Bruce Units 34 or Bruce Units 58. However, the CNSC's comments on the Bruce Units 1&2 Systematic Review of Safety included actions to improve the CA process [160]. The assessment conducted for the Safety Basis Report [6] for Units 058 referred to CAs prepared according to a documented process, as required in [101], including demonstration of a comprehensive and systematic approach compliant with CSA N286.2, encompassing identification of ageing related degradation mechanisms and obsolescence issues, time limited ageing assessments, and the basis for the scope and extent of system and component level inspections and tests.

INPO AP-913 Equipment Reliability Process Description [105], outlines specific process elements for the integration and co-ordination of a broad range of equipment reliability activities and combines these into one process. INPO AP-913 provides a systematic approach for plant personnel to evaluate condition, and make ongoing adjustments to predefined tasks and frequencies based on equipment experience. This process is based on a number of programs, such as reliability-centered maintenance, preventive maintenance, corrective maintenance surveillance and testing, LCM and performance/condition monitoring. As part of the ER Plan, an independent gap analysis assessment [161] was conducted to ensure that the station ER Integration Plan was aligned with INPO AP-913.

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 licensees 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

This section contains information on Regulatory Inspections related to procedures and performance experience related to Condition Assessment. Audits relating to CA that were conducted since 2010 are listed in Appendix E.

7.3.1. Condition Assessment Inspection by CNSC

In 2014, the CNSC conducted an extensive inspection of the Condition Assessment process. Because this inspection was so directly relevant and recent, summaries are provided of only two inspections in this category. Section E.3 of Appendix E provides a listing of correspondence directly or tangentially associated with Condition Assessment. Note that one inspection could easily generate three separate letters and that the Units 1 and 2 Startup generated a high volume of inspections.

The chronology of the inspections for this section is contained in a chain of four correspondence letters, as follows:

- NK29-CORR-00531-11456 [162], CNSC Type II Inspection - Condition Assessments
- NK29-CORR-00531-11668 [163], CNSC Type II Inspection - Condition Assessments
- NK29-CORR-00531-11783 [164], Action Item 2014-07-4687: CNSC Type II Inspection Condition Assessment Inspection - BRPD-AB-2014-002
- NK29-CORR-00531-11921 [165], Action Item 2014-07-4687: Bruce Power Responses to CNSC Type II Inspection - Condition Assessment Inspection - BRPD-AB-2014-002.

In the opening letter [162], the CNSC suggested modifications to the Condition Assessment procedure BP-PROC-00498 and announced a Type II Inspection on the topic of Condition Assessment for February 2014. Bruce Power responded [163] with the plans to update BP-PROC-00498. The scheduled revision of BP-PROC-00498 has been postponed pending integration into the Ageing Management process [165].

Following the inspection, the CNSC issued their report [164] that comprehensively captured a snapshot of the CA status with the following conclusions:

> "*Processes are in place to manage the ageing facilities and provide condition monitoring of the systems which include safety system tests, periodic inspection, assessments and operating experience (OPEX). System health reports and component health reports are produced on a routine basis and include items such as equipment failures, maintenance backlogs, aging and obsolescence issues. Bruce Power has also implemented Life Cycle Management Plans (LCMP) for some systems and is developing additional ones by 2016. Degradation mechanisms for all systems have been identified, assessed and are being monitored. Certain issues and uncertainties exist in some areas, however Bruce Power has initiated programs to understand and resolve these issues and uncertainties.*
>
> *CNSC staff has conducted a condition assessment inspection to verify that Bruce Power is aware of the current condition of their aging systems, structures and components. Observations on improvements to help alleviate the effects of ageing were made. Condition Assessment Reports (CARs) produced in 2011 provided many recommendations for improvements such as the completion of modifications and projects, maintenance activities and new inspections or tests to better monitor the condition of the equipment. All of this work has been prioritized based on a risk management process. CNSC staff has noted a reduced number of equipment failures and improvements in areas such as containment leak rates.*
>
> *Bruce Power is aware of the condition of the systems at their facilities and has implemented measures to ensure that systems remain fit for service and meet regulatory requirements over the next license period. CNSC staff will review the process for monitoring of the systems, e.g. LCMPs and the issues during future compliance activities*."

There were 6 action notices revolving around detailed observations of specific systems and processes at Bruce A and B, and four recommendations. Bruce Power has responded to the action notices with formal Action Tracking commitments (managed process) to address those not already completed. The only outstanding work at the time of writing this Safety Factor Report is the completion of two straightforward commitments, one on the delayed commitment to revise BP-PROC-00498 [166], which would include the other, the incorporation of RD-334 [104], CSA N287.7 [103], and CSA N291 [39] into BP-PROC-00498 [101]. (RD-334 has been superseded by REGDOC-2.6.3 [106]. Bruce Power completed a gap assessment of Bruce Power governance against CNSC REGDOC-2.6.3, and submitted a transition plan for CNSC REGDOC-2.6.3 implementation [107]. The gap assessment confirmed that the existing governance largely aligns with the requirements of CNSC REGDOC-2.6.3 [106], and identified some areas requiring clarification, for example, in the requirements for periodic reviews of aggregate effects of ageing, as well as governance considerations for ageing management during all phases of the lifecycle of the plant.)

This CNSC Inspection provides independent confirmation that BP Programs meet the overall intent of this Safety Factor.

7.3.2. Fukushima Followup Actions (Reactive Inspection)

The Fukushima event produced a significant reaction among utilities and regulators world-wide. In Canada, utilities and the CNSC developed a co-ordinated plan to address utilities' ability to respond to Beyond Design Basis Events (BDBE) such as Fukushima. This prompted a Type II inspection of Bruce Power's progress on the plan, held in the period March 7 to April 18, 2014.

This inspection is pertinent to Condition Assessment because it verifies the pre-existing and newly installed equipment to address BDBEs. It is recent, confirming the present status of station equipment and overall preparedness.

The CNSC conducted a compliance inspection to verify the completion of the Fukushima Action Items as per four Bruce Power semi-annual progress reports. This verification was a simple visual verification that equipment was procured and appropriate modifications were made to the station.

Paraphrasing from the CNSC summary letter [167] following the inspection, the inspection was part of a multi-pronged verification approach which included the following additional elements:

- CNSC staff had previously witnessed emergency mitigating equipment (EME) deployment and the execution of field actions necessary to survive station blackout conditions in inspections and observations of emergency exercises.
- CNSC staff would be performing a more detailed documentation review of the EME technical specifications, commissioning plans, maintenance plans, and testing practices in future inspections.
- CNSC staff would conduct further inspections similar to this one to verify the completion of additional station modifications as they are completed by Bruce Power (i.e., heat transport and moderator makeup).

The inspection verified the following:

- Installation of modifications necessary for emergency makeup water to boilers and irradiated fuel bays (Section 4.1) [28]
- Installation of emergency electrical connections (Section 4.2)
- Procurement of emergency mitigating equipment (Section 4.3)
- Installation of Passive Auto Catalytic Re-combiners (Section 4.4)

Of these four items, the installation of the Passive Auto Catalytic Re-combiners in Bruce B Unit 0 had not been completed at the time of the inspection. Also, the inspection noted 6 in-progress items as of June 2014[29]. Five of the six items are related to temporary connection provisions for EME; the sixth item is related to overpressure protection for the shield tank.

There was one recommendation arising from the inspection that did not affect Bruce B.

Overall, the CNSC inspection found Bruce Power's progress on the installation of mitigating equipment to address Fukushima type events satisfactory.

7.4. Performance Indicators

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

Bruce Power monitors a number of performance indicators related to the actual condition of SSCs, and related programs and procedures. These performance indicators are documented in the SHRs, CHRs, and Program Health Reports.

Program Health Reports are developed for engineering programs that are deemed critical to ensure safe and reliable plant operation, in order to meet Bruce Power's Equipment Reliability goals and continuous improvement. Equipment Cornerstones, included in the engineering program health reports, monitor critical component failures, adverse failure trends and life cycle management plans.

The Equipment Reliability Index (ERI) provides a numerical point value that is used to gauge the status of station and unit equipment reliability. The ERI is reviewed on a monthly basis by the Station Plant Health Committee and includes a number of sub-indicators such as Forced Loss Rate, Quarterly Forced Loss Events, ER Clock Resets and Safety System Unavailability. The

[28] In a previous review of the Irradiated Fuel Bays (IFBs) structural analysis [162], the CNSC staff assessed the Bruce Power information and analysis report on the IFB and found it acceptable. Based on that review, the CNSC closed FAIs 1.5.1, 1.6.1 and 1.6.2. This addressed the topic of the structural integrity of the IFBs in Beyond Design Basis Accident (BDBAs).

[29] Bruce Power has continued to respond diligently to the CNSC Fukushima Action Items (FAIs) with equipment changes/additions and associated procedural changes, Of the 36 Fukushima Actions raised by the CNSC, the most recent status report [168] shows that 33 were closed. Of the previously closed items, 13 items were allocated to new action items and one action allocated to a previous 2009 action for final completion.

ERI dashboard is available on the Bruce Power intranet for personnel access to the ERI. A sampling of ERIs from 2014 and 2015 is shown in Table 10. The 2014 data shows the ERI improving continuously over the year, consistently better than the internal target ERI. While there were some setbacks during 2015, the ERI was better than the internal target ERI until the end of the year, at which time it was the same as the target. In both years, the ERI overtook the industry best ERI of 75 reported by COG, but falls short of the industry best ERI of 90 reported by INPO.

Table 10: Bruce B Equipment Reliability Indices for 2014-2015

Calendar Quarter	2014 ERI		2015 ERI	
	Target ERI	Actual ERI	Target ERI	Actual ERI
March	70	75	74	75
June	71.5	75	76	78
September	72	74	77	80
December	72	80	80	80

The following are examples of sub-indicators that contribute to the ERI:

- Schedule compliance (proportion of work completed as scheduled (inage))
- Outage schedule compliance (early start or late outage finish due to equipment failure)
- Critical work backlog and deferral of critical PMs.
- Chemistry effectiveness.

Performance indicators relevant to life cycle management and maintenance of SSCs include functional failures and maintenance backlogs, as well as component ageing and obsolescence. The Performance Indicator for Station Rework is measured as a percentage of all corrective maintenance completed.

WANO performance objectives are standards for plant and corporate performance intended to promote excellence in the operation, maintenance, support and governance of commercial nuclear power plants. Bruce Power has adopted and implemented the WANO performance objectives and criteria in its ER processes [169] site-wide. Under Equipment Reliability, WANO performance objectives and criteria are identified in the areas of equipment performance, equipment failure prevention, long term equipment reliability and materials reliability.

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 2014, CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2014, issued in September 2015 [170], summarizes the 2014 ratings for Canada's NPPs in each of the 14 CNSC Safety and Control Areas (SCA), including fitness for service. The fitness for service SCA covers activities that affect the physical condition of SSCs to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform their intended design function when called upon to do so. For 2014, the Bruce B rating for the fitness for service SCA was "satisfactory".

8. Summary and Conclusions

The overall objectives of the Bruce B PSR are to conduct a review of Bruce B against modern codes and standards and international safety expectations, and to provide input to a practicable set of improvements to be conducted during the MCR in Units 5 to 8, as well as U0B, 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 in this Safety Factor, as stated in the PSR Basis [5], is to determine the actual condition of SSCs important to safety and whether it is adequate for them to meet their design requirements. This objective has been interpreted herein to be a demonstration that processes are in place that ensure that the condition of SSCs is known and documented and that it is adequate for them to meet their design requirements. This specific objective has been met by the completion of the review tasks specific to actual condition of SSCs.

The review tasks have shown that processes are in place to document U058 SSC condition and the conditions of the SSCs are tracked in SHRs and LCMPs. Bruce Power continues to improve and streamline these processes as part of ageing and asset management, integrating these improvements with their anticipated obsolescence, testing, inspection and maintenance programs.

The Equipment Reliability improvement initiative launched as the Ageing and Obsolescence Project was intended to raise the Bruce A and B station equipment reliability. The AOP evolved into the existing programs and initiatives in effect today – Obsolescence, PM Basis Reviews, and Asset Management. The products of these processes are in place for most Category 1 and 2 components, thus supporting ongoing confidence in the health of SSCs.

There were no key issues arising from the Periodic Safety Review of Safety Factor 2. The following observations are made with respect to improvement opportunities previously identified:

- There were four potential improvement opportunities described in the interim PSR [6], although none required a direct IIP item [171].
- The condition of the SSCs of Units 058 has been assessed in [126] and updated in the SHRs in [127]. A number of issues have been identified in the SHRs, but most are of low significance and are being tracked following the well-established Bruce Power managed processes, such as System and Component Health Reporting. The SHRs show that the SSC health ratings (colour) are generally improving.
- Fitness for service and estimated remaining life has been assessed and is documented in the LCMPs [131] within the Asset Management program. A number of SSCs will require replacement within the timeframe covered by this PSR. Replacement is being tracked following the well-established Bruce Power managed processes.

Bruce Power recognizes that a significant improvement in the station equipment health is a major contributor to achieving strong safety and successful business plan performances going forward as there will be fewer unplanned, forced outages and increasingly more predictable operations.

Overall, Bruce Power meets the requirements of the Safety Factor related to actual condition of the SSCs. The review demonstrates that the current implementations of the programs related to condition assessment ensure that Bruce Power is aware of the condition of the SSCs at Bruce B and has implemented measures to ensure that SSCs remain fit for service and meet regulatory requirements during the 10-year period covered by this PSR. Thus, these programs are sufficient to support continued operation of Bruce B.

9. References

[1] NK21-CORR-00531-12136/NK29-CORR-00531-12546/E-DOC 4723908 , Nuclear Power Reactor Operating Licence, Bruce Nuclear Generating Stations A and B, PROL 18.00/2020, Canadian Nuclear Safety Commission, May 27, 2015.

[2] NK21-CORR-00531-12135/NK29-CORR-00531-12545/E-DOC 4659316, Licence Conditions Handbook, LCH-BNGS-R000, Bruce Nuclear Generating Station A and Bruce Nuclear Generating Station B Nuclear Reactor Operating Licence, PROL 18.00/2020 (Effective: June 1, 2015), Canadian Nuclear Safety Commission, May 27, 2015.

[3] CNSC REGDOC-2.3.3, Operating Performance: Periodic Safety Reviews, CNSC, April 2015.

[4] BP-PROC-01024-R000, Periodic Safety Reviews, December 2015.

[5] NK29-CORR-00531-12932, Bruce B Periodic Safety Review Basis Document, Bruce Power Letter, F. Saunders to K. Lafrenière, January 25, 2016.

[6] NK21-CORR-00531-11005/NK29-CORR-00531-11397, Submission of Safety Basis Report, Bruce Power Letter, F. Saunders to R. Lojk, December 30, 2013.

[7] NK21-CORR-00531-00514, Bruce A: CNSC Approval to Restart Units 3 and 4 and Application to Amend PROL 15.01/2003, Bruce Power Letter, F. Saunders to J.H.M. Douglas, November 16, 2001.

[8] NK21-CORR-00531-04636, Bruce A Units 1 and 2 Return to Service: Systematic Review of Safety – Basis, Bruce Power Letter, F. Saunders to D.A. Desjardins, December 22, 2006.

[9] NK21-CORR-00531-04059, Bruce A Refurbishment for Life Extension – Systematic Review of Safety: Plant Design, Bruce Power Letter, F. Saunders to P. Webster, March 30, 2006.

[10] NK21-CORR-00531-04339, Bruce A Units 1 and 2 Return to Service – Systematic Review of Safety, Bruce Power Letter, F. Saunders to P. Webster, July 31, 2006.

[11] NK21-CORR-00531-05749, Bruce A Refurbishment for Life Extension and Continued Operation of Units 3 and 4 – Integrated Safety Review Basis, Bruce Power Letter, F. Saunders to P. Elder, February 29, 2008.

[12] NK21-CORR-00531-05976, Bruce A Units 3 and 4 Refurbishment for Life Extension and Continued Operations: ISR Safety Factor Reports, Bruce Power Letter, F. Saunders to P. Elder, June 2, 2008.

[13] NK21-CORR-00531-06596, Bruce A Units 3 and 4 Refurbishment for Life Extension and Continued Operation: ISR Safety Factor Reports 1, 2, 3 and 4, Bruce Power Letter, F. Saunders to K. Lafrenière, December 18, 2008.

[14] NK21-CORR-00531-06076, Bruce A Units 3 and 4 Refurbishment for Life Extension and Continued Operation: ISR Safety Factor Reports 5, 6, and 7, Bruce Power Letter, F. Saunders to P. Elder, July 22, 2008.

[15] NK21-REP-03600-00025-R001, Bruce NGS A Units 3 and 4 Global Assessment Report and Integrated Implementation Plan, May 29, 2009.

[16] NK21-CORR-00531-11617, Integrated Safety Review for Bruce A, Bruce Power Letter, F. Saunders to K. Lafrenière, including enclosure K-421231-00010-R00, Candesco Report, October 27, 2014.

[17] NK21-CORR-00531-12269, Bruce A Integrated Safety Review – Safety Factor Reports, Bruce Power Letter, F. Saunders to K. Lafrenière, August 27, 2015.

[18] NK21-CORR-00531-10576/NK29-CORR-00531-10975, Application Requirements for Renewal of Power Reactor Operating Licences for Bruce Nuclear Generating Stations A and B, Bruce Power Letter, F. Saunders to R. Lojk, July 17, 2013.

[19] NK29-CORR-00531-11252, Application for the Renewal of the Power Reactor Operating Licence for Bruce Nuclear Generating Station B, Letter, F. Saunders to M. Leblanc, October 31, 2013.

[20] NK21-CORR-00531-11711/NK29-CORR-00531-12101, Bruce A and Bruce B Licence Renewal – Supplemental Update, F. Saunders to M. Leblanc, November 27, 2014.

[21] NK21-CORR-00531-11715/NK29-CORR-00531-12105, Bruce Power: Requests and Supplemental Information for Licence Renewal, F. Saunders to M. Leblanc, November 28, 2014.

[22] Nuclear Safety and Control Act, 1997, c. 9, N-28.3, Assented to March 20, 1997.

[23] CNSC RD/GD-98, Reliability Programs for Nuclear Power Plants, June 2012.

[24] CAN/CSA N285.4-14, Periodic Inspection of CANDU Nuclear Power Plant Components, May 2014.

[25] CAN/CSA N286-05, Management System Requirements for Nuclear Facilities, CSA, February 2005, (Update No.2, 2010), R2010.

[26] CAN/CSA N286-12, Management System Requirements for Nuclear Facilities, CSA, June 2012

[27] CSA N286.5-95, Operations Quality Assurance For Nuclear Power Plants, CSA, May 1995.

[28] CAN/CSA N286.7-99, Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants, CSA, March 1999, (R2012).

[29] CAN/CSA N290.13-05, Environmental Qualification of Equipment for CANDU Nuclear Power Plants, CSA, February 2005, (Update No.1 October 2009), (R2015).

[30] CAN/CSA N290.15-10, Requirements for the Safe Operating Envelope of Nuclear Power Plants, CSA, August 2010, (R2015).

[31] S-98 Rev. 1, Reliability Programs for Nuclear Power Plants, CNSC Regulatory Document/Guide, CNSC Regulatory Standard, July 2005.

[32] CAN/CSA N285.4-09, Periodic Inspection of CANDU Nuclear Power Plant Components,

January 2010.

[33] NK21-CORR-00531-11494/NK29-CORR-00531-11881, Response to Bruce Power letter, CSA N286-12 “Management system requirements for nuclear facilities”, Action Item 1307-4697, CNSC Letter, K. Lafrenière to F. Saunders, July 24, 2014.

[34] NK21-CORR-00531-11189/NK29-CORR-00531-11593, Action Item 1307-4697: CSA N286-12 - Management System Requirements for Nuclear Facilities, Bruce Power Letter, F. Saunders to K. Lafrenière, May 16, 2014.

[35] NK21-CORR-00531-11563/NK29-CORR-00531-11946, CSA N286-12 - Management System Requirements for Nuclear Facilities, Action Item 1307-4697, Bruce Power Letter, F. Saunders to K. Lafrenière, September 9, 2014.

[36] NK21-CORR-00531-12570/NK29-CORR-00531-12996, Action Item 1307-4697: CSA N286-12 - Management Systems Requirements for Nuclear Facilities, Bruce Power Letter, F. Saunders to K. Lafrenière, January 29, 2016.

[37] BP-PROG-10.01-R009, Plant Design Basis Management, Bruce Power, December 4, 2014.

[38] CAN/CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code, CSA, 2014.

[39] CAN/CSA N291-15, Requirements for Safety-Related Structures for CANDU Nuclear Power Plants, November 2015.

[40] NK21-CORR-00531-12107/NK29-CORR-00531-12514, 2015 Annual COG Research and Development Reporting, Bruce Power Letter, F. Saunders to K. Lafrenière, June 12, 2015.

[41] IAEA SSG-25, Periodic Safety Review of Nuclear Power Plants, IAEA, March 2013.

[42] B-REP-00701-26MAR2012-003, Asset Management Initiative – Description, Bruce Power, March 2012.

[43] BP-MSM-1-R012, Management System Manual, Bruce Power, June 2014.

[44] BP-OPP-00001-R019, Operating Policies and Principles – Bruce B, Bruce Power, July 15, 2015.

[45] BP-PROG-00.04-R022, Pressure Boundary Quality Assurance Program, Bruce Power, June 2015.

[46] BP-PROC-00098-R015, Records Management, Bruce Power, November 13, 2014.

[47] BP-PROC-00166-R024, General Procedure and Process Requirements, Bruce Power, December 17, 2014.

[48] BP-PROC-00335-R007, Design Management, Bruce Power, July 30, 2015.

[49] BP-PROC-00014-R009, Technical Operability Evaluation, Bruce Power, October 23, 2014.

[50] BP-PROC-00261-R005, Environmental Qualification, Bruce Power, November 7, 2012.

[51] BP-PROC-00582-R003, Engineering Fundamentals, Bruce Power, July 25, 2014.

[52] BP-PROG-10.02-R010, Engineering Change Control, Bruce Power, November 12, 2014.

[53] BP-PROG-10.03-R006, Configuration Management, Bruce Power, February 5, 2015.

[54] BP-PROG-11.01-R005, Equipment Reliability, Bruce Power, December 16, 2015.

[55] BP-PROC-00383-R000, Performance and Condition Assessment, Bruce Power, December 15, 2006.

[56] BP-PROC-00778-R002, Scoping and Identification of Critical SSCs, Bruce Power, September 3, 2015.

[57] BP-PROC-00666-R004, Component Categorization, Bruce Power, October 1, 2015.

[58] BP-PROC-00779-R001, Continuing Equipment Reliability Improvement, Bruce Power, September 14, 2015.

[59] BP-PROC-00457-R007, Development and Approval of Predefined, Bruce Power, January 23, 2013.

[60] BP-PROC-00532-R002, Critical and Strategic Spares, Bruce Power, March 5, 2014.

[61] BP-PROC-00534-R003, Technical Basis Assessment, Bruce Power, September 1, 2015.

[62] BP-PROC-00780-R002, Preventive Maintenance Implementation, Bruce Power, September 11, 2015.

[63] BP-PROC-00501-R005, Integrated Preventive Maintenance Program, Bruce Power, May 27, 2014.

[64] BP-PROC-00781-R003, Performance Monitoring, Bruce Power, September 11, 2015.

[65] BP-PROC-00267-R000, Management of Steam Generator and Preheater Tube Integrity, Bruce Power, November 30, 2004.

[66] BP-PROC-00268-R007, Safety System Testing (SST) Program Procedure, Bruce Power, August 28, 2015.

[67] BP-PROC-00284-R004, Predictive Maintenance, Bruce Power, October 13, 2015.

[68] BP-PROC-00334-R003, Periodic Inspection, Bruce Power, May 2, 2014.

[69] BP-PROC-00361-R002, In-Service Testing and Inspection to Satisfy CAN/CSA N287.7-08 Requirements, Bruce Power, March 13, 2015.

[70] BP-PROC-00387-R001, Plant Inspection, Bruce Power, July 29, 2015.

[71] BP-PROC-00825-R001, Buried Piping Inspection Program, Bruce Power, March 24, 2015.

[72] BP-PROC-00849-R001, Aggregate Risk Assessment and Monitoring, Bruce Power, September 3, 2013.

[73] BP-PROC-00863-R001, Engineering Programs Health Reporting, Bruce Power, April 26, 2013.

[74] BP-PROC-00893-R000, Fuel and Fuel Channel Program, Bruce Power, December 10, 2012.

[75] SEC-ME-00007-R003, Pipe Wall Thinning - FAC, Bruce Power, October 6, 2010 (superseded by BP-PROC-00923).

[76] BP-PROC-00923-R000, Pipe Wall Thinning – FAC, Bruce Power, January 16, 2014 (Replaces SEC-ME-00007).

[77] DPT-PE-00008-R006, System and Component Performance Monitoring Plans, Bruce Power, September 11, 2015.

[78] DPT-PE-00009-R002, System and Component Performance Monitoring Walkdowns, Bruce Power, September 30, 2015.

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

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

[81] SEC-ME-00008-R001, Heat Exchangers, Bruce Power, October 30, 2006.

[82] SEC-ME-00010-R002, Inspection and Monitoring Once-Through Service Water Systems, Bruce Power, November 14, 2008.

[83] SEC-RE-00017-R000, Motor Program, Bruce Power, April 7, 2011.

[84] BP-PROC-00782-R001, Equipment Reliability Problem Identification & Resolution, Bruce Power, October 14, 2014.

[85] BP-PROC-00783-R001, Long Term Planning & Life Cycle Management, Bruce Power, September 25, 2013.

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

[87] BP-PROC-00533-R002, Obsolescence Management, Bruce Power, October 28, 2014.

[88] BP-PROG-11.02-R006, On-Line Work Management Program, Bruce Power, October 23, 2012.

[89] BP-PROG-11.03-R005, Outage Work Management, Bruce Power, July 26, 2011.

[90] BP-PROG-11.04-R006, Plant Maintenance, Bruce Power, November 27, 2013.

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

[92] BP-PROC-00699-R003, Maintenance Work, Bruce Power, December 5, 2013.

[93] SEC-MSS-00004-R000, Proactive Maintenance Process, Bruce Power, June 14, 2006.

[94] BP-PROC-00694-R008, Maintenance Procedure Development and Revision, Bruce Power, January 26, 2015.

[95] BP-PROG-12.01-R007, Conduct of Plant Operations, Bruce Power, August 13, 2013.

[96] GRP-OPS-00034-R006, Control of Operator Challenges, Bruce Power, November 13, 2014.

[97] GRP-OPS-00047-R007, Operator Routines and Inspections - Bruce A and Bruce B, Bruce Power, December 10, 2013.

[98] BP-PROC-00561-R003, Operations Fundamentals, Bruce Power, December 2, 2015.

[99] BP-PROG-12.02-R006, Chemistry Management, Bruce Power, June 8, 2015.

[100] BP-PROG-12.03-R003, Fuel Management, Bruce Power, November 20, 2008.

[101] BP-PROC-00498-R006, Condition Assessment of Generating Units in Support of Life Extension, Bruce Power, January 19, 2011.

[102] CNSC REGDOC-3.1.1, Reporting Requirements: Reporting Requirements for Nuclear Power Plants, CNSC, Regulatory Document, May 2014.

[103] CAN/CSA N287.7-08, In-Service Examination and Testing Requirements for Concrete Containment Structure for CANDU Nuclear Power Plants, May 2008, (Update No.1 September 2010), (R2013).

[104] CNSC RD-334, Aging Management for Nuclear Power Plants, June 2011.

[105] INPO AP-913-R004, Equipment Reliability Process Description, 2007.

[106] CNSC REGDOC-2.6.3, Fitness for Service: Aging Management, March 2014.

[107] NK21-CORR-00531-11763/NK29-CORR-00531-12158, Transition Plan for REGDOC-2.6.3 Implementation, Bruce Power Letter, F. Saunders to K. Lafrenière, December 12, 2014.

[108] B-REP-00701-31MAY2012, EOL Projections and Mitigation Options - Review Process, May 31, 2012.

[109] CNSC RD-360, Life Extension of Nuclear Power Plants, CNSC, February 2008.

[110] EPRI TR1019161, Plant Support Engineering: Proactive Obsolescence Management, Program Implementation and Lessons Learned, December 2009.

[111] NX-1037-R2, Nuclear Utility Obsolescence Group (NUOG) Obsolescence Guideline, (produced by NUOG and distributed by INPO), March 2013.

[112] BP-PROC-00789-R001, Maintenance Strategy, Bruce Power, April 23, 2014.

[113] BP-PROC-00936-R001, Asset Management Planning, Bruce Power, November 7, 2015.

[114] BP-PROC-00169-R002, Safety Related System List, Bruce Power, September 28, 2007.

[115] DPT-RS-00012-R001, Systems Important to Safety (SIS) Decision Methodology, Bruce Power, September 24, 2013.

[116] BP-PROC-00456-R009, Preventive Maintenance (PM) WO Deferral Process, Bruce Power, January 30, 2015.

[117] BP-PROC-00599-R000, Engineering Guidance for Preventative Maintenance Program Support, Bruce Power, August 20, 2008.

[118] BP-PROC-00603-R003, Preventive Maintenance Program "Just in Time" (JIT) Review Process, Bruce Power, May 11, 2015.

[119] DPT-RS-00015-R000, Safe Operating Envelope Gap Assessment, Bruce Power, May 31, 2011.

[120] BP-PROG-01.07-R010, Corrective Action Program, Bruce Power, August 30, 2013.

[121] B-REP-08133-00002-R001, Document Management Orientation, Bruce Power, September 2005.

[122] B 3/4 Refurbishing Preparation: U3/4 CA-DOR Condition Assessment Summary, May 14, 2008.

[123] GRP-PRJT-00001-R000, U 3/4 Condition Assessment: Screening SSCs for Generating Unit Refurbishment, November 16, 2007.

[124] B-REP-09034-00001-R000, Bruce Power Reliability Program, Bruce Power, May 27, 2008.

[125] DPT-NSAS-00012-R004, Preparation and Maintenance of Operational Safety Requirements, Bruce Power, October 28, 2014.

[126] B-REP-00701-23SEP2013-057, Assessment of System and Component Health Reports, Bruce Power, September 2013.

[127] Bruce Power –Condition Report - 2014, email from M. Burton, Bruce Power, to J. Stevenson, CNSC, February 29, 2016.

[128] COG Report 02-901, Principles and Guidelines for the Definition, Implementation and Maintenance of the Safe Operating Envelope at CANDU Power Plants in Canada, March 2003.

[129] NK29-CORR-00531-12458, Items 1314-4293, 1214-3934 and the Bruce B Annual Reliability Report -2014 (Confidential), Bruce Power Letter, F. Saunders to K. Lafrenière April 30, 2015 (transmission of internally confidential report).

[130] BP-PROG-12.01-R007, Conduct of Plant Operations, Bruce Power, August 13, 2013.

[131] Bruce Power Life Cycle Management Plan Summaries, email from M. Burton, Bruce Power, to J. Stevenson, CNSC, February 29, 2016.

[132] BP-PROC-00363-R003, Nuclear Safety Assessment, Bruce Power, January 24, 2013.

[133] CNSC S-210, Maintenance Programs for Nuclear Power Plants, July 2007.

[134] CNSC RD/GD-210, Maintenance Programs for Nuclear Power Plants, November 2012.

[135] Nuclear Energy Institute (NEI) AP-940, Nuclear Asset Management (NAM) Process Model, December 2007.

[136] NK29-CORR-00531-11252, Application to Renew Reactor Operating Licence for Bruce Nuclear Generating Station B, (PROL 16.00/2014), Bruce Power Letter, F. Saunders to R. Leblanc, November 2013.

[137] BP-PROC-00584-R008, PassPort Equipment Data Management, Bruce Power, October 19, 2015.

[138] Equipment Reliability Centre of Excellence Execution Plan, R. Blackwood, Rev. 1, August 2010.

[139] NK21-OM-03672-R011[30], Safety Related System Impairments Manual, Bruce A Operating Manual, August 2011.

[140] BP-PROC-00539-R016, Design Change Package, Bruce Power, June 23, 2015.

[141] NK21-CORR-00531-11324/NK29-CORR-00531-11729, Submission of S-294 Probabilistic Risk Assessment Final Reports, Bruce Power Letter, F. Saunders to K. Lafrenière, July 31, 2014.

[142] NK29-CAR-20000-00001-R000, Containment Structures and Buildings, Bruce Power, December 2011.

[143] NK29-CAR-20000-00002-R000, Containment Structures and Buildings, Bruce Power, May 3, 2011.

[144] NK29-CAR-34400-00002-R000, Irradiated Fuel Bay, Bruce Power, April 19, 2011.

[145] NK29-CAR-35000-00002-R000, Fuel Handling, Bruce Power, August 17, 2011.

[146] Used Fuel Dry Storage, System Health Report, Bruce Power, Bruce B, Q1 2015.

[147] Used Fuel Dry Storage, System Health Report, Bruce Power, Bruce B, Q4 2015.

[148] Irradiated Fuel Bays and Systems, System Health Report, Bruce Power, Bruce B, Q1 2015.

[149] Irradiated Fuel Bays and Systems, System Health Report, Bruce Power, Bruce B, Q4 2015.

[150] B-PLAN-20000-00001-R000, Life Cycle Management Plan for Civil Structures, Bruce Power, July 2010.

[151] ISO 55000, Asset Management - Overview, Principles, and Terminology, January 2014.

[152] BP-PROC-00899-R000, Asset Life Projections and Options, Bruce Power, May 10, 2013.

[153] BP-PROC-00559-R004, Station Plant Health Committee, Bruce Power, November 21, 2013.

[154] BP-PROC-00480-R001, Pipe Support Inspection, Bruce Power, November 24, 2014.

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

[156] BP-PROC-00078-R008, Quality Program Manual for Testing and Repair of Pressure Relief Valves, Bruce Power, May 19, 2015.

[157] DPT-CHM-00003-R006, Control of Chemistry, Bruce Power, June 7, 2013.

[30] As for most operating manuals, OM-03672 is published on a section basis, one file per section (system) to facilitate editing. This means the document has a cover page plus about 26 sections (files), each with their own revision number so the cover page revision is not necessarily indicative of the sub-section age.

[158] BP-PROC-00638-R012, Temporary Change Configuration Management, Bruce Power, May 7, 2014.

[159] IAEA Safety Guide No. NS-G-2.10, Periodic Safety Review of Nuclear Power Plants, IAEA Safety Standards Series, August 2003.

[160] NK21-CORR-00531-05929, Bruce A Refurbishment for Life Extension, Condition Assessment[31], CNSC Letter, P. Elder to F. Saunders, April 8, 2008. *See also* NK21-CORR-00531-06977, April 16, 2009 which closes the corresponding CNSC Action Item 080708, noting Bruce Power's continuing commitment to conducting future Condition Assessments.

[161] B-REP-00701-25JUL2011-0002, Quality Assessment of Condition Assessment Reports against the Requirements of BP-PROC-00498 R006 and Findings in CNSC Inspection Report NK21-CORR-00531-06046 for Bruce Units 3-8, Units 0A and 0B, CPUS Report, October 4, 2011.

[162] NK29-CORR-00531-11456, CNSC Type II Inspection - Condition Assessment, CNSC Letter, R. Lojk to F. Saunders, January 17, 2014.

[163] NK29-CORR-00531-11668, CNSC Type II Inspection - Condition Assessments, Bruce Power Letter, F. Saunders to K. Lafrenière, April 29, 2014.

[164] NK29-CORR-00531-11783, Action Item 2014-07-4687: CNSC Type II Inspection - Condition Assessment Inspection – BRPD-AB-2014-002, CNSC Letter, K. Lafrenière to F. Saunders, June 3, 2014.

[165] NK29-CORR-00531-11921, Action Item 2014-07-4687: Bruce Power Responses to CNSC Type II Inspection - Condition Assessment Inspection - BRPD-AB-2014-002, Bruce Power Letter, F. Saunders to K. Lafrenière, September 9, 2014.

[166] NK21-CORR-00531-11913/NK29-CORR-00531-12294, Action Item 2014-07-4687: CNSC Type II Inspection - Condition Assessment Inspection - BRPD-AB-2014-002, CNSC Letter, K. Lafrenière to F. Saunders, February 4, 2015.

[167] NK21-CORR-00531-11381/NK29-CORR-00531-11784, CNSC Type II Compliance Inspection Report: BPRD-AB-2014-005 Fukushima Action Item Field Verification, CNSC Letter, K. Lafrenière to F. Saunders, June 3, 2014.

[168] NK21-CORR-00531-12209/NK29-CORR-00531-12635, Bruce Power Progress Report No. 7 on CNSC Action Plan - Fukushima Action Items, Bruce Powert Letter, F. Saunders to K. Lafrenière, August 7, 2015.

[169] WANO POC 2013-1, Performance Objectives and Criteria, World Association of Nuclear Operators, March 2013.

[170] CC171-25E, CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants: 2014, ISSN 2369-5579, September 2015.

[31] Also referred to as: "Inspection – IDB-2007-A093 for Units 1 and 2"

[171] NK21-CORR-00531-11567/NK29-CORR-00531-11950, Integrated Implementation Plan for Bruce A, Bruce B and Centre of Site in the Next Licence Period, Bruce Power Letter, F. Saunders to K. Lafrenière, October 31, 2014.

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

A.1. CSA N291-15, Requirements for Safety-Related Structures in CANDU Nuclear Power Plants

CSA N291-15 provides material, analysis and design, construction, fabrication, inspection, examination, and aging management requirements for safety-related structures for nuclear power plants. Safety-related structures covered in this Standard are:

- Structures that support, house or protect nuclear safety systems
- Components of structures that are required for the safe operation and/or safe shutdown of the reactor;
- Structures for the storage of wet and dry irradiated fuel, and
- Structures for the storage of radioactive waste material as agreed with the Authority Having Jurisdiction.

The 2008 version of this standard is included in the Licence Conditions Handbook (LCH) [A-1] and was assessed at a high level in SFR2 for the Bruce A Integrated Safety Review (ISR) [A-2]. The differences between the two versions can be summarized as follows:

1. The seismic requirements in the 2008 version have been replaced with reference to the CSA N289 series of standards;
2. Section 8.3 of the 2008 version has been deleted in favour of referring to CSA A23.3, Design of Concrete Structures, in Section 8 of the 2015 version; and
3. Requirements for aging management have been added to the 2015 version.

The reference to CSA N289 in Item 1 has little impact on the assessment in Reference [A-2], since this series of standards is a licence requirement and compliance is demonstrated through the licensing process. The 2008 version of N291 also leans on the N289 series of standards, as well as CSA A23.3 in Item 2, so the additional emphasis on these standards in the 2015 version has little impact on the compliance assessments in Reference [A-2].

Therefore, this high level assessment of the compliance to N291 focuses on the aging management aspect of this standard.

To comply in part with CSA N291-15 Bruce Power intends to utilize the research described in Reference [A-3]. N291 excludes structures covered by the N287 series of standards on containments. While the research in this reference is focused on containment concrete, it will be applicable to other safety-related concrete structures. The condition assessments produced for the life cycle management plan (LCMP) for civil structures [A-4] provides baseline data for aging management of the N287 and N291 structures.

Condition assessment reports (CARs) have been prepared for the civil structures important to safety, such as the Unit 0B structures. The CARs have been followed by ongoing preparation of periodic system health reports (SHRs), as summarized in Reference [A-5]. The LCMPs pull together relevant technical information, such as age-related degradation mechanisms and current condition, from the Technical Basis Assessment(s) (TBA) [A-6], Component and System Performance Monitoring Plan(s) (CPMP/SPMP) [A-7], Health Report(s) [A-8], and other data sources and use this information to document the recommended long-term aging mitigation options for the subject structures. Thus, the condition of the Bruce B safety-related structures has been established and the processes are in place to manage structure aging.

Further, the in-service examination program required by CSA N291 is documented in NK29-PIP-20000-00001, R000, CSA N291 In-Service Inspection Program for Bruce NGS B Safety-Related Structures, September 2014 [A-9], covering structures not already inspected according to the CSA N287.7 inspection program for containment structures. The inspection schedule and the report names for the safety-related structures to be inspected are included in NK29-PIP-20000-00001.

With these provisions, Bruce Power will be compliant with N291-15.

Appendix A.1 References

[A-1] NK21-CORR-00531-12135/NK29-CORR-00531-12545/E-DOC 4659316, Licence Conditions Handbook, LCH-BNGS-R000, Bruce Nuclear Generating Station A and Bruce Nuclear Generating Station B Nuclear Reactor Operating Licence, PROL 18.00/2020 (Effective: June 1, 2015), Canadian Nuclear Safety Commission, May 27, 2015.

[A-2] NK21-CORR-00531-12269, Integrated Safety Review for Bruce A, Bruce Power Letter, F. Saunders to K. Lafrenière, August 27, 2015.

[A-3] NK21-CORR-00531-12107/NK29-CORR-00531-12514, 2015 Annual COG Research and Development Reporting, Bruce Power Letter, F. Saunders to K. Lafrenière, June 12, 2015.

[A-4] B-PLAN-20000-00001-R000, Life Cycle Management Plan for Civil Structures, Bruce Power, July 5, 2010.

[A-5] NK21-CORR-00531-10576/NK29-CORR-00531-10975, Application Requirements for Renewal of Power Reactor Operating Licences for Bruce Nuclear Generating Stations A and B, Bruce Power Letter, F. Saunders to R. Lojk, July 17, 2013.

[A-6] BP-PROC-00534-R003, Technical Basis Assessment, Bruce Power, September 2015.

[A-7] BP-PROC-00781-R003, Performance Monitoring, Bruce Power, September 2015.

[A-8] DPT-PE-00010-R006, System Health Reporting, Bruce Power, August 2013.

[A-9] NK29-PIP-20000-00001-R000, CSA N291 In-Service Inspection Program for Bruce NGS B Safety Related Structures, September 2014.

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

No codes or standards relevant to Safety Factor 2 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.

Appendix C – Units 058 Condition Assessment Reports

Title of Units 058 CAs	NuSCI #	Reference #
Containment Structures and Buildings	20000	[C-1] [C-2]
Airlocks and Transfer Chambers	21120	[C-3] [C-4]
Fuel Channel Assemblies	31100	[C-5]
Calandria	31200	[C-6]
Shield Tank	31300	[C-7]
Neutron Flux Monitors	31740	[C-8]
Adjuster and Control Absorber Units	31770	[C-9]
Feeder Pipe Freezing System	31940	[C-10]
Moderator Auxiliary Systems	32000	[C-11]
Main Moderator System	32100	[C-12]
Primary Heat Transport System	33000	[C-13]
PHT Auxiliaries	33100	[C-14]
Steam Generators and Preheaters	33110	[C-15]
HT Feed, Bleed, Relief, Storage and Recovery	33300	[C-16]
End Shield Cooling	34100	[C-17]
Negative Pressure Containment	34200	[C-18]
Emergency Filtered Air Discharge System (EFADS) and Post-Accident Radiation Monitoring (PARM) System	34310	[C-19]
Emergency Coolant Injection (ECI)	34330	[C-20]
Emergency Coolant Injection Supply System (ECISS)	34340	[C-21]
Powerhouse Emergency Venting System	34360	[C-22]
Irradiated Fuel Bay	34400	[C-23]
Radioactive Filter and Resin Handling Systems	34500	[C-24]
Shutdown Cooling System	34710	[C-25]

Title of Units 058 CAs	NuSCI #	Reference #
Maintenance Cooling	34720	[C-26]
Liquid Zone Control System	34800	[C-27]
Heavy Water Sampling System	34940	[C-28]
Heavy Water Transfer, Supply/Inventory, and BIOTS	34960	[C-29]
Annulus Gas	34980	[C-30]
Fuel Handling Systems	35000	[C-31]
Reactor Area Bridge - Service Area Bridges and Fuelling Machine Head Suspension	35220	[C-32]
Steam System	36100	[C-33]
Steam and Feedwater Chemical Addition and Sampling	36600	[C-34]
Vapour Recovery Systems and Instrument Rooms D2O Recovery	38310	[C-35]
Heavy Water Cleaning and Upgrading	38400	[C-36]
Turbine Auxiliaries Equipment	41100	[C-37]
Generator and Auxiliaries	41200	[C-38]
Governing System	41700	[C-39]
Moisture Separators & Reheater System	41800	[C-40]
Condenser & Auxiliaries	42110	[C-41]
Feedwater Heating and Steam Drain Systems	43100	[C-42]
Condensate and Feedwater	43200	[C-43]
Main Power Output	51000	[C-44]
13.8 kV Distribution System	53100	[C-45] [C-46]
4.16 kV Distribution	53200	[C-47] [C-48]
600/120 VAC Distribution - Class II	53320	[C-49] [C-50]
600 VAC Class III and IV Distribution	53330	[C-51]
Emergency Power	54300	[C-52]

Title of Units 058 CAs	NuSCI #	Reference #
Standby Generators	54600	[C-53]
Class I 250/48 VDC Distribution System	55000	[C-54]
Cable, Conduit and Cable Pans	57000	[C-55]
Overall Plant Control	60040	[C-56]
Communications System	60200	[C-57]
Emergency Communications System	60210	[C-58]
Instrument Hardware	60400	[C-59]
Transmitters	60430	[C-60]
Post LOCA Hydrogen Ignition System	62111	[C-61]
Channel Flow and Power Measurement	63101	[C-62]
Gaseous Fission Product Monitor and Delayed Neutron Monitor for Failed Fuel Detection	63103	[C-63]
Unit Regulating System	63710	[C-64]
Ion Chambers and Amplifiers	63715	[C-65]
Shutdown System Number One (Shut Off Rods)	63720	[C-66]
Shutdown System Number Two (Poison Injection)	63730	[C-67]
Secondary Control Areas	63760	[C-68] [C-69]
Heavy Water Leak Detection	63850	[C-70]
Fixed Area Gamma Monitors	67873	[C-71]
Fixed Gaseous Process Monitors	67876	[C-72]
Tritium Monitoring	67878	[C-73]
Common Service Water System	71110	[C-74]
Condenser Cooling Water	71210	[C-75]
Service Water Systems	71300	[C-76]
Emergency Water System	71380	[C-77] [C-78]

Title of Units 058 CAs	NuSCI #	Reference #
Fire Protection Systems	71400	[C-79] [C-80]
Water Treatment Plant	71600	[C-81]
Inactive Drainage	71710	[C-82]
Active Drainage	71720	[C-83]
Heating, Ventilation & Air Conditioning	73000	[C-84] [C-85]
Reactor Vault and Fuelling Duct Atmosphere System	73120	[C-86]
Service Air and Instrument Air Systems	75100	[C-87]
Breathing Air	75140	[C-88]
Cranes and Hoists	76100	[C-89]
Active Liquid Waste - Handling and Treatment	79200	[C-90]
Off-Gas Management System	79320	[C-91]

C.1. References

[C-1] NK29-CAR-20000-00001-R000, Containment Structures and Buildings, Units 5678 Condition Assessment Report, April 29, 2011.

[C-2] NK29-CAR-20000-00002-R000, Containment Structures and Buildings, Unit 0B Condition Assessment Report, May 3, 2011.

[C-3] NK29-CAR-21120-00001-R000, Airlocks and Transfer Chambers, Units 5678 Condition Assessment Report, September 22, 2011.

[C-4] NK29-CAR-21120-00002-R000, Airlocks and Transfer Chambers, Unit 0B Condition Assessment Report, September 23, 2011.

[C-5] NK29-CAR-31100-00001-R000, Fuel Channel Assemblies, Units 5678 Condition Assessment Report, February 8, 2012.

[C-6] NK29-CAR-31200-00001-R000, Calandria, Units 5678 Condition Assessment Report, May 4, 2011.

[C-7] NK29-CAR-31300-00001-R000, Shield Tank, Units 5678 Condition Assessment Report, March 31, 2011.

[C-8] NK29-CAR-31740-00001-R000, Neutron Flux Monitors, Units 5678 Condition Assessment Report, June 2, 2011.

[C-9] NK29-CAR-31770-00001-R000, Adjuster and Control Absorber Units, Units 5678 Condition Assessment Report, August 25, 2011.

[C-10] NK29-CAR-31940-00001-R000, Feeder Pipe Freezing System, Units 05678 Condition Assessment Report, July 27, 2011.

[C-11] NK29-CAR-32000-00001-R000, Moderator Auxiliary Systems, Units 5678 Condition Assessment Report, July 27, 2011.

[C-12] NK29-CAR-32100-00001-R000, Main Moderator System, Units 5678 Condition Assessment Report, July 19, 2011.

[C-13] NK29-CAR-33000-00001-R000, Primary Heat Transport System, Units 5678 Condition Assessment Report, May 16, 2011.

[C-14] NK29-CAR-33100-00001-R000, PHT Auxiliaries, Units 5678 Condition Assessment Report, June 9, 2011.

[C-15] NK29-CAR-33110-00001-R000, Steam Generators and Preheaters, Units 5678 Condition Assessment Report, December 9, 2011.

[C-16] NK29-CAR-33300-00001-R000, Heat Transport Feed, Bleed, Relief, Storage, and Recovery, Units 5678 Condition Assessment Report, November 8, 2011.

[C-17] NK29-CAR-34100-00001-R000, End Shield Cooling, Units 5678 Condition Assessment Report, February 8, 2011.

[C-18] NK29-CAR-34200-00002-R000, Negative Pressure Containment System, Unit 0B Condition Assessment Report, July 15, 2011.

[C-19] NK29-CAR-34310-00002-R000, Emergency Filtered Air Discharge System (EFADS) and Post-Accident Radiation Monitoring (PARMS) System, Unit 0B Condition Assessment Report, May 16, 2011.

[C-20] NK29-CAR-34330-00001-R000, Emergency Coolant Injection System (ECI), Units 5678 Condition Assessment Report, July 12, 2011.

[C-21] NK29-CAR-34340-00002-R000, Emergency Coolant Injection Supply System (ECISS), Unit 0B Condition Assessment Report, July 12, 2009.

[C-22] NK29-CAR-34360-00001-R000, Powerhouse Emergency Venting System, Units 05678 Condition Assessment Report, August 24, 2011.

[C-23] NK29-CAR-34400-00002-R000, Irradiated Fuel Bay, Unit 0B Condition Assessment Report, April 19, 2011.

[C-24] NK29-CAR-34500-00002-R000, Radioactive Filter and Resin Handling Systems, Unit 0B Condition Assessment Report, October 20, 2011.

[C-25] NK29-CAR-34710-00001-R000, Shutdown Cooling System, Units 5678 Condition Assessment Report, June 22, 2011.

[C-26] NK29-CAR-34720-00001-R000, Maintenance Cooling, Units 5678 Condition Assessment Report, August 24, 2011.

[C-27] NK29-CAR-34800-00001-R000, Liquid Zone Control System, Units 5678 Condition Assessment Report, October 27, 2011.

[C-28] NK29-CAR-34940-00001-R000, Heavy Water Sampling System, Units 5678 Condition Assessment Report, November 22, 2011.

[C-29] NK29-CAR-34960-00002-R000, Heavy Water Transfer, Supply/Inventory, and BIOTS, Unit 0B Condition Assessment Report, August 24, 2011.

[C-30] NK29-CAR-34980-00001-R000, Annulus Gas, Units 5678 Condition Assessment Report, September 8, 2011.

[C-31] NK29-CAR-35000-00002-R000, Fuel Handling, Unit 0B Condition Assessment Report, August 17, 2011.

[C-32] NK29-CAR-35220-00001-R000, Reactor Area Bridge - Service Area Bridges and Fuelling Machine Head Suspension, Units 05678 Condition Assessment Report, June 3, 2011.

[C-33] NK29-CAR-36100-00001-R000, Steam System, Units 5678 Condition Assessment Report, January 18, 2012.

[C-34] NK29-CAR-36600-00001-R000, Steam and Feedwater Chemical Addition and Sampling, Units 05678 Condition Assessment Report, December 2, 2011.

[C-35] NK29-CAR-38310-00001-R000, Vapour Recovery Systems and Instrument Rooms D2O Recovery, Units 05678 Condition Assessment Report, January 17, 2012.

[C-36] NK29-CAR-38400-00002-R000, Heavy Water Cleaning and Upgrading, Unit 0B Condition Assessment Report, September 27, 2011.

[C-37] NK29-CAR-41100-00001-R000, Turbine Auxiliaries Equipment, Units 5678 Condition Assessment Report, June 20, 2011.

[C-38] NK29-CAR-41200-00001-R000, Generator and Auxiliaries, Units 5678 Condition Assessment Report, February 2, 2012.

[C-39] NK29-CAR-41700-00001-R000, Governing System, Units 5678 Condition Assessment Report, June 9, 2011.

[C-40] NK29-CAR-41800-00001-R000, Moisture Separators and Reheater System, Units 5678 Condition Assessment Report, May 24, 2011.

[C-41] NK29-CAR-42110-00001-R000, Condenser and Auxiliaries, Units 5678 Condition Assessment Report, March 1, 2012.

[C-42] NK29-CAR-43100-00001-R000, Feedwater Heating and Steam Drain Systems, Units 5678 Condition Assessment Report, May 24, 2011.

[C-43] NK29-CAR-43200-00001-R000, Condensate and Feedwater, Units 05678 Condition Assessment Report, August 25, 2011.

[C-44] NK29-CAR-51000-00001-R000, Main Power Output, Units 05678 Condition Assessment Report, November 16, 2011.

[C-45] NK29-CAR-53100-00001-R000, 13.8 kV Distribution System, Units 5678 Condition Assessment Report, March 22, 2011.

[C-46] NK29-CAR-53100-00002-R000, 13.8 kV Distribution System, Unit 0B Condition Assessment Report, May 16, 2011.

[C-47] NK29-CAR-53200-00001-R000, 4.16 kV Distribution, Units 5678 Condition Assessment Report, May 5, 2011.

[C-48] NK29-CAR-53200-00002-R000, 4.16 kV Distribution System, Unit 0B Condition Assessment Report, July 8, 2011.

[C-49] NK29-CAR-53320-00001-R000, 600/120 VAC Distribution - Class II, Units 5678 Condition Assessment Report, June 16, 2011.

[C-50] NK29-CAR-53320-00002-R000, 600/120 VAC Distribution - Class II, Unit 0B Condition Assessment Report, April 13, 2011.

[C-51] NK29-CAR-53330-00001-R000, 600 V Class III and IV Distribution System, Units 05678 Condition Assessment Report, June 21, 2011.

[C-52] NK29-CAR-54300-00002-R000, Emergency Power, Units 05678 Condition Assessment Report, October 5, 2011.

[C-53] NK29-CAR-54600-00002-R000, Standby Generators, Units 0B Condition Assessment Report, November 15, 2011

[C-54] NK29-CAR-55000-00001-R000, Class I 250/48 VDC Distribution System, Units 05678 Condition Assessment Report, October 26, 2011.

[C-55] NK29-CAR-57000-00001-R000, Cable, Conduit and Cable Pans, Units 05678 Condition Assessment Report, December 14, 2011.

[C-56] NK29-CAR-60040-00001-R000, Overall Plant Control, Units 5678 Condition Assessment Report, October 25, 2011.

[C-57] NK29-CAR-60200-00001-R000, Communications System, Units 05678 Condition Assessment Report, June 1, 2011.

[C-58] NK29-CAR-60210-00002-R000, Emergency Communications System, Unit 0B Condition Assessment Report, June 2, 2009.

[C-59] NK29-CAR-60400-00001-R000, Instrumentation Hardware, Units 05678 Condition Assessment Report, January 17, 2012.

[C-60] NK29-CAR-60430-00001-R000, Transmitters, Units 05678 Condition Assessment Report, August 23, 2011.

[C-61] NK29-CAR-62111-00001-R000, Post LOCA Hydrogen Ignition System, Units 05678 Condition Assessment Report, June 30, 2011.

[C-62] NK29-CAR-63101-00001-R000, Channel Flow and Power Measurement, Units 5678 Condition Assessment Report, October 4, 2011.

[C-63] NK29-CAR-63103-00001-R000, Gaseous Fission Product Monitor and Delayed Neutron Monitor for Failed Fuel Detection and Location, Units 5678 Condition Assessment Report, October 6, 2011.

[C-64] NK29-CAR-63710-00001-R000, Unit Regulating System, Units 5678 Condition Assessment Report, May 24, 2011.

[C-65] NK29-CAR-63715-00001-R000, Ion Chambers and Amplifiers, Units 5678 Condition Assessment Report, July 21, 2011.

[C-66] NK29-CAR-63720-00001-R000, Shutdown System Number One (Shut-Off Rods), Units 5678 Condition Assessment Report, August 12, 2011.

[C-67] NK29-CAR-63730-00001-R000, Shutdown System Number Two (Poison Injection), Units 5678 Condition Assessment Report, June 1, 2011.

[C-68] NK29-CAR-63760-00001-R000, Secondary Control Areas, Units 5678 Condition Assessment Report, May 4, 2009.

[C-69] NK29-CAR-63760-00002-R000, Common Secondary Control Area, Unit 0B Condition Assessment Report, June 21, 2011.

[C-70] NK29-CAR-63850-00001-R000, Heavy Water Leak Detection, Units 5678 Condition Assessment Report, March 16, 2011.

[C-71] NK29-CAR-67873-00001-R000, Fixed Area Gamma Monitors, Units 05678 Condition Assessment Report, November 22, 2011.

[C-72] NK29-CAR-67876-00001-R000, Fixed Gaseous Process Monitors, Units 05678 Condition Assessment Report, November 22, 2011.

[C-73] NK29-CAR-67878-00002-R000, Tritium Monitoring, Unit 05678 Condition Assessment Report, November 4, 2011.

[C-74] NK29-CAR-71110-00002-R000, Common Service Water, Unit 0B Condition Assessment Report, May 17, 2011.

[C-75] NK29-CAR-71210-00001-R000, Condenser Cooling Water, Units 5678 Condition Assessment Report, March 1, 2012.

[C-76] NK29-CAR-71300-00001-R000, Service Water Systems, Units 5678 Condition Assessment Report, July 12, 2012.

[C-77] NK29-CAR-71380-00001-R000, Emergency Water System, Units 5678 Condition Assessment Report, May 17, 2011.

[C-78] NK29-CAR-71380-00002-R000, Emergency Water System, Unit 0B Condition Assessment Report, May 24, 2011.

[C-79] NK29-CAR-71400-00001-R000, Fire Protection Systems, Units 5678 Condition Assessment Report, August 23, 2011.

[C-80] NK29-CAR-71400-00002-R000, Fire Protection System, Unit 0B Condition Assessment Report, July 21, 2011.

[C-81] NK29-CAR-71600-00002-R000, Water Treatment Plant, Unit 0B Condition Assessment Report, January 11, 2011.

[C-82] NK29-CAR-71710-00001-R000, Inactive Drainage, Unit 05678 Condition Assessment Report, July 28, 2011.

[C-83] NK29-CAR-71720-00001-R000, Active Drainage, Unit 05678 Condition Assessment Report, July, 2009.

[C-84] NK29-CAR-73000-00001-R000, Heating, Ventilation & Air Conditioning, Units 5678 Condition Assessment Report, February 2, 2012.

[C-85] NK29-CAR-73000-00002-R000, Heating, Ventilation & Air Conditioning, Unit 0B Condition Assessment Report, February 13, 2012.

[C-86] NK29-CAR-73120-00001-R000, Reactor Vault and Fuelling Duct Atmosphere System, Units 05678 Condition Assessment Report, September 2, 2011.

[C-87] NK29-CAR-75100-00001-R000, Service Air and Instrument Air Systems, Unit 05678 Condition Assessment Report, July, 2008.

[C-88] NK29-CAR-75140-00002-R000, Breathing Air System, Units 05678 Condition Assessment Report, July 6, 2011.

[C-89] NK29-CAR-76100-00001-R000, Cranes and Hoists, Units 05678 Condition Assessment Report, July 27, 2011.

[C-90] NK29-CAR-79200-00002-R000, Active Liquid Waste - Handling and Treatment, Unit 0B Condition Assessment, July 28, 2011.

[C-91] NK29-CAR-79320-00001-R000, Off Gas Management System, Units 5678 Condition Assessment Report, June 24, 2011.

Appendix D – Units 058 Tier 1 and Tier 2 System Health Reports

Title of System Health Report	NuSCI#	Reference #
Main Moderator System	32000	[D-1]
Primary Heat Transport (PHT) System	33000	[D-2]
PHT Auxiliaries HT Feed, Bleed, Relief	33300, 33200	[D-3]
Negative Pressure Containment	21000, 34200, 34300	[D-4]
Airlocks and Transfer Chambers	21122, 21185, 21190, 21220, 24122, 24522, 25222	[D-5]
Emergency Filtered Air Discharge and Post-Accident Radiation Monitoring Systems	34310	[D-6]
Vapour Recovery Systems	38310, 38320, 38330, 38340, 38350	[D-7]
Reactor Vault & Fuelling Duct Atmosphere System	73120	[D-8]
End Shield Cooling	34110	[D-9]
Emergency Coolant Injection		
Unit 5-8 ECI	34330	[D-10]
Unit 0B ECI	63434	[D-11]
Powerhouse Emergency Venting	34360	[D-12]
Shutdown Cooling System	34710	[D-13]
Maintenance Cooling System	34720	[D-14]
Liquid Zone Control	34810, 31750	[D-15]
Annulus Gas	34980	[D-16]
Irradiated Fuel Bays and Systems	34400, 35300	[D-17]

Title of System Health Report	NuSCI#	Reference #
Fuel Handling Systems	35000	[D-18][D-19] [D-20] [D-21] [D-22] [D-23] [D-24] [D-25] [D-26] [D-27] [D-28]
Main Steam Supply, Boiler Blowoff and Boiler Steam Relief	36100, 36400, 41180	[D-29]
D_2O Systems (Transfer, S&I, BIOTS)	34960, 38100, 38700	[D-30]
Upgraders	38410, 38420, 38430	[D-31]
Turbine and Auxiliaries	41000	[D-32]
Reheat Moisture Separators	41800	[D-33]
Generator and Auxiliaries	41200	[D-34]
Excitation System	41220	[D-35]
Condensate and Feedwater	43200, 45310	[D-36]
Condenser & Auxiliaries	42100	[D-37]
Feedwater Heaters and Extraction Steam Drains	43100	[D-38]
Main Power Output	51000	[D-39]
Class IV Electrical Distribution	53000, 53100, 53103, 53140, 53200, 53203, 53240, 53340, 53348, 53540	[D-40]
Class III Electrical Distribution	53000, 53130, 53230, 53300, 53330, 53530	[D-41]
Standby Generators & Associated Fuel Delivery Systems	54600	[D-42]
Class II Electrical Distribution	53320, 53520, 55400	[D-43]
Class I Electrical Distribution	55000	[D-44]
Emergency Power Generators and EPS System	54300	[D-45]
Reactor Regulating System	31710, 31740, 31770, 63101, 63102, 63106	[D-46]

Title of System Health Report	NuSCI#	Reference #
Failed Fuel Detection	63105	[D-47]
Digital Control Computer Hardware	66400	[D-48]
Safety System Monitoring Computer	66460	[D-49]
Shutdown System #1 Shutdown System #2	31730 31760, 31780	[D-50] [D-51]
Service Water Common Service Water Condenser Cooling Water	71310, 71320, 71340 71110 71000	[D-52] [D-53] [D-54]
Fire Protection	71400	[D-55]
Emergency Water System	71380	[D-56]
Domestic Water	71500	[D-57]
Water Demin Plant	71610, 71620, 71626, 71640	[D-58]
Powerhouse Heat and Ventilation	73200, 73300, 73400, 73600, 73700, 73800	[D-59]
Powerhouse Air Conditioning System Control Room and Chilled Water	73240 73440 73500, 73600 73430, 73440	[D-60] [D-59]
Instrument and Service Air	75110, 75120	[D-62]
Breathing Air	75140	[D-63]
Used Fuel Dry Storage	34400 35390	[D-64]

D.1. References

[D-1] Main Moderator, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-2] Main Heat Transport Circuit, Gland Seal Circuit, Pumps and Purification, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-3] Feed, Bleed, Relief, Storage, and Recovery, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-4] Negative Pressure Containment, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-5] Airlocks, Transfer Chambers and Bulk Heads, System Health Report, Bruce Power, Bruce BA, Q4 2015.

[D-6] EFADS and PARMS, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-7] Vapour Recovery, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-8] Reactor Vault and Fuelling Duct Atmosphere, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-9] End Shield Cooling System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-10] Unit 5-8 Emergency Coolant Injection, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-11] Unit 0B Emergency Coolant Injection, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-12] Powerhouse Emergency Venting, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-13] Shutdown Cooling System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-14] Maintenance Cooling System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-15] Liquid Zone Control System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-16] Annulus Gas, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-17] Irradiated Fuel Bays and Systems, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-18] Fuel Handling Control Computers, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-19] Fuel Handling Inverters, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-20] Fuel Handling Power Tracks, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-21] Fueling Machine Bridges, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-22] Fueling Machine D2O Auxiliary System, System Health Report, Bruce Power, Bruce B Q4 2015.

[D-23] Fueling Machine Flow Injection System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-24] Fuelling Machine Air Auxiliaries, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-25] Fuelling Machine Heads and Suspensions, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-26] Fuelling Machine Transport Trolley, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-27] New Fuel Transfer, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-28] Irradiated Fuel Discharge, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-29] Main Steam, Boiler Blowoff, Boiler Steam Relief, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-30] D_2O Systems (Transfer, S&I, BIOTS), Boiler Steam Relief, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-31] Upgraders, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-32] Turbine and Auxiliaries, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-33] Reheat Moisture Separators, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-34] Generator and Auxiliaries, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-35] Excitation System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-36] Condensate and Feedwater, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-37] Condensers and Auxiliaries, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-38] Feed Heating and Extraction Steam Drains, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-39] Main Power Output, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-40] Class IV Electrical Distribution, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-41] Class III Electrical Distribution, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-42] Stand By Generators, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-43] Class II Electrical Distribution, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-44] Class I Electrical Distribution, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-45] Emergency Power Generators and EPS System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-46] Reactor Regulating System Hardware, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-47] Failed Fuel Location, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-48] Digital Control Computer Hardware, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-49] Safety System Monitoring Computer, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-50] Shutdown System #1, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-51] Shutdown System #2, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-52] Service Water, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-53] Common Service Water, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-54] CCW and Intake Structure, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-55] Fire Protection System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-56] Emergency Water System, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-57] Domestic Water, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-58] Water Demin Plant, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-59] Powerhouse Heat and Ventilation, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-60] Powerhouse Air Conditioning, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-61] Control Room and Chilled Water Systems, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-62] Instrument and Service Air, System Health Report, Bruce Power, Bruce B, Q4 2015.

[D-63] Breathing Air, System Health Report, Bruce Power, Bruce B, Q4 2015,

[D-64] Used Fuel Dry Storage, System Health Report, Bruce Power, Bruce B, Q4 2015.

Appendix E – Lists of FASAs, Audits and Inspections, 2010-2014

This appendix lists the Bruce B FASAs, Audits and Inspection Correspondence in the period from 2011-01-01 to 2015-12-31. This Appendix is to be read in concert with Section 7 of the main report.

E.1. FASAs

FASA Number	FASA Title
SA-COM-2011-03	CM Performance Indicators & Configuration Management Index
SA-COM-2011-04	Technical Effectiveness of Component & System Condition Monitoring Activities on EQ Applications
SA-COM-2011-10	Fidelity of Configuration Information to Plant
SA-ELCE-2011-02	Aging and Obsolescence Project Review
SA-ELCE-2011-06	ELCE - Automated Program/Component Health Reporting with IKS Programs
SA-ELCE-2011-08	Assessing the Interactions Between Departments for Improved Performance in Equipment Reliability
SA-ELCE-2011-10	Large Motor Program WANO AFI
SA-MPR-2011-03	Maintenance Line Management Reinforcement & Monitoring of Maintenance
SA-MPR-2011-05	Line Ownership of Maintenance Training
SA-MPR-2011-07	Valve Maintenance
SA-OCP-2011-01	Reactivity Management
SA-RPR-2011-01	Fixed Instrumentation Calibration & Maintenance Processes
SA-BPMS-2012-02	NORA Documentation Review against N286-05 Requirements and Understanding
SA-BPMS-2012-01	BPMS Effectiveness Review against N286-05 Requirements and Understanding
SA-ERI-2012-04	Assessing Life Cycle Management Plan Effectiveness
SA-PI-2012-01	Root Cause Investigation - Root Cause Investigation (RCI) Success

FASA Number	FASA Title
SA-COM-2014-02	Obsolescence Management
SA-BPMS-2014-01	Compliance with CSA N286-05
SA-ERI-2013-01	Component Programs
SA-ERI-2013-02	Engineering Program
SA-ERI-2013-03	System and Component Performance Monitoring Program Compliance
SA-ERI-2013-04	System Engineering Effectiveness
SA-ERI-2013-05	Equipment Reliability Performance Review Meeting
SA-ERI-2013-06	Buried Piping Program
SA-ERI-2013-07	Station Engineering Training FASA
SA-ERI-2013-08	PM Program
SA-ERI-2013-08	Effectiveness of ERCOE Implementation in Reducing Equipment Failures
SA-ERI-2013-09	Fuel Handling Software Procedure Updates
SA-ERI-2013-10	Plant Engineering Evaluations
SA-ERI-2013-11	Benefits Realization for Ventyx ER Suite (formerly IKS)
SA-ERI-2014-01	Review of Data Needs to Assess SSC Aging
SA-ERI-2014-02	Asset Management Program Effectiveness
SA-ERI-2014-03	Aggregate Risk Review
SA-ERI-2014-05	ER Interface with PB Program, JUN 302014
SA-ERI-2014-06	Heat Exchanger Program
SA-ERI-2014-07	Quality of System Health Reporting
SA-ERI-2014-08	Effectiveness of deployment of SmartSignal at BA and BB
SA-ERI-2014-09	Ice Plugging - Resources and Applications
SA-MPR-2014-02	Foreign Material Exclusion
SA-MPR-2014-03	Post Maintenance Testing
SA-MPR-2014-08	Equipment Capability
SA-PI-2014-01	Serious and systemic problems as per CSA 286-05 clause 5.11
SA-WMSI-2014-02	Seasonal Readiness

FASA Number	FASA Title
SA-ERI-2015-01	Review of Criticality Categorization Basis Information Quality and Clarity
SA-ERI-2015-02	Use of Condition Monitoring Inputs for PM Scheduling Decisions
SA-ERI-2015-04	Alignment of ER Governance implementation at Bruce A and Bruce B Stations
SA-ERI-2015-05	CSA N286-12 Gap Analysis
SA-ERI-2015-06	Engineering Software Portfolio Cost Optimization and Business Alignment
SA-ERI-2015-07	Mentoring Program Benchmarking
SA-ERI-2015-08	Inspection Services Department Governance Review
SA-ERI-2015-10	Technical Advocacy
SA-ERI-2015-11	System Engineering Effectiveness
SA-ERI-2015-12	Solenoid Valves Component Health Reporting
SA-ERI-2015-13	Evaluating Pipe Support Inspection Scope and Resourcing
SA-ERI-2015-14	Evaluating Service Water Piping Inspection Program Scope Execution
SA-ERI-2015-15	RV Program Evaluation
SA-ERI-2015-16	Business Impact Analysis (BIA)
SA-ERI-2015-17	Station Engineering Setting and Reinforcing Standards
SA-ERI-2015-SOFA	2015 SOFA Report
SA-MPR-2015-04	Pressure Boundary
SA-MPR-2015-02	Troubleshooting Plant Equipment
SA-MPR-2015-05	FME
SA-MPR-2015-07	Equipment Health - Oval 2, 3 and 4 Progress
SA-MPR-2015-08	Work Preparation
SA-MPR-2015-09	Inspection and Test Plans
SA-MPR-2015-11	Pressure Boundary
SA-MPR-2015-12	M&TE
SA-AUD-2015-05	MCR Detube/Retube Project
SA-AUD-2015-06	MCR Feeder Project

FASA Number	FASA Title
SA-AUD-2015-07	MCR Lead Out and Lead In Project
SA-AUD-2015-08	MCR Steam Generator Project
SA-AUD-2015-09	MCR Project Controls
SA-AUD-2015-10	MCR Lessons Learned & Documentation Processes
SA-SSO-2015-03	Breaker Maintenance
SA-SSO-2015-05	Assessment of Sewage Processing and Sewage Pumping station risks #195, 196 and 197
SA-SC-2015-04	Catalogue Health Project Implementation Review
SA-CHM-2015-02	Chemistry In System Health Reports
SA-CHM-2015-03	Control of Feedwater Iron
SA-COM-2015-02	EQ Program Assessment
SA-COM-2015-03	Configuration Management Engineering Governance Review
SA-COM-2015-06	Pressure Boundary Assessment

E.2. Audits

Audit Serial#	Title
AU-2010-00019	Restart Maintenance and Maintenance Programs
AU-2010-00031	N286-05 Implementation
AU-2010-00032	Fuel Handling - Bruce B SIFB Activities
AU-2010-00036	Pressure Boundary Quality Assurance Program
AU-2010-00037	Bruce A RV Field Repairs
AU-2010-00038	PBQAP Section 18 Audit
AU-2010-00039	SLAR Trolley Rehab Project
AU-2011-00002	Chemistry and Environment
AU-2011-00003	Pressure Boundary Quality Assurance Program
AU-2011-00004	Available for Restart
AU-2011-00007	RV Field Repairs

Audit Serial#	Title
AU-2011-00016	Environmental Qualification
AU-2011-00017	SST Scheduling and Completion
AU-2011-00018	Steam Generator Life Cycle Management
AU-2011-00019	Summer Readiness
AU-2011-00021	Pressure Boundary Quality Assurance Program Section 18
AU-2011-00024	Chemistry Program
AU-2011-00025	PM Deferrals
AU-2011-00027	Foreign Material Exclusion
AU-2011-00028	Performance and Condition Monitoring
AU-2012-00001	Pressure Boundary Quality Assurance Program Section 18
AU-2012-00002	Pressure Boundary Quality Assurance Program
AU-2012-00006	Equipment Reliability
AU-2012-00016	Procurement Engineering
AU-2013-00001	Pressure Boundary Quality Assurance Program Section 18
AU-2013-00002	Pressure Boundary Quality Assurance Program
AU-2013-00005	RV Field Repairs
AU-2013-00006	Maintenance
AU-2013-00007	Bruce Power Management System
AU-2013-00008	Outage Management
AU-2013-00010	Nuclear Fuel Management
AU-2013-00018	Fluid Leak Management Program
AU-2014-00001	Pressure Boundary Quality Assurance Program Section 18
AU-2014-00002	Pressure Boundary Quality Assurance Program
AU-2014-00006	RV Program and Field Maintenance
AU-2014-00009	Compliance Evaluation to BP-PROC-00666 Component Categorization
AU-2014-00010	Control of System Chemistry
AU-2014-00017	Position Assured Components
AU-2014-00024	Compliance Evaluation: BP-PROC-00603 & BP-PROC-00789
AU-2015-00002	RV Program and Field Maintenance

Audit Serial#	Title
AU-2015-00006	Pressure Boundary Quality Assurance Program Section 18
AU-2015-00007	Pressure Boundary Quality Assurance Program
AU-2015-00008	Seasonal Readiness
AU-2015-00010	Technical Operability Evaluation
AU-2015-00011	Configuration Information Changes
AU-2015-00016	OSD&D Process
AU-2015-00018	Temporary Change Control

E.3. CNSC Inspections

Doc #[32]	Title
-09183	QUARTERLY FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2010-AB-012
-09296	QUARTERLY FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2010-AB-014
-09416	BRUCE A AND B CNSC COMPLIANCE INSPECTION REPORT BRPD-2011-AB-003 MAINTENANCE PLAN AND SCHEDULE INSPECTION ACTION ITEM 110721
-09433	Bruce B CNSC Compliance Inspection Report BRPD-2011-B-012 Bruce B Unit 8 Outage Regulatory Undertakings Action Item 111405
-09654	QUARTERLY FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2011-AB-012
-09894	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT BRPD-2011-AB-019
-09928	Bruce B CNSC Compliance Inspection Report BRPD-B-2012-005 Unit 5 Fall 2011 Outage Regulatory Undertakings
-09993	BRUCE A AND B CNSC COMPLIANCE INSPECTION REPORT BRPD-AB-2012-002 MAINTENANCE PLAN AND SCHEDULE INSPECTION - ACTION ITEM 1207-3218
-09995	Bruce B CNSC Compliance Inspection Report BRPD-B-2012-021 Emergency Power Supply System Inspection

[32] All Document numbers preceded by NK29-CORR-00531-

Doc #[32]	Title
-10014	Bruce B CNSC Compliance Inspection Report BRPD-B-2012-009 - Maintenance Inspection Work Execution of MMPB Crew (Action Item 1214-3233)
-10115	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT BRPD-AB-2012-005
-10296	Bruce B CNSC Compliance Inspection Report BRPD-B-2012-023 Instrument and Service Air System Inspection Action Item 1214- 3513
-10298	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q1 BRPD-AB-2012-008 ACTION ITEM 1207-3510
-10491	BRUCE B CNSC COMPLIANCE INSPECTION REPORT BRPD-AB-2012-011 - PRESSURE BOUNDARY PROGRAM COMPLIANCE AT BRUCE POWER
-10496	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q2, BRPD-AB-2012-014
-10528	Bruce B CNSC Compliance Inspection Report BRPD-B-2012- 025 - Class I and II Power System Inspection
-10656	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q3, BRPD-AB-2012-017
-10746	Bruce B CNSC Type II Compliance Inspection Report: Unit 5 B Outage Inspection, Report BRPD-B-2013-002
-10926	Bruce B CNSC Type II Compliance Inspection Report: Unit 6 Outage Inspection, Report BRPD-B-2013-005
-10927	CNSC Type II Compliance Inspection Report BRPD-B-2013-004 Work Execution in Bruce B by Periodic Inspection Contractor
-10933	BRUCE A AND B: MAINTENANCE PLANNING AND SCHEDULING INSPECTION BRPD-AB-2013-004, NEW ACTION ITEM 1307-4113
-10945	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q4, BRPD-AB-2013-005
-11079	ACTION ITEM 1307-4229: BRUCE A AND B: PMOG INSPECTION AT BRUCE A AND B BRPD-AB-2013-008
-11118	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q1 BRPD-AB-2013-010" - NEW ACTION ITEM 1307-4270
-11191	Action Item 1314-4302: Compliance Inspection Report BRPD-B- 2013-003 Implementation of the Periodic Inspection Program at Bruce B
-11194	Bruce B CNSC Type II Compliance Inspection Report: Unit 8 Outage Inspection, Report BRPD-B-2013-006

Doc #[32]	Title
-11305	New Action Item 1307-4427: Compliance Inspection Report BRPD-AB-2013-011 - Engineering Change Control Process
-11317	Bruce B CNSC Type ll Compliance Inspection Report: BRPD-B- 2013-008 - Chemistry Compliance Inspection
-11367	Action Item 1314-4496: Electrical Power Systems Inspection BRPD-B-2013-007
-11412	CNSC Type II Compliance Inspection Report: BRPD-B-2013-009- Fire Protection Walkdown Units 5-8
-11414	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q2 BRPD-AB-2013-015
-11598	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q3 BRPD-AB-2014-001
-11755	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q4 OF 2013-14 BRPD-AB-2014-003
-11783	ACTION ITEM 2014-07-4687: CNSC TYPE II INSPECTION CONDITION ASSESSMENT INSPECTION - BRPD-AB-2014-002
-11890	Action Item 2014-07-5294: CNSC Type II Compliance Inspection - Problem Identification and Resolution - BRPD-AB- 2014-007
-11951	CNSC Type II Compliance Inspection Report: BRPD-B-2014-003 Bruce B Unit 7 Planned Maintenance Outage
-12088	Bruce A and B Quarterly Field Inspection Report Q2 2014-15 BRPD-AB-2014-011
-12190	CNSC Type II Compliance Inspection Report: BRPD-AB-2014- 015-Development, Maintenance and Use of Procedures, Action Item 2014-07-5700
-12243	CNSC Type II Compliance Inspection Report: BRPD-AB-2014- 019 Fire Protection Bruce A and B
-12283	Action Item 2015-07-5155: CNSC Type II Compliance Inspection Report: BRPD-AB-2014-020, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q3 2014-15
-12332	CNSC Type II Compliance Inspection Report: BRPD-B-2014- 004 - Bruce B Unit 5 Planned Maintenance Outage
-12414	CNSC Type II Compliance Inspection Report: BRPD-B-2015-001, Action Item 2015-14-6226
-12443	CNSC Type II Compliance Inspection Report: BRPD-B-2015-002, Bruce B Station Air Conditioning System Inspection - Action Item 2015-14-6296

Doc #[32]	Title
-12565	CNSC Type II Compliance Inspection Report: BRPD-AB-2015- 003, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q4 2014-15
-12657	CNSC Type II Compliance Inspection Report: BRPD-B-2015-003 2015 Planned Station and Vacuum Building Outage at Bruce B
-12707	Action Item 2015-07-6855: CNSC Type II Compliance Inspection Report: BRPD-AB-2015-004 Fukushima Verifications
-12715	Action Item 2015-07-5489: CNSC Type II Compliance Inspection Report: BRPD-AB-2015-006, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q1 2015-16
-12911	Action Item 2015-07-7231: CNSC Type II Compliance Inspection Report - BRPD-AB-2015-008 Implementation of the Bruce Power Reliability Program
-12910	CNSC Type II Compliance Inspection Report: BRPD-AB-2015- 011: Bruce A and B Generating Stations Quarterly Field Inspection Report for Q2 2015-16