FORM-14159 R000*

Periodic Safety Review - Final Document Review Traveler

Bruce Power

Bruce Power Document #:	Revision:	Information Classification	Usage Classification
NK29-SFR-09701-00008	R000	Internal Use Only	Information
Bruce Power Document Title: Safety Factor 8 – Safety Performance			
Bruce Power Contract/Purchase Order: 00193829	Bruce Power Project #: 39075		
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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

FORM-14129 R000

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Sheet # 2 of 6

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Periodic Safety Review - Final Document Review Traveler

Sheet # 3 of 6

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Periodic Safety Review - Final Document Review Traveler

Sheet # 4 of 6

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Periodic Safety Review - Final Document Review Traveler

Sheet # 5 of 6

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Periodic Safety Review - Final Document Review Traveler

Sheet # 6 of 6

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Periodic Safety Review - Final Document Review Traveler

Sheet # _____ of _____

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Division of Kinectrics Inc.

NK29-SFR-09701-00008

Title: Safety Factor 8 - Safety Performance

File: K-421231-00208-R00

A Report Submitted to Bruce Power

September 20, 2016

Issue R00D0	**Reason for Issue:** For harmonization				
	Author: J. Sobolewski	Verifier:	Reviewer: L. Watt	Approver:	Date: May 9, 2016
Issue R00D1	**Reason for Issue:** For internal review				
	Author: J. Sobolewski	Verifier:	Reviewer: L. Watt G. Archinoff	Approver:	Date: May 16, 2016
Issue R00D2	**Reason for Issue:** For Bruce Power review				
	Author: J. Sobolewski	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: June 10, 2016
Issue R00D3	**Reason for Issue:** Addresses Bruce Power review comments and internal verification comments.				
	Author: J. Sobolewski	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: August 15, 2016

Issue	**Reason for Issue:**				
R00	For use				
	Author: J. Sobolewski	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver: L. Watt	Date: Sept 20, 2016
Document Classification: Report			Security Classification: Client Proprietary		

Table of Contents

List of Tables

Acronyms and Abbreviations

ACE	Apparent Cause Evaluation
ACR	Annual Compliance Report
AHP	Authorized Health Physicist
ALARA	As Low As Reasonably Achievable
ANR	Automatic Neutron Overpower Set Point Reduction
AR	Action Request
BP	Bruce Power
BPMS	Bruce Power Management System
CANDU	Canada Deuterium Uranium
CCA	Contamination Control Area
CFAM	Corporate Functional Area Manager
CHRs	Component Health Reports
CM	Configuration Management
CMLF	Central Maintenance and Laundry Facility
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
DCN	Design Change Notice
DCP	Design Change Package
DRL	Derived Release Limit
DRP	Discrete Radioactive Particles
EA	Environmental Assessment
EACE	Equipment Apparent Cause Evaluation
EMS	Environmental Management System
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ER	Equipment Reliability
ERCI	Equipment Root Cause Investigation
ERCOE	Equipment Reliability Centre of Excellence

FASA	Focus Area Self-Assessment
FCN	Field Change Notice
HTLF	Heat Transport Low Flow
HTS	Heat Transport System
HU	Human Performance
IAEA	International Atomic Energy Agency
INPO	Institute of Nuclear Power Operations
ISO	International Organization for Standardization
ISR	Integrated Safety Review
JHSC	Joint Health and Safety Committee
JIT	Just In Time
KPIs	Key Human Performance (HU) Indicators
LBLOCA	Large Break Loss of Coolant Accident
LCH	Licence Conditions Handbook
LTEP	Long Term Energy Plan
M&TE	Maintenance and Test Equipment
MCR	Major Component Replacement
MOECC	Ministry of the Environment and Climate Change
MRM	Management Review Meeting
NIEP	Nuclear Industry Evaluation Program
NORA	Nuclear Oversight and Regulatory Affairs
NPP	Nuclear Power Plant
NSCA	Nuclear Safety and Control Act
NSRD	Nuclear Substance and Radiation Device
OFIs	Opportunities for Improvement
OHSMS	Occupational Health and Safety Management System
OP&Ps	Operating Policies and Principles
OPEX	Operating Experience
OPG	Ontario Power Generation
OSART	Operational Safety Review Team
OSR	Operational Safety Requirement

PAC	Position Assured Component
PDS	Problem Development Sheets
PIs	Performance Indicators
PM	Preventative Maintenance
PMOG	Preventative Maintenance Oversight Group
PMP	Performance Monitoring Plan
POC	Performance Objectives and Criteria
PORC	Plant Operational Review Committee
PPE	Personal Protective Equipment
PROL	Power Reactor Operating Licence
PSAs	Probabilistic Safety Assessments
PSR	Periodic Safety Review
QRSPI	Quarterly Reports of Safety Performance Indicators
RCEs	Responsible Component Engineers
RCI	Root Cause Investigation
REMP	Radiological Environmental Monitoring Program
RIDM	Risk Informed Decision Making
RP	Radiation Protection
RSEs	Responsible System Engineers
SAT	Systematic Approach to Training
SBR	Safety Basis Report
SCA	Safety and Control Area
SCR	Station Condition Record
SFR	Safety Factor Report
SHRs	System Health Reports
SIS	Systems Important to Safety
SOE	Safe Operating Envelope
SOER	Significant Operating Experience Report
SPHC	Station Plant Health Committee
SSCs	Structures, Systems, and Components
SSCT	System, Structure, Component, and Significant Tools

SST	Safety System Testing
TCC	Temporary Configuration Change
WANO	World Association of Nuclear Operators
WIS	Workplace Inspections System
WNSL	Waste Nuclear Substance Licence
WWMF	Western Waste Management Facility

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 whether the plant's safety performance indicators and records of operating experience, including the evaluation of root causes of plant events, indicate the need for safety improvements.

1.2. Description

The review is conducted in accordance with the Bruce B PSR Basis Document [5], which states that the review tasks are as follows:

1. The review of safety performance will evaluate whether the plant has in place appropriate processes for the routine recording and evaluation of safety related operating experience, including:
    a. Safety related incidents, low level events and near misses;
    b. Safety related operational data;
    c. Maintenance, inspection and testing;
    d. Replacements of Structures, Systems and Components (SSCs) important to safety owing to failure or obsolescence;
    e. Modifications, either temporary or permanent, to SSCs important to safety;
    f. Unavailability of safety systems;
    g. Radiation doses (to workers, including contractors);
    h. Off-site contamination and radiation levels;
    i. Discharges of radioactive effluents;
    j. Generation of radioactive waste;
    k. Compliance with regulatory requirements.
2. Where safety performance indicators are used, the review considers their adequacy and effectiveness, applying trend analysis and comparing performance levels with those for other plants in Canada;
3. The review considers the effectiveness of the processes and methodology used to evaluate and assess operating experience and trends. The findings of the reviews of other Safety Factor Reports is taken into account when undertaking this task;
4. Records of radiation doses and radioactive effluents are reviewed to determine whether these are within prescribed limits, as low as reasonably achievable and adequately managed. Although radiation risks is considered in all Safety Factor Reports, the review of this Safety Factor Report examines specifically data on radiation doses and radioactive effluents and the effectiveness of the radiation protection measures in place. The review takes into account the types of activity being undertaken at the plant, which may not be directly comparable with those at other nuclear power plants in Canada; and

5. Data on the generation of radioactive waste will be reviewed to determine whether operation of the plant is being optimized to minimize the quantities of waste being generated and accumulated, taking into account the national policy on radioactive discharges and international treaties, standards and criteria.

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.

2. Methodology of 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 Factor Reports 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 Report 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 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 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 step 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 that 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 where 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 SFRs, 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 safety performance 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. The following licence conditions have been re-affirmed as applicable for Safety Performance:

- Licence Condition G.1: Conduct activities in accordance with the licensing basis, including regulatory requirements.

- Licence Condition G.2: Written notification of changes to facilities or their operation, including deviations from design, operating conditions, policies, programs and methods referred to in the licensing basis.
- Licence Condition 3: Operating Performance
    - Licence Condition 3.1: Maintain an Operations Program
        - (i): Safety Operating Envelope;
        - (ii): Maintaining Operating Policies and Principles (OP&Ps).
    - Licence Condition 3.3: REGDOC-3.1.1: Reporting Requirements for Nuclear Power Plants.
    - Licence Condition 3.4: Not Restart the Reactor after a Serious Process Failure, without consent.
- Licence Condition 6.1: Maintain Fitness for Service for SSCs.
- Licence Condition 7.1: Radiation Protection - Implement and maintain a radiation protection program, including a set of action level and notify, within 7 days of becoming aware that an action level has been reached.
- Licence Condition 9.1: Environmental Protection - Maintain an Environmental Protection Program and Control, releases of nuclear and hazardous substances, limits, and monitor effluents.
- Licence Condition 9.2: Maintain Environmental action levels for nuclear substances and notify, within 7 days of becoming aware these have been reached.
- Licence Condition 11.1: Waste Management - Maintain a Waste Management Program.
- Licence Condition 15.2: Inform Commission of any plan to refurbish a reactor or replace a major component.

These clauses are considered in this sub-section of Section 3 to determine where additional code and standard reviews are necessary.

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
Examination Guide EG-1 (2005)	Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants	[23]	NA

Document Number	Document Title	Modern Version Used for PSR Comparison	Type of Review
Examination Guide EG-2 (2004)	Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants	[24]	NA
CNSC G-129 Rev 1 (2004/10)	Keeping Radiation Exposures and Doses As Low As Reasonably Achievable (ALARA)	[25]	2SF
CNSC G-228 2001-3	Developing and Using Action Levels	[26]	NA
CNSC Internal Guide, 2010/08	CNSC Expectations for Licensee Hours of Work Limits - Objectives and Criteria	[27]	NA
CNSC Internal Guide, 2009/05	Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants	[28]	NA
CNSC RD-204	Certification of Persons Working at Nuclear Power Plants	[29]	NA
CNSC RD/GD-210	Maintenance Programs for Nuclear Power Plants	[30]	NA
CNSC REGDOC-2.3.3	Periodic Safety Reviews	[3]	NA
CNSC REGDOC-2.6.3	Fitness for Service: Aging Management	[31]	NA
CNSC REGDOC-3.1.1 (2014)	Reporting Requirements for Operating Nuclear Power Plants	[32]	NA
CNSC RD/GD-99.3 (2012)	Public Information and Disclosure	[33]	NA
CNSC REGDOC-2.2.2 (2014)	Personnel Training	[34]	2SF

Document Number	Document Title	Modern Version Used for PSR Comparison	Type of Review
CSA N286-05 [35]	Management System Requirements for Nuclear Power Plants	CSA N286-12 [36]	NA
CSA N288.1-08 [37] (Version 2008 with Update 1 2011 is listed in the LCH)	Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities	CSA N288.1-14 [38]	2SF
CSA N288.4-10 (R2015)	Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills	[39]	NA
CSA N288.5-11	Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills	[40]	NA
CSA N288.6-12	Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills	[41]	NA
CSA N290.15	Requirements for the safe operating envelope of nuclear power plants	[42]	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 Examination Guide EG-1: Table C-1 of the PSR Basis Document [5] identifies Examination Guide EG-1, Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants [23]. The PSR Basis Document shows EG-1 need not be assessed as a part of this PSR. It is referenced in the LCH (Reference [2] Section 2.3) and is associated with RD-204. It has been captured in the Bruce Power training program and the adequacy of its inclusion continues to be affirmed as part of training compliance audits.

CNSC Examination Guide EG-2: Table C-1 of the PSR Basis Document [5] identifies Examination Guide EG-2, Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants [24]. The PSR Basis Document states that EG-2 need not be assessed as a part of this PSR. It is referenced in the LCH

(Reference [2] Section 2.3) and is associated with RD-204. It has been captured in the Bruce Power training program and the adequacy of its inclusion continues to be affirmed as part of training compliance audits.

CNSC G-129: Table C-1 of the PSR Basis Document [5] identifies CNSC G-129 [25], Keeping Radiation Exposures and Doses As Low As Reasonably Achievable (ALARA) is to have a high level assessment review performed as part of Safety Factor Report 14, Radiological Impact on the Environment. The Guideline is referenced in the LCH (Reference [2] under Licence Condition 7.1). G-129 provides guidance for developing, implementing and maintaining a radiation protection program to ensure exposures will be ALARA. While this Regulatory Guide applies primarily to radiation protection of workers, some clauses are applicable to environmental releases so it is included here. A high-level assessment of the document was included in Safety Factor Report 14, Radiological Impact on the Environment as part of the Bruce A ISR [17]. However, this SFR does capture key BP-RPP documents in Section 4.8 as they relate to records of radiation doses and effluents, and the need to show activities are managed consistent with ALARA practices (e.g., [43][44][45][46]). These are discussed in Section 5.9.

CNSC G-228: Table C-1 of the PSR Basis Document [5] identifies a high level assessment of CNSC G-228 [26], Developing and Using Action Levels will be performed as part of SF14 and SF15. G-228 is identified in the LCH (Reference [2] under Licence Condition 7.1). G-228 discusses the Action Levels which have been set for the purpose of radiation protection of members of the public. Calculation of these Action Levels is described in the procedure, Radiological Emissions Monitoring: Limits, Action Levels [47]. These action levels have been defined through the Bruce Power Radiation Protection (RP) Action Level procedure [48]. An action level is a measure of dose or other parameter that if reached gives an indication of a loss of control of the radiation protection program. This SFR reviews the performance against the action levels to assess Bruce Power's safety performance with respect to radiation doses in Section 5.9.

CNSC Internal Guidance: Table C-1 of the PSR Basis Document identifies CNSC internal Guidance regarding the CNSC Expectation for Licensee Hours of Work Limits – Objectives and Criteria and Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants. The PSR Basis Document states these internal guidance documents need not be assessed as a part of this PSR. They are referenced in the LCH (Reference [2] Sections 2.2 and 2.3), the PROL (conditions 2.2 and 2.3) and are associated with RD-204 [29]. They have been captured in the Bruce Power operational and training programs and the adequacy of their inclusion continues to be affirmed as part of training compliance audits.

CNSC RD/GD-99.3: Table C-1 of the PSR Basis Document identifies CNSC RD/GD-99.3 [33], Public Information and Disclosure, need not be assessed. It establishes regulatory requirements for public information and disclosure for licensees. It is identified in the PROL ([1] condition G.5) and identified in the LCH ([2] Section G.5). CNSC RD/GD-99.3 replaces Regulatory Guide G-217, Licensee Public Information Programs. Bruce Power has established an effective public information, disclosure and communication program ([49] Appendix G), and RD/GD-99.3 is already included in Bruce Power's Management System Manual [50]. Neither RD/GD-99.3 nor its predecessor G-217 are included in the CNSC's Safety and Control Areas (SCAs) and they are not applicable to safety. This regulatory document is included in the current licence and accordingly RD/GD-99.3 is not reviewed in Safety Factor Report 8.

CNSC RD-204: Table C-1 of the PSR Basis Document [5] identifies CNSC RD-204 [29], Certification of Persons Working at NPPs does not need to be assessed. It is in the PROL ([1] condition 2.3). RD-204 defines requirements regarding persons working at NPPs in positions that have a direct impact on nuclear safety. The document specifies the requirements to be met by persons working, or seeking to work, in positions where certification by the Canadian Nuclear Safety Commission is required. It specifies the requirements regarding the programs and processes supporting certification of workers that NPP licensees must implement to train and examine persons seeking or holding a certification delivered by the CNSC.

Consistent with the CNSC's regulatory philosophy and with international practice, licensees are first and foremost responsible for the safe operation of their respective NPPs. Consequently, NPP licensees are held responsible for training and testing their workers to ensure that they are fully qualified to perform the duties of their position, in accordance with current regulatory requirements. The CNSC obtains assurances that each person it certifies is qualified to perform the duties of the applicable position by means of a regulatory oversight regime of the licensees' training programs and certification examinations based on a combination of appropriate regulatory guidance and compliance activities.

Training and Human Performance aspects are considered in Safety Factor Report 12. From the Safety Factor Report 8 perspective, there simply needs to be an assurance workers are qualified. Safety Factor Report 12 performs an in-depth review of whether workers are qualified and the means to qualify them, and the processes and results are audited regularly by the CNSC as part of their inspection programmes. RD-204 is not reviewed in Safety Factor Report 8.

CNSC RD/GD-210: Table C-1 of the PSR Basis Document [5] identifies RD/GD-210 [30], Maintenance Programs for Nuclear Power Plants does not need to be assessed. The Regulatory Document sets out the requirements of the CNSC with regard to maintenance programs for nuclear power plants. It specifies that a maintenance program consists of policies, processes and procedures that provide direction for maintaining SSCs of the plant. RD/GD-210 [30] replaces regulatory standard S-210 (published in 2007). RD/GD-210 is listed in the PROL line-by-line compliance with this regulatory document is verified on an ongoing basis to ensure compliance with the PROL. RD/GD-210 is mapped to the Equipment Reliability Program BP-PROG-11.01 [51] procedures in Appendix D of the program document.

CNSC REGDOC-2.2.2: Table C-1 of the PSR Basis Document [5] identifies CNSC REGDOC-2.2.2 [34], Human Performance Management: Personnel Training, is covered in more than one

Safety Factor Report and identifies Safety Factor Report 12 is to perform a clause-by-clause review. REGDOC-2.2.2 sets out the CNSC's requirements for the development of a training system at nuclear facilities, and provides guidance on how these requirements should be met. Specifically, it defines the requirements and guidance for the analysis, design, development, implementation, evaluation, documentation, and management of training for workers at nuclear facilities in Canada, including the principles and elements essential to an effective training system. The requirements and guidance contained in CNSC REGDOC-2.2.2 align with the International Atomic Energy Agency's (IAEA's) recommendations on the use of the Systematic Approach to Training (SAT) methodology, as set forth in Technical Report Series 380 [52], Nuclear Power Plant Personnel Training and its Evaluation: A Guidebook. CNSC REGDOC-2.2.2 formalizes the CNSC's existing oversight program for training in nuclear facilities, and provides the basis for assessing the acceptability of licensee training programs.

The majority of CNSC REGDOC-2.2.2 is applicable to Safety Factor Report 12, rather than Safety Factor Report 8. There is a minor relevance to Safety Factor Report 8 in clauses 5.4 and 5.5, which respectively discuss continual monitoring to ensure learning is occurring on a routine basis and incident reports and rework statistics are raised when shortcoming arise. As it is identified in Table 1, CNSC REGDOC-2.2.2 is not assessed further, but given its limited relevance to Safety Factor Report 8, the comprehensive clause-by-clause assessment is provided in Safety Factor Report 12. Safety Factor Report 12 is used as the basis for confirming the qualification of workers, discussed in Section 5. Bruce Power and the CNSC reviews show there are few if any gaps in Bruce Power's ability to comply with CNSC REGDOC-2.2.2 [53]. The clause-by-clause review from Safety Factor Report 12 Section 5.3 shows the Bruce Power Training Programs met the intent of REGDOC-2.2.2 (Appendix B.1).

CNSC REGDOC-2.3.3: This PSR [3] is being conducted in accordance with CNSC REGDOC-2.3.3 per Licence Condition 15.2 (i), and associated compliance verification criteria [2]. REGDOC-2.3.3 supersedes RD-360 Life Extension of Nuclear Power Plants LCH ([2] Section 15.2), REGDOC-2.3.3 is not reviewed further in this document.

CNSC REGDOC-2.6.3: Fitness for Service: Aging Management [31] sets out the requirements of the Regulator for managing the aging of SSCs of the reactor facility. It provides guidance on how the requirements may be met. Management of aging of a reactor facility is the means to ensure the availability of required safety functions throughout the facility's service life. Aging management is the set of engineering, operational, inspection and maintenance actions that address and where practicable control the effects of physical aging and obsolescence of SSCs that occur over time or with use within acceptable limits, particularly where aging has a direct or indirect adverse effect on the safe operation of the reactor facility. An aging management program or plan is a set of policies, processes, procedures, arrangements and activities for managing the aging of SSCs of a reactor facility. Effective aging management ensures that required safety functions are reliable and available throughout the service life of the facility, in accordance with the licensing basis ([31] Preface and Section 1.1).

This REGDOC was included in PROL 15.00/2015 and Bruce Power has a transition plan with respect to compliance. Therefore, this REGDOC is not assessed for this safety factor.

CNSC REGDOC-3.1.1: Table C-1 of the PSR Basis Document [5] identifies CNSC REGDOC-3.1.1 [32], Reporting Requirements for Operating Nuclear Power Plants, does not

need to be assessed. This REGDOC was included in PROL 15.00/2015 and was the basis document the CNSC used to assess past refurbishments at Bruce A, as Bruce Power has had an obligation to meet this Regulatory Document since before 2008. CNSC REGDOC-3.1.1 [32], is listed as condition 3.1 in PROL 18.00/2020 and sets reporting requirements for nuclear power plants. Bruce Power switched over to CNSC REGDOC-3.1.1 at the beginning of 2015[1], as committed in a letter submitted to the CNSC [21]. Line-by-line compliance with this regulatory document is verified on an ongoing basis to ensure compliance with the PROL.

Reporting requirements from REGDOC-3.1.1 are addressed through various procedures, including BP-PROC-00059, Event Response and Reporting [54], an implementing procedure of BP-PROG-01.07, Corrective Action [55], and BP-PROC-00165, Reporting to CNSC – Power Reactor Operating Licenses [56], which resides on the document hierarchy of BP-PROG-06.03, CNSC Interface Management [57] and BP-PROG-11.01, Equipment Reliability [51]. The ER program ensures the reliability of the nuclear power plant via periodic inspection reporting requirements, which are part of the Performance Monitoring process (BP-PROC-00781 [58]) as described in the program ([51] Appendix D).

Therefore, this REGDOC is not assessed in this Safety Factor.

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" [59].

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 [60]. 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 [61]. 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 [62]. Per [62], 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.

[1] Reporting up to the end of 2014 is performed under S-99, and under CNSC REGDOC-3.1.1 for periods thereafter.

- 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 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 N288.1-14: CSA N288.1 [38] provides guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard in Safety Factor 14, but does not call for an assessment in the current Safety Factor Report. Section 5.11 of the current Safety Factor Report addresses discharges of radioactive effluents, and accordingly CSA N288.1-14 is discussed in Section 5.11.

CSA N288.4-10: CSA N288.4 [39] addresses the design and operation of environmental monitoring programs at Class I nuclear facilities and uranium mines and mills, and is currently in the process of being implemented at Bruce Power. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard in Safety Factor 14, but does not call for an assessment in the current Safety Factor Report. Section 5.10 of the current Safety Factor Report addresses off-site contamination and radiation levels, and accordingly CSA N288.4 is discussed in Section 5.10.

CSA N288.5-11: CSA N288.5 [40] addresses the design and operation of effluent monitoring programs for Class I nuclear facilities and uranium mines and mills, and is currently in the process of being implemented at Bruce Power. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard in Safety Factor 14, but does not call for an assessment in the current Safety Factor Report. Section 5.11 of the current Safety Factor Report addresses discharges of radioactive effluents, and accordingly CSA N288.5 is discussed in Section 5.11.

CSA N288.6-12: CSA N288.6 [41] addresses the design, implementation and management of environmental risk assessments for nuclear facilities and uranium mines and mills, and is currently in the process of being implemented at Bruce Power. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard in Safety Factor 14, but does not call for an assessment in the current Safety Factor Report. Section 5.11 of the current Safety Factor Report addresses discharges of radioactive effluents, and accordingly CSA N288.6 is discussed in Section 5.11.

CSA N290.15: Table C-1 of the PSR Basis Document [5], identifies CSA N290.15 [42], Requirements for the safe operating envelope of nuclear power plants, does not need an

assessment review. It is referenced in the LCH [2] Section 3.1 the means whereby the PROL safe operating envelope condition is met ([1] condition 3.1). Bruce Power has procedures to ensure compliance with it [63] under the auspices of the Safe Operating Envelope (SOE). As part of the SOE, consistent with the deterministic safety analyses, Bruce Power has comprehensively identified the operating limits and conditions for safety-related systems where operator actions are effective in keeping the systems within the analyzed envelope. Some limits are included directly in the licence, including the fuel bundle power and reactor power limits. Recognizing further support has been discussed with the Regulator to enhance the SOE has extended its full implementation [64]. CSA N290 is mapped to the Equipment Reliability Program BP-PROG-11.01 [51] procedures in Appendix D of the program document. BP-PROC-00779, Continuing Equipment Reliability Improvement is a specific procedure whose intent to is to comply with N290.15 ([65] Section 5.1). A similar mapping is performed in BP-PROG-10.01 [66], Plant Design Basis Management Appendix A to cover the relevant sections of the code with respect to Design Basis Management. Therefore, this document is not assessed for this safety factor.

3.3. Regulatory Documents

In addition to those listed in the PROL [1] and the LCH [2], the Regulatory Documents 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: Regulatory Documents

Document Number	Document Title	Reference	Type of Review
CNSC R-10 (1977)	The Use of Two Shutdown Systems in Reactors	[67]	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 R-10: CNSC R-10 [67] provides requirements for the shutdown systems in reactors. Section 3 of this regulatory document identifies the design requirements for the use of two shutdown systems for reactors, thus is relevant to design. The CNSC has recently reviewed and reorganized its regulatory framework program to develop a more robust, manageable and up-to-date regulatory requirements framework. A key objective of the review was ensuring that CNSC regulatory requirements are well defined and supported by additional guidance, as necessary. CNSC staff has been working with the CSA Group to develop amendments to CSA N290.1 Requirements for the Shutdown Systems of CANDU Nuclear Plants to incorporate all necessary existing requirements available in R-10. With the publication of this standard, R-10 no longer reflects the regulatory environment and as such during FY 2012-13 [68] the Regulator identified it is not necessary to maintain R-10 and it can be withdrawn and archived. Table C-1 of the PSR Basis Document shows there is no need to assess this Regulatory document. A clause-by-

clause assessment of the latest edition (i.e., 2013) of CSA N290.1 standard is performed and documented in Bruce A Safety Factor 1 [17] Section 5.3.9. Therefore, R-10 is not assessed for this Safety Factor.

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 3.

Table 3: CSA Standards

Document Number	Document Title	Reference	Type of Review
CSA N288.2-14	Guidelines for Calculating Radiation Doses to the Public from a Release of Airborne Radioactive Material under Hypothetical Accident Conditions in Nuclear Reactors	[69]	NA
CSA N288.3.4-13	Performance testing of nuclear air cleaning systems at nuclear facilities	[70]	2SF
CSA N292.0-14	General Principles for the Management of Radioactive Waste and Irradiated Fuel	[71]	NA
CSA N292.3-14	Management of Low and Intermediate-Level Radioactive Waste	[72]	2SF
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 N288.2-14: CSA N288.2 [69] provides guidelines for calculating radiation doses to the public from a release of airborne radioactive material under hypothetical accident conditions in nuclear reactors. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard in Safety Factor 5, but does not call for an assessment in the current Safety Factor Report. A high-level review of CSA N288.2-14 is performed in Safety Factor Report 5 (Appendix A.3), and is not assessed further for this Safety Factor.

CSA N288.3.4-13: CSA N288.3.4 [70] sets requirements and provides guidance for the performance testing of air-cleaning systems at nuclear facilities. Its scope is limited to systems that remove radioactive particulate matter and iodine species from airborne effluent streams. Table C-1 of the PSR Basis Document [5] calls for a high-level assessment of this standard as part of this Safety Factor. A high-level review of CSA N288.3.4-13 is performed in Bruce B Safety Factor Report 14 (Appendix A.9), and is not assessed further for this Safety Factor.

CSA N292.0: CSA N292.0-14 General principles for the management of radioactive waste and irradiated fuel [71] is not identified in Table C-1 of the PSR Basis Document [5]; however CSA N292.3 was re-written so they are companion standards used in conjunction. This Standard is part of a series of Standards on radioactive waste management. It specifies common requirements for the management of radioactive waste and irradiated fuel from generation to storage or disposal and is used in concert with all CSA Standards that apply to the management of radioactive waste and irradiated fuel (e.g., CSA N292.2, CSA N292.3, CSA N292.5, and CSA N294). Section 5.12 of the current Safety Factor Report addresses radioactive waste, and accordingly CSA N292.0-14 is discussed in Section 5.12.

CSA N292.3: Table C-1 of the PSR Basis Document [5] identifies CSA N292.3-14 [72], clause-by-clause review. This Standard provides specific requirements for the management of low- and intermediate-level radioactive waste to protect the health and safety of people, physical security, and the environment for the life cycle of radioactive waste. This Standard was originally developed in response to a need for guidelines consistent with international recommendations. It incorporates best practices and existing regulatory requirements. This Standard also draws on the operating experience of radioactive waste generators, waste brokers, and those who regulate, operate, and conduct research and development on radioactive waste processing, storage, and long-term management facilities in Canada. It includes: a) information on radioactive waste addressed throughout the life-cycle up to the point of disposal; b) updated reference publications; c) the removal of definitions and requirements generic to all radioactive waste classifications, which now appear in N292.0; and d) the addition of a requirement that this edition of this Standard be applied in conjunction with CSA N292.0, which defines general principles of radioactive waste management and provides a classification system for radioactive waste in Canada.

Bruce B Safety Factor Report 11 contains a Clause-by-Clause review of N292.3. For Bruce A there was a similar clause-by-clause review in Appendix B.2 [17]. It concluded Bruce Power was in compliance with the standard but micro-gaps were identified with respect to the procedures not explicitly covering each clause of the standard with respect consideration of the concept of storage for decay, dismantling and segmentation of equipment and/or structures to reduce waste volumes.

3.5. International Standards

As applicable international guidance considered for application to review tasks of this Safety Factor are included in Table 4.

Table 4: International Standards

Document Number	Document Title	Reference	Type of Review
IAEA SSG-25	Periodic Safety Review For Nuclear Power Plants	[73]	NA
IAEA-TECDOC-1141	Operational Safety Performance Indicators for Nuclear Power Plants	[74]	NA
IAEA-TECDOC-1335	Configuration Management of Nuclear Power Plants	[75]	NA
ISO 14001:2004 [76]	International Standard Environmental Management Systems - Requirements	ISO 14001:2015[2] [77]	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			

IAEA SSG-25: IAEA SSG-25 [73] 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.

IAEA-TECDOC-1141 (2000): Table C-1 of the PSR Basis Document [5] does not identify IAEA-TECDOC-1141, Operational Safety Performance Indicators for Nuclear Power Plants [74]. It provides a framework for identification of performance indicators which have a relationship to the derived safety attributes, therefore to safe plant operation. A high level of safety is the result of the complex interaction of good design, operational safety and human performance. Experience has shown focusing on any single aspect of performance is less effective and can be misleading. A more valid approach is provided by a diverse set of indicators designed to monitor all aspects of operational safety performance. Section 5.4 of this Safety Factor report indicates that Safety-Related Operational Data is collected, reviewed and trended by Bruce Power using guidance from this document.

IAEA-TECDOC-1335 (2003): Table C-1 of the PSR Basis Document [5] does not identify IAEA-TECDOC-1335, Configuration Management of Nuclear Power Plants, [75]. It focuses primarily on setting up, implementing and improving a configuration management program to support the overall engineering and operational change process for existing nuclear power

[2] The Environment Division is assessing the 2015 version of the standard. It was released after the PSR Basis Document [5] was assembled.

plants. Guidance is provided in developing and implementing a configuration management program for control of engineering records and operational documentation needed to maintain the authorization basis and design basis of nuclear power facilities. The configuration management program has to ensure that design requirements are met for all operational situations, including transients or accidents. Section 5.13 of this Safety Factor report indicates that BP-PROG-10.01 references this document among its external standards.

ISO 14001 (2015): Table C-1 of the PSR Basis Document [5] does not identify ISO 14001, International Standard Environmental Management Systems – Requirements [77]. ISO 14001 is a systematic framework to manage the immediate and long term environmental impacts of an organization's products, services and processes. Although it is not assessed, it is mentioned here because BP-PROG-00.02 [78], Environmental Safety Management Program, conforms with this internationally recognised environmental management standard.

3.6. Other Applicable Codes and Standards

Additional codes and standards considered in this Safety Factor Report are included in Table 5. Bruce Power routinely considers external industry standards such as those from the IAEA, Institute of Nuclear Power Operations (INPO) and World Association of Nuclear Operators (WANO) when developing their procedures.

Table 5: Other Applicable Codes and Standards

Document Number	Document Title	Reference	Type of Review
ANSI/NIRMA CM 1.0 (2007)	Configuration Management of Nuclear Facilities	[79]	2SF
INPO 05-008 March 2016	Radiological Protection at Nuclear Power Station	[80]	NA
INPO AP-913 Rev. 4 (2013)	Equipment Reliability Process Description	[81]	NA
INPO AP-928 Rev. 4 (2016)	On-Line Work Management Process Description	[82]	NA
WANO GL 2004-01 (2012)	Guideline for Radiological Protection at Nuclear Power Stations	[83]	2SF
WANO Good Practice ATL-11-006 Rev. 3	Work Management Process Description	[84]	NA

Document Number	Document Title	Reference	Type of Review
INPO 09-003-R1	Systematic Excellence in the Management of Design and Operating Margins	[85]	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			

ANSI/NIRMA CM 1.0-2000: Table C-1 of the PSR Basis Document [5] identifies the need for a high level assessment of ANSI/NIRMA CM 1.0-2000. This is provided in Safety Factor Report 1. This standard provides guidelines for the development and implementation of Configuration Management (CM) Programs by organizations operating nuclear facilities. The principle focus is on establishing essential elements of a CM Program and identifying associated industry-acceptable approaches for satisfying the requirements for each element. Its purpose is to be a guidance document not a prescriptive standard. The goal is to ensure the consistency between the design requirements, physical installations and related facility information for nuclear power plants and other nuclear facilities as applicable. Section 5.13 of this Safety Factor report indicates that BP-PROG-10.01 references this document among its external standards.

WANO GL 2004-01: Table C-1 of the PSR Basis Document [5] identifies the need for a clause-by-clause assessment review of WANO GL 2004-01 [83], Guidelines for Radiological Protection at Nuclear Power Stations. This is provided in Safety Factor Report 15. Since WANO GL 2004-01 is derived from and supersedes the INPO 91-014 Guideline [86], which was specifically intended for Pressurized Water Reactors or Boiling Water Reactors, some specific items of guidance are less relevant to the Bruce CANDU reactors. BP-RPP-00041, Executing Radiological Work [46] Section 5.6 references the 2012 version of WANO GL-2004-01.

INPO 05-008: Table C-1 of the PSR Basis Document [5] does not identify INPO 05-008, Radiological Protection at Nuclear Power Station [80] as it was issued subsequent to the issuance of the Basis Document. This document was re-affirmed and re-issued in March 2016 based on the latest industry Radiation Protection experience.

INPO AP-913: Table C-1 of the PSR Basis Document [5] does not identify INPO AP-913, Equipment Reliability Process Description [81]. It describes an equipment reliability process offered to assist member utilities to maintain high levels of safe and reliable plant operation in an efficient manner. Equipment reliability is one of an integrated set of processes for the operation and support of nuclear plants. The process description reflects the experience gained from equipment performance assistance visits to operating plants and benchmarking trips to domestic and international utilities. The equipment reliability process was designed with the direct participation of utility representatives actively involved in improving processes. It incorporates lessons learned over the past 10 years of AP-913 implementation. Bruce Power's Equipment Reliability Program, BP-PROG-11.01 [51] and its implementing procedures such as

BP-PROC-00781-R003 ([58] Section 5.6) are based on the INPO Equipment Reliability Process Description AP-913 ([51] Section 1.0).

INPO AP-928: Table C-1 of the PSR Basis Document [5] does not identify INPO AP-928, On-Line Work Management Process Description [82]. It describes a work management process in increasing level of detail: a top-level process map representing an overview of major process elements and their relationships; an intermediate process map expands on the top-level process elements and includes the detailed activities necessary to achieve the process objectives; and written process instructions providing criteria and considerations for implementing the work management process activities. BP-PROC-00328 [88] aligns with the guiding principles of AP-928.

WANO Good Practice ATL-11-006: Table C-1 of the PSR Basis Document [5] does not identify WANO Good Practice ATL-11-006, Work Management Process Description [84]. It describes a work management process used to identify, scope, plan, schedule, prepare, and execute work in a manner to ensure high levels of safe and reliable plant operation. The process provides the fundamental structure for efficient use of station resources as well as overall improvement of equipment condition. This is an evolutionary document that incorporates current best industry practices and that will be revised periodically as process improvements are developed. BP-PROC-00328 [88] aligns with the guiding principles of ATL-11-006.

INPO 09-003-R1: Table C-1 of the PSR Basis Document [5] does not identify INPO 09-003-R0, Excellence in the Management of Design and Operating Margins. (INPO 09-003-R1 [85] was renamed Systematic Excellence in the Management of Design and Operating Margins.) It provides guidance in identifying, evaluating, prioritizing, and resolving margin concerns. Conservatisms incorporated into system design and operational limits—the design and operating margins—ensure that operators and plant systems have sufficient flexibility to accommodate routine activities and the capability to respond to anticipated transients and accident scenarios effectively. Careful configuration control, evaluation of changes, and monitoring of equipment degradation are necessary to maintain acceptable levels of design and operating margins. In addition, when margins are low, personnel should fully evaluate the risk, evaluate degradation mechanisms, and establish compensatory actions to mitigate the loss of margin until sufficient margin is established. BP-PROC-00786 [89] aligns with the structure of the earlier version of INPO 09-003, as described in Section 5.6 of the procedure.

4. Overview of Applicable Bruce B Station Programs and Processes

Sections 4.1 through 4.6 provide an overview of Bruce Power programs, procedures and practices related to this Safety Factor.

4.1. Key Implementing Documents

The key Bruce Power documents related to implementation of the elements related to Safety Performance are indicated in Table 6[3].

Table 6: Key Implementing Documents

Level 0	Level 1	Level 2	Level 3
BP-MSM-1: Management System Manual [90]	BP-OPP-00001: Operating Policies and Principles – Bruce B [91]		
	BP-PROG-00.02: Environmental Safety Management [78]	BP-PROC-00080: Effluent Monitoring Program [92]	BP-PROC-00171: Radiological Emissions Monitoring [47]
		BP-PROC-00094: Environmental Objectives, Targets, and Management Plans [93]	
		BP-PROC-00793: Environmental Performance Index Indicator [94]	

[3] Table 6 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.

Level 0	Level 1	Level 2	Level 3
	BP-PROG-00.06: Health and Safety Management [95]	BP-PROC-00651: Safety Performance Metric and Monitoring, [96]	
	BP-PROG-00.07: Human Performance Program [97]	BP-PROC-00271: Observation and Coaching [98]	
		BP-PROC-00617: Human Performance Tools for Workers [99]	
		BP-PROC-00794: Monitoring Human Performance [100]	
		BP-PROC-00811: Procedure Alterations [101]	
		BP-PROC-00795: Human Performance Tools for Knowledge Workers [102]	
	BP-PROG-01.01: Business Planning Program [103]	BP-PROC-00936: Asset Management Planning [104]	
		BP-PROC-00162: Business Risk Management – Business Risk Register [105]	
	BP-PROG-01.02: Bruce Power Management System (BPMS) Management [106]		

Level 0	Level 1	Level 2	Level 3
	BP-PROG-01.06: Operating Experience Program [107]	BP-PROC-00062: Processing External and Internal Operating Experience [108]	
		BP-PROC-00137: Focus Area Self-Assessment [109]	
		BP-PROC-00147: Benchmarking and Conference Activities [110]	
		BP-PROC-00892: Nuclear Safety Culture Monitoring [111]	
	BP-PROG-01.07: Corrective Action [55]	BP-PROC-00019: Action Tracking [112]	
		BP-PROC-00059: Event Response and Reporting [54]	
		BP-PROC-00060: Station Condition Record Process [113]	
		BP-PROC-00252: Control of Nonconforming Items [114]	
		BP-PROC-00412: Trend identification and Reporting of SCRs [115]	

Level 0	Level 1	Level 2	Level 3
		BP-PROC-00506: Effectiveness Reviews [116]	
		BP-PROC-00518: Root Cause Investigation [117]	
		BP-PROC-00519: Apparent Cause Evaluation (ACE) [118]	
		BP-PROC-00644: Common Cause Analysis [119]	
		BP-PROC-00965, Visual Management Boards [120]	
	BP-PROG-06.01: CNSC Licence Acquisition [121]	BP-PROC-00114: Power Reactor Operating Licence Amendment or Renewal [122]	
	BP-PROG-06.03: CNSC Interface Management [57]	BP-PROC-00058: CNSC Commitment Management [123]	
		BP-PROC-00064: Formal Correspondence with the CNSC [124]	
		BP-PROC-00833: Reporting to the CNSC [125]	BP-PROC-00165: Reporting to CNSC – Power Reactor Operating Licences [56]

Level 0	Level 1	Level 2	Level 3
			BP-PROC-00509: Bruce A and B Quarterly Report on Safety Performance Indicators [126]
			BP-PROC-00836: Reporting to CNSC – WNSL and NSRD Licences [127]
			BP-PROC-00837: Reporting to CNSC – Class II Nuclear Facilities Licences [128]
			BP-PROC-00839: Reporting to CNSC/IAEA – Safeguards [129]
	BP-PROG-10.01: Plant Design Basis Management [66]	BP-PROC-00335: Design Management [130]	SEC-EQD-00035[4]: Environmental Qualification Sustainability Monitoring [131]
			DPT-PDE-00019: Steam Protection Barriers [132]
		BP-PROC-00363: Nuclear Safety Assessment [133]	DPT-NSAS-00003: Guidelines for Evaluating and Prioritizing Safety Report Issues [134]

[4] SEC-EQD-00035 is a Level 4 Document, taking its guidance from BP-PROC-00261, Environmental Qualification.

Level 0	Level 1	Level 2	Level 3
			DPT-NSAS-00007: Processing of REGDOC-3.1.1 Reportable Conditions Arising from Safety Analysis or Research Findings [135]
			DPT-NSAS-00012: Preparation and Maintenance of Operational Safety Requirements [63]
			DPT-NSAS-00016: Integrated Aging Management for Safety Assessment [136]
			DPT-RS-00012: Systems Important to Safety (SIS) Decision Methodology [137]
	BP-PROG-10.02: Engineering Change Control [138]	BP-PROC-00539: Design Change Package [139]	
		BP-PROC-00542: Configuration Information Change [140]	
	BP-PROG-10.03 Configuration Management [141]	BP-PROC-00638: Temporary Configuration Change Management [142]	
		BP-PROC-00786: Margin Management [89]	

Level 0	Level 1	Level 2	Level 3
	BP-PROG-11.01: Equipment Reliability [51]	BP-PROC-00268: Safety System Testing (SST) Program Procedures [143]	
		BP-PROC-00498[5] Condition Assessment of Generating Units in Support of Life Extension [144]	
		BP-PROC-00603: Preventative Maintenance Program "Just in Time" (JIT) Review Process [145]	
		BP-PROC-00666: Component Categorization [146]	
		BP-PROC-00778: Scoping and Identification of Critical SSCs [147]	
		BP-PROC-00779: Continuing Equipment Reliability Improvement [65]	
		BP-PROC-00780: Preventative Maintenance Implementation [148]	

[5] BP-PROC-00498 Section 5.2 says it is affiliated with BP-Policy-14, which no longer exists. It was transferred to BP-PROG-11.01 [51] per Figure 1 of that program document but the procedure has not been updated. This is identified as a gap in Table 10.

Level 0	Level 1	Level 2	Level 3
		BP-PROC-00781: Performance Monitoring [58]	DPT-PE-00005: Performance Requirements for Contamination Exhaust Control Filters [149]
			DPT-PE-00008: System and Component Performance Monitoring Plans [150]
			DPT-PE-00009: System and Component Performance Monitoring Walkdowns [151]
			DPT-PE-00010: System Health Reporting [152]
			DPT-PE-00011: Component Health Reporting [153]
		BP-PROC-00782: Equipment Reliability Problem Identification and Resolution [154]	BP-PROC-00559: Station Plant Health Committee [155]
		BP-PROC-00783: Long Term Planning & Life Cycle Management [156]	BP-PROC-00533: Obsolescence Management [157]
		BP-PROC-00849: Aggregate Risk Assessment and Monitoring [158]	

Level 0	Level 1	Level 2	Level 3
	BP-PROG-11.02: On-Line Work Management Program [159]	BP-PROC-00329: On-Line Work Management Process [160]	BP-PROC-00328: Work Prioritization and Approval [88]
		BP-PROC-00439: Seasonal Readiness [161]	
		BP-PROC-00735: Long Range Cycle Planning [162]	
	BP-PROG-11.03: Outage Work Management [163]		
	BP-PROG-11.04: Plant Maintenance [164]		
	BP-PROG-12.01: Conduct of Plant Operations [165]	GRP-OPS-00047: Operator Routines and Inspections - Bruce A and Bruce B [166]	
		BP-PROC-00136: Plant Operational Review Committee (PORC) [167]	
		BP-PROC-00260: Material Condition and Housekeeping [168]	
		BP-PROC-00734: Plant Status Control [169]	

Level 0	Level 1	Level 2	Level 3
	BP-PROG-12.02: Chemistry [170]	SEC-CHD-00001: Guidelines for Preparing/ Revising System Chemistry Specifications and Associated CYSs Documents [171]	
		DPT-CHM-00003: Control of Chemistry [172]	
	BP-PROG-12.03: Nuclear Fuel Management [173]	BP-PROC-01032: Fuel Performance Management [174]	
	BP-PROG-12.05: Radiation Protection Program [87]	BP-RPP-00008: Access Control [175]	
		BP-RPP-00010: Segregation and Handling of Radioactive Waste [43]	
		BP-RPP-00015: Zoning [176]	
		BP-RPP-00020: Dosimetry and Dose Reporting [44]	
		BP-RPP-00022: Contamination Control [45]	
		BP-RPP-00041: Executing Radiological Work [46]	

Level 0	Level 1	Level 2	Level 3
		BP-PROC-00714: Level Radioactive Waste Minimization [177]	
		BP-PROC-00878: Radioactive Waste Management [178]	
	BP-PROG-13.01: Corporate Governance and Legal Services [179]		
	BP-PROG-15.01: Nuclear Oversight Management [180]	BP-PROC-00295: Planning and Scheduling Audits [181]	
		BP-PROC-00169: Safety Related System List[6] [182]	

4.2. Overview Discussion

Bruce Power's Management model contains the company's vision, mission, values, behaviours, policies, key results areas, summary of the Board structure and a statement of commitment from the Chief Executive to the management system. It includes Sheets covering a summary of the complete list of Programs, a listing of Program owners and approvers, as well as functional area (process) groupings, the responsibilities and authorities of all section manager and above positions at Bruce Power and a summary of regulatory, legal and business requirements [90]. Central to this is fostering a healthy Safety Culture and being recognized for excellence in all aspects of nuclear safety including reactor safety, radiation safety, personnel safety and environmental safety management. More details on the Management System Manual can be found in Safety Factor Report 10.

BP-OPP-00001 [91], Operating Policies and Principles – Bruce B identifies the policies and principles agreed with the CNSC that drive the programs and processes to comply with these aforementioned requirements. The OP&P is subdivided into general and specific subjects. The front end covers multiple SSCs, records, reporting, while from Section 21 onwards it covers

[6] BP-PROC-00169 does not identify the PROG where it takes its authority. This is identified as gap SF8-9 in Table 10.

requirements for specific SSCs. For example, Section 10.4 of the OP&P mentions that to protect the public and station personnel in emergencies involving the release of radioactive material, emergency procedures are provided specifying staff responsibilities, available equipment, prerequisite training, and procedures to be followed ([91] Section 10.4). This document and the underlying Operating Procedures ensuring compliance to it are covered in Safety Factor Report 11, which is discussed briefly in Section 6.

BP-PROG-01.02 [106], Bruce Power Management System (BPMS) Management implements the management system and it controls changes to the interdependent processes, organization and document structures that are essential to managing business to ensure commitment to the four pillars of nuclear safety: reactor safety, radiological safety, industrial safety and environmental safety. It establishes the governance, provides oversight, support and enables the maintenance of an integrated management system framework for Bruce Power and establishes the framework for the planning, implementation, maintenance, and continual improvement of business processes, activities, and human behaviors which contribute to the achievement of Bruce Power's objectives. This Program supports the implementation of the BPMS in such a way that it is known, understood and followed. The BPMS serves as the overall quality assurance program, which complies with CSA N286, the standard required by the PROL. Nuclear Safety is a primary consideration of the management system including the enhancement and improvement of safety culture and the achievement of high levels of safety as well as business performance ([106] Section 1.0).

The OP&P defines the key safety parameters, and it and BP-PROG-01.02 establish the processes and programs to ensure the plants remain within the Safe Operating Envelope so the risk to the public and envirnoment is minimized.

From a Safety Performance perspective the key implementing documents are those involving the programmatic and process aspects of condition assessment and performance monitoring which are used to ensure the availability of SSCs to perform their safety functions when called upon during an abnormal operational occurrence, a design basis event, design extension condition or beyond design basis event. During normal operation the more relevant programmatic and process aspects involve day-to-day monitoring, prevention, mitigation and accommodation of radiation doses to workers and the public and similarly control or containment of radioactive materials and radioactive effluents to the environment.

The prevention aspects are covered by ensuring operations stays within the envelope established by the design and licensing basis. The design basis and design requirements, with a particular focus on nuclear safety, are discussed in greater detail in Safety Factor Reports 1 and 2.

The next subsections discuss the programs and processes key in identifying when there is a possibility the safety aspects of the design and operation may be diverging from the envelope agreed in the licensing and design basis, including safety. The effectiveness of these management processes is discussed in Section 5. The observations from Section 5 are supported by reviews (self-assessments, audits and inspections) of the implementation of these programs and processes. These reviews are discussed in Section 7.

Bruce Power maintains a comprehensive set of processes and procedures to perform continuous, daily and weekly SSC surveillance and testing. Daily maintenance reviews and

activities are undertaken and accomplished commensurate with the safety and production significance to ensure continued safe operation. Past S-99 and now CNSC REGDOC 3.1.1 [32] event notification occurs immediately or within 5 days depending on the safety significance and event reporting based on the timing requirements specified in the Regulatory Documents (e.g., preliminary and detailed within 5 and 60 days, respectively). Similarly the IAEA is notified of events via the CNSC Safeguards Section.

Additionally, Bruce Power maintains a comprehensive set of indicators that allow on-going monitoring of safety performance. These indicators are reported during each shift, daily or over a longer term depending on the purpose of the indicator. The less frequent indicators are captured in Quarterly Performance Assessment reports, Quarterly Reports of Safety Performance Indicators for the CNSC, Annual Environmental Compliance Reports (e.g., Water), and Quarterly Operations Reports. Furthermore, Bruce Power invites Industry Experts to provide insight on areas for improvement and continuing strengths through INPO, WANO and the IAEA (e.g., see Sections 5.1 and 5.14.3). These discussions are privileged/confidential but corrective actions from many of these reports are discussed with staff and the CNSC as they are logged through the Station Condition Record (SCR) process.

Similarly Bruce Power ensures each employee, augmented staff consultants and long-term contractors attend monthly Safety and Business Performance Meetings focusing on the four pillars of Nuclear Safety - Reactor Safety, Industrial Safety, Radiation Safety, Environmental Safety, where employees are continually indoctrinated on the importance of safety. On a weekly and even daily basis meetings such as the Morning and Station Leadership Meetings at Bruce A and B, respectively, are held to review emergency or emergent safety issues, including topics covering Radiation Protection, Physics, and System, Structure and Equipment performance (e.g., [183] Section 2.0, page 26). Visual Management Boards, BP-PROC-00965 [120] are used to ensure staff is up-to-date on activities and safety performance in their area, including issues to be stressed due to recent events and conditions, to promote team engagement and performance. Visual Management Boards provide a method for leaders to establish regular communication and visible field presence to foster an environment that promotes effective feedback and continual improvement in worker performance.

4.3. Performance Measurement

BP-PROG-11.01 [51], Equipment Reliability, in Section 1.0 defines the fundamental engineering operational performance needs, requirements, implementing approaches, and responsibilities of the plant equipment reliability integration process. The objective of the Equipment Reliability Program is to “ensure:

- The process is efficient, incorporates human factor considerations, and ensures effective performance during all phases of plant operations.
- A uniform process is used among all plants in the organization.
- Applicable in house and industry lessons learned are incorporated into the process to improve adequacy and efficiency.

- Changes to the process are timely, responsive to user feedback, and implemented at all affected plants."

Performance Monitoring at Bruce Power builds on the international lessons learned and experience gained through organizations such as INPO and Electric Power Research Institute (EPRI) ([51] Section 4.0, [58] Section 5.6).

BP-PROC-00498 Condition Assessment of Generating Units in Support of Life Extension [144] evaluates the physical condition, functionality, and remaining service life of SSCs. The assessment leads to two determinations:

- First, whether there are any SSCs which are not practical to replace that would prevent a life extension project from being undertaken. (An example might be vault concrete deterioration.)
- Second, identification of structures, systems and components that are recommended for replacement or repair during a contemplated refurbishment outage and identification of the repairs which may be made during future outages.

BP-PROC-00533 [157], Obsolescence Management, defines 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 life cycle management ([157] Section 1.0). REGDOC-2.6.3 on Aging Management [31] is relevant to the procedure. It provides an overview and guidance with respect to the processes used to identify, prioritize and resolve Obsolescence Issues. Specific objectives of this procedure are:

- Provide an overview of the Site Obsolescence Management Process.
- Define Roles and Responsibilities.
- Provide guidance for the proactive identification of obsolete equipment.
- Provide guidance for reactive identification of obsolete equipment.
- Provide guidance for the prioritization and management of identified obsolete equipment.

Provide guidance and information for the execution of solutions to obsolescence.

The Obsolescence Management Process strives to identify and resolve Obsolescence Issues before they are encountered through equipment failure or other emergent circumstances. This portion of the Obsolescence Management Process is called Proactive Obsolescence. The Obsolescence Management Process will also provide provisions for handling Obsolescence Issues when they emerge during normal work activities (reactive) ([157] Section 4.0).

BP-PROC-00603 [145], Preventative Maintenance Program "Just in Time" (JIT) Review Process defines the JIT process methodology used by Engineering, Work Management, Assessing, Maintenance and Operations to efficiently and effectively support the Preventative Maintenance (PM) program activities, achieve Equipment Reliability goals, and continuously improve the site PM programs (Section 1.0).

BP-PROC-00666 [146], Component Categorization, provide the basis for categorizing (Criticality, Duty Cycle, Service Condition, Single Point Vulnerability) components. Consistent and accurate categorization of components supports BP-PROC-00778 [147], Scoping and Identification of Critical SSCs, and is fundamental to the successful execution of BP-PROG-11.01, Equipment Reliability program. This procedure is consistent with the recommendations in INPO AP-913 R4, Equipment Reliability [81].

BP-PROC-00268 [143], Safety System Testing (SST)[7] Program Procedure, defines the Safety-Related System Testing program and lists the roles and responsibilities of stakeholders in relation to the testing requirements of Safety Related Systems. The SST program is intended to test Safety-Related SSCs to determine if they are available and directly links to equipment reliability. Routine SST is performed to ensure the continued availability of Safety-Related Systems. Testing requirements and frequencies are determined by considering design manuals, safety analysis, reliability models, and probabilistic risk assessments.

SST frequency is selected to ensure that Systems Important to Safety and Safety-Related Systems meet their availability targets, while considering the impact of repeated testing on equipment life cycle.

BP-PROC-00778 [147], Scoping and Identification of Critical SSCs, describes the process for identifying SSCs important to maintaining safe, reliable power operation. All aspects of nuclear safety (Reactor Safety, Industrial Safety, Environmental Safety and Radiation Safety) are addressed.

This procedure identifies (from Section 1.0):

- Scoping criteria.
- Functions of SSCs related to safety and reliability.
- Components included in OSRs in support of the SOE.
- Critical structures and components that support these functions.
- Non-critical components.
- Run-to-Maintenance components.

BP-PROC-00779 [65], 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 SSCs identified in BP-PROC-0778, Scoping and Identification of Critical SSCs [147].

BP-PROC-00780 [148], Preventative Maintenance Implementation describes the process for performing Preventive Maintenance to support continuous improvement of the Equipment Reliability Program. It includes periodic, predictive and planned maintenance. It covers preventive maintenance performed during operation and during outages. Preventive maintenance includes tasks scheduled for components on the Master Equipment List (such as pumps, motors, tanks) and inspection programs performed for components not on this list (such

[7] BP-PROC-00268 [143] uses Safety-Related System Testing and Safety System Testing interchangeably, and each has the acronym SST.

as piping, building structures, feeders). The procedure outlines the interface with the Work Management system (BP-PROG-11.02 [159], On-line Work Management Program, and BP-PROG-11.03 [163], Outage Work Management) in order to assess and schedule periodic, predictive and planned maintenance for SSCs on a prioritized basis. It describes the development and application of a standard set of post maintenance tests to verify important SSC functions and the effectiveness of the maintenance performed ([51], Section 4.1.3).

BP-PROC-00781 [58], Performance Monitoring, provides the basis and expectations for the Equipment Performance Monitoring Process. The Structures, Systems and Components (SSCs) included in the performance and condition monitoring program are identified by assessing the criticality of the SSC as well as the Operational Safety Requirements (OSRs). It describes the process for establishing performance criteria and monitoring parameters for important structures, important system functions and critical components and program performance. Section 1.0 of this procedure describes the:

- Monitoring and trending of system performance.
- Monitoring and trending of component performance.
- Monitoring and trending of program performance.
- Trending of predictive maintenance results.
- Use of operator rounds monitoring.
- Monitoring of Safety System Test (SST) results.
- Monitoring by Responsible System Engineers (RSEs)/Responsible Component Engineers (RCEs) through walk-downs.

Safety is the primary consideration on how the SSCs are graded and requirements are established:

- Tier 1 Systems (Important to Safety).
- Tier 2 Systems (Important to Generation and Asset Preservation).
- Components.

Performance monitoring results are recorded in System Health Reports (SHRs), Component Health Reports (CHRs) or Program Health Reports. The maintenance operator routines provide insight into degradation of SSCs and equipment in a preventative manner to alert to impending failures.

BP-PROC-00936 [104], Asset Management Planning, defines the process to select and approve the Asset Management options to achieve a resource leveled, integrated Asset Management Plan that provides safe, reliable long term operation in consideration of nuclear safety and in alignment with corporate strategic and business planning objectives. An input to the plan is the required modifications that support the Periodic Safety Review process. Upon approval of the plan and its revisions, the Asset Management Plan direction is incorporated by Engineering in various Life Cycle Management Plans.

DPT-PE-00008 [150], System and Component Performance Monitoring Plans (PMPs), states RSEs and RCEs develop and establish PMPs to monitor the performance of their systems/components on a continual basis to determine the health of their equipment.

- The trended PMP information is used to capture degradation in performance and initiate investigation and maintenance activities before there is an adverse impact on the system/component performance and reliability.
- Documentation of performance monitoring activities includes the record of the completed data collected and the results of the applicable analyses and assessments.

The engineers identify the list of equipment to be monitored and the performance indicators (PIs) to be trended. Mandatory System and Component PIs are outlined in the Appendices and cover topics such as trending for aging, obsolescence, maintenance backlogs, operational failures, the number of SCRs or unresolved OPEX issues relevant to the system to indicate potential reduced performance and the number of operating memos active.

Section 4.1.2.3 of DPT-PE-00008 [150], stresses the link to Environmental Qualification components that have Safety Related functions from the safety requirements matrix and discusses re-evaluations of equipment qualified life that may in addition benefit personnel safety as maintenance requirements are better optimized.

Sections 4.2.1, 4.2.2 and 4.2.3 of DPT-PE-00008 [150], discuss the need for inclusion of the critical component and testing performance requirements based on the Operational Safety Requirements and Section 4.2.3.5 discusses the Performance Monitoring Equipment List: a list of equipment and performance parameters to be monitored, trended, and analyzed by the respective System and/or Component Engineers. As a minimum, this includes equipment that has been identified in the Functional Failure Evaluation. Other equipment may be added, based on such factors as operation and maintenance costs, industry experience, radiological/conventional safety, significant environmental effects, historical system/component performance, known failures. Source Data Collection Frequency is linked with the safety system test programs and the Probabilistic Safety Assessments.

DPT-PE-00009 [151], System and Component Performance Monitoring Walkdowns, explains in Section 4.1 that Field Walk-downs are an essential component of performance and condition monitoring. Walk-downs provide: an opportunity for first hand direct observation of physical performance and are the basis to allow an assessment of the state of the SSCs; the means for detection of adverse trends; and the Plant Engineer with the opportunity to detect nominal changes and a recognition of abnormal or degrading situations which in turn provides the basis for implementation of mitigating actions.

A field walk-down is the mechanism used for performing a field evaluation of the SSC performance and condition. The Plant Engineer looks for signs of degradation or changes from previous (normal) operation. The Engineer recognizes and improves the awareness of general conditions such as housekeeping deficiencies, safety deficiencies, and radiological protection deficiencies. The focus is on areas which have the greatest degree of uncertainty with regard to the state of equipment degradation. Field walk-downs provide information and data through sensory observation (sight, sound, smell, touch), and opportunities for conversation with plant staff and provide means of manually collecting equipment data from field monitors and sensors.

Support is solicited from other functional areas to provide assistance, e.g., containment access, green man support, resident inspection leads and operations.

DPT-PE-00010 [152], System Health Reporting, provides the basis and expectations related to the development and generation of SHRs to meet the Equipment Reliability (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.

SHRs are issued as follows (from Section 4.1):

- Overall Colour Rating[8] YELLOW or RED: SHR are issued bi-annually (i.e., once every 6 months).
- Overall Colour Rating WHITE or GREEN: SHR are issued annually (i.e., once every 12 months).

The RSE may justify to the Section Manager for an adjustment to the SHR schedule approval.

SHRs include information on consideration of work-arounds and operator work burdens in the calculation of system health.

DPT-PE-00011 [153], Component Health Reporting, provides the basis and expectations related to the development and generation of CHRs to meet the ER goals and continuous improvement. Health Reports are developed for those Components that are deemed critical to ensure safe and reliable plant operation.

Component Engineers establish CHRs to assess and document the overall Component health and condition of the associated critical equipment.

Specifically, the scope and content of CHRs is defined as follows (Section 1.0):

- It provides 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.
- It assesses Component condition by measuring the Component Performance Monitoring Plan Performance Indicators (PIs) against a predefined set of criteria.
- It provides for trending of Component health and PIs over time to discern the direction of Component performance and proactively identify changes needed to improve equipment reliability and Component health.
- It defines the Health Report document and communication requirements to capture and convey the graded Component health and identified issues/action plans to Plant Management.

Component Health Reports are issued bi-annually if the overall Colour Rating is YELLOW or RED or issued annually if the rating is WHITE or GREEN.

[8] Red means unacceptable as degradation requires near term attention to minimize operational challenges, while Yellow means the degradation presents challenges to long term reliability and possibly safe and efficient operation. White is acceptable with some challenges to long term reliability, while Green is excellent with no additional action necessary beyond routine maintenance and evaluation.

Department Manager approval and justification is needed for an extension to a CHR due date.

BP-PROG-11.02 [159], the On-Line Work Management Program, defines the performance needs, requirements, implementing approaches and responsibilities of 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 maximize the availability and reliability of SSCs. It accounts for the risks associated with conducting work and identifies the impact of work to the station and to work groups; protects the station from unanticipated transients due to the execution of work; and supports nuclear safety and fosters a nuclear safety culture.

BP-PROC-00329 [160], OnLine Work Management Process, establishes and fosters nuclear safety by providing the process where station online work is identified, processed, scheduled and controlled in order to: Manage plant risk, Optimize the health of assets and health of process, Optimize plant systems and component availability, Optimize overall cost to Bruce Power, and Satisfy Licensing and Regulatory Maintenance and Monitoring Commitments and Requirements ([160] Section 1.0).

BP-PROC-00328 [88], Work Prioritization and Approval, specifies the screening and prioritization process which ensures a consistent and timely review and approval of work into the Work Management process to improve station availability and equipment reliability. Governed by BP-PROC-00329 [160], On Line Work Management Process, these two procedures align with the guiding principles in the following documents: WANO Good Practice ATL-11-006 [84], Work Management Process Description, INPO AP-928 Online Work Management Process Description [82], INPO AP-913, Equipment Reliability Process Description [81]. ([88] and [160] Section 1.0)

BP-PROC-00735 [162], Long Range Cycle Planning, establishes the methodology and guidance necessary to ensure that work meeting the criteria for long term planning has sufficient time to identify and obtain the right resources, design, and materials to promote successful field execution consistent with the Station's Business Planning process [162] (Section 1.0).

Major on line work due for field execution in the next two years shall be identified on the Cycle Plan to ensure sufficient time to get work properly planned, including availability of long lead time parts and materials. Where appropriate, outage support work with potential to impact on the On-line Cycle Plan shall also be identified [162] (Section 4.1).

BP-PROG-11.03 [163], the Outage Work Management program, defines the performance needs, requirements, implementing approaches, and responsibilities of Outage Work Management. It identifies the controls associated with planning, implementation, and control of work performed on a reactor unit when the unit is shut down so maintenance, inspections, and modifications are performed safely and on the basis of value to maintaining safe, reliable and cost effective operation. This includes selecting and controlling the scope of work, planning, scheduling, coordinating work execution, and completing the outage.

BP-PROG-11.04 [164], Plant Maintenance, defines the performance needs, requirements, implementing approaches and responsibilities of the management of the plant maintenance process. It covers the hands-on maintenances of plant SSCs based on the 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 maintaining the commitment to Nuclear Safety: Reactor, Radiation, Environmental and Industrial Safety. Predictive and preventative maintenance supports enhanced equipment reliability and improved operational safety performance. Maintenance strategies are continually refined using improved technologies, Operating Experience (OPEX) and equipment reliability feedback. Work selection, prioritization and response are guided by risk informed decision making. The aforementioned information addresses Section 1.2 Review Task 3.

BP-PROC-00076 [184], Management of the Off-site Radiological Environment, requires the maintenance of a Radiological Environmental Monitoring Program (REMP) in compliance with the PROLs and as a requirement of the Class I Nuclear Facility Regulations. The REMP is designed to meet the requirements of CSA N288.4 10, Guidelines for the Radiological Monitoring of the Environment, ([184] Section 1.0). Non-radiological environmental contaminants or to effects on non-human biota are covered separately [184] (Section 2.0).

BP-PROG-12.01 [165], Conduct of Plant Operations activities, in particular GRP-OPS-00047 [166], Operator Routines and Inspections ensures Operator Field Inspections and Routines are monitoring and checking measurement of the process systems and components to determine they are operating properly, parameter values are within limits, poised systems are available to operate properly, and overall unit conditions are maintained. Inspection sheets help ensure that inspections are done consistently and to a high standard. These Operational practices and processes are discussed further in Section 4.4.

The aforementioned information addresses Section 1.2 Review Task 3.

4.4. Performance Monitoring

BP-PROG-00.02 [78], Environmental Safety Management Program, provides the framework to manage the environmental aspects of the Station operations, consistent with its Management System Manual, safety, environment, quality, economic and other requirements putting safety as the overriding priority.

The Bruce Power Environmental Safety Management Program is structured to address the Environmental Management System (EMS) requirements of the International Organization for Standardization (ISO) 14001 standard [76]. The Program defines the requirements and elements of environmental protection and oversees the planning, implementation and control of activities to minimize potential adverse impacts of operations on the natural environment. It conforms to S-296, CSA N286-05 ([35] 2007 version) clauses 6.28 and 6.29 as well as ISO 14001 [76]. Programs, processes, and procedures, at a minimum, assure compliance with regulatory and statutory requirements and facilitate continual improvement in environmental performance, and provide a system based approach to managing environmental aspects. ([78] Section 1.0)

DPT-PE-00005 [149], Performance Requirements for Contamination Exhaust Control Filters, specifies the requirements for the testing and remediation of contaminated exhaust ventilation control filters used under emergency and normal operating conditions.

BP-PROG-00.07 [97], Human Performance Program, ensures personnel, particularly line management, are trained to be knowledgeable in Human Performance (HU) processes and the proper use of HU tools, so they are role models and reinforce the use of HU tools to their peers and teams. As such, they search for and eliminate, wherever it is possible to do so, conditions that may lead to human error. Where the conditions for human error may not be eliminated and may impact the performance of critical steps, line management ensures staff is trained to take defensive action to detect and to correct against human error, and to ensure known measures are implemented to mitigate event consequences if they occur (Section 4.0).

Staff and contractors adhere to leadership and worker behaviours that contribute to excellence in human performance by their adherence to the use of HU tools and identification and reporting to line management of conditions that might lead to human error (Section 7.1).

The Performance Improvement Department monitors the status of HU indicators and generates site-wide HU reports, manages HU initiatives and makes HU recommendations based on industry best practices, benchmarking, self-assessments, and operating experience (Section 7.5).

BP-PROC-00794 [100], Monitoring Human Performance, provides guidance in practices for tracking and trending Human Performance. It describes the practices for monitoring and promoting high standards of Human Performance and the practices employed in monitoring HU.

The key HU indicators (KPIs) are common measurements used to determine site Human Performance program effectiveness in the prevention of events. The KPIs provide the capability to compare HU across the stations and with all NPP sites that have adopted similar practices per INPO 08-004 (Human Performance Key Performance Indicators). ([100], Section 4.1)

BP-PROC-00795 [102], Human Performance Tools for Knowledge Workers, describes these tools which are used to anticipate, prevent and detect errors before they cause harm to people, plant, property or the environment. Although these tools can be used by any employee in a wide range of situations, they are particularly useful for knowledge workers, especially engineers, who are capable of making “in-process” errors that cause latent defects in plant equipment and supporting documentation.

Human Performance Tools for Knowledge Workers help the engineer or knowledge worker maintain positive control of a work situation, especially during critical tasks or activities – that is, what is intended to happen is what happens, and nothing else happens (Section 1.0).

BP-PROC-00811 [101], Procedure Alterations provides direction on how to proceed when a problem is encountered that threatens procedure adherence.

BP-PROC-00617 [99], Human Performance Tools for Workers, describes the requirements for the Procedure Use and Procedure Adherence tools, as well as twenty other human performance tools to assist workers ([99] Sections 4.0 and 4.3.2). When procedure adherence is challenged, work stops and does not proceed until the problem has been assessed and resolved.

Examples of Problems Threatening Procedure Adherence:

- Unexpected results could occur or have occurred.

- Procedure step sequencing problems.
- Procedure is incorrect, unclear or inconsistent.
- Procedure requirements, entry conditions, or step(s) are not applicable in the current circumstances.
- Performer is uncertain as to how to proceed.
- Partial performance for corrective maintenance or post-maintenance testing is required.
- Parallel performance of steps or sections of a maintenance procedure is desirable, where the sequencing does not affect risk or the outcome.

BP-PROG-12.01 [165], Conduct of Plant Operations, defines the functional requirements and responsibilities associated with the conduct of operations at Bruce A and Bruce B. The program lays out the means to safely and reliably operate the station systems within the design basis that the plants are licensed. Operations are conducted in accordance with the standards and expectations defined by this program, thereby ensuring strong support for the four pillars of nuclear safety. There are four operational areas implemented by the program: Operations Documentation, Operator Staffing, Plant Operation (execution of activities) and Work Protection (Section 1.0).

Plant operations are 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. Plant operations are conducted within the bounds of the Safe Operating Envelope, licence requirements, and approved plant procedures during normal and abnormal conditions ([165], Section 4.3). Examples of operating procedures to ensure safe operation include:

- Where a component's correct positioning is essential to ensure safe and proper system function and response, and where a mis-positioning would likely escape timely detection by normal monitoring activities, it is designated as a Position Assured Component (PAC). Repositioning of PACs are controlled. Regular checks are made to ensure PACs are in their expected positions ([165], Section 4.3.1).
- Where not clearly defined by approved procedures, a structured approach is defined for making operational decisions in response to degrading equipment or plant conditions that could potentially challenge safe, reliable operation ([165], Section 4.3.8). This equipment is taken off-line in an orderly manner and if necessary and appropriate for the situation the Operators ensure reactor operations are curtailed.
- Requirements for turnover are defined to ensure that turnover between the outgoing and incoming shifts provides a thorough transfer of plant status to the incoming shift ([165], Section 4.3.9) ensuring the next operating crews are aware of the current state and condition of the plant.
- Unless specifically exempted, all work affecting plant systems requires an approved Work Authorization ([165], Section 4.3.10) to ensure full awareness of the impacts is considered as part of the monitoring processes.

The operational procedures to discuss how this is done are discussed in Safety Factor Report 11.

BP-PROC-00136 [167], Plant Operational Review Committee (PORC), describes the manner of functioning of the Committee established to ensure periodic and event driven high level, multidisciplinary oversight is maintained of issues which influence reactor safety. The PORC is an advisory committee to the Plant Manager and to the Senior Operations Authority - Bruce A and Bruce B. Accountability for reactor safety remains with the station power reactor operating licence holders in the Senior Operations Authority line. The PORC consistently supports the basis of conservative decision making as outlined in the Bruce Power Management System. The PORC serves as a forum for challenging the safety culture of the organization with open and self-critical discussion in the spirit of continuous improvement. PORC may provide direction or assign and track actions when necessary but it is not a forum for problem solving. PORC provides oversight to ensure that presented issues are being addressed in a timely and safe manner.

GRP-OPS-00047 [166], Operator Routines and Inspections ensures Operator Field Inspections and Routines are monitoring the process systems and components to determine they are operating properly, parameter values are within limits, poised systems are available to operate properly, and overall unit conditions are maintained. Inspection sheets help ensure that inspections are done consistently and to a high standard. GRP-OPS-00047 defines what Routines and Operator Field Inspections are, how they are initiated, changed, scheduled, conducted, and documents the process, standards and requirements for their completion.

Operator routines are a set of regularly performed tasks such as recording data, testing equipment, changes to equipment duty, and inspections. They are scheduled, viewed, printed, and updated in station routines programs. The Operator accesses them at the beginning of each shift to obtain a list of routines assigned for the duty unit and area. Assigned tasks are noted, and performed during the shift. Prior to the end of shift, they update the completion status of assigned routines in the program. Routines are reviewed to ensure they are completed and recorded by the end of each shift. Scheduled routines that are not completed are reported to ensure follow-up so safety related Operator Routines comply with regulatory expectations.

BP-PROC-00260 [168], Material Condition and Housekeeping Facilities recognizes Safety Performance and relies on the separation of equipment and components as a defence to mitigate the effects from common mode events, e.g., the spread of fires, which may cause multiple failures of components and adversely affect the station/facility safety. The existence of combustible and flammable materials between systems, components or buildings, degrades this design feature impacting both the ability to fight fires and to operate facilities in a safe manner. To assure the design intent, high housekeeping standards are maintained. Also, the potential impact of severe weather is taken into account when inspecting storage and staging areas external to permanent, enclosed facilities (unapproved outside storage areas are not permitted). Airborne objects and flooding can impact safe operation.

Each facility is subdivided into inspection and ownership areas. Each area is assigned an accountable line manager Area Owner and an independent, line manager Area Inspector. Inspection areas and associated, accountable Inspectors and Owners, are designated by the facility Department/Section Managers. These areas are grouped into larger housekeeping

areas, such as Station Units or Site Buildings and are in turn, assigned an accountable, Management Unit Owner, by the facility Senior Management.

A Planned Inspections Coordinator is assigned for each of the major facilities on site as the Single Point of Contact for administration of the database and monitoring of facility specific trends. The Operations Department ensures material and equipment deficiencies are identified to the Maintenance Department, who maintain and restore equipment to function as designed.

It is recognized that excellent Material/Equipment condition and high Housekeeping standards are fundamental to safe and efficient Operation. Staff are to ensure areas are left in a better condition than before the work/task/activity was started (Better Than As Found).

The Workplace Inspections System (WIS) provides Management and the Joint Health and Safety Committee (JHSC) an oversight tool for the program and is designed to assign accountability for areas in each facility and ensure that these standards are being met on a continuous basis.

Housekeeping Inspections help to ensure Contamination Control Areas (CCAs) are established and maintained according to the BP-RPP-00022 [45], Contamination Control (Interface Document).

Inspections of a CCA confirm:

- CCA boundaries are clearly marked and boundaries are intact.
- CCA Identification Tag is completed and up to date.
- The area within the CCA is generally tidy with no additional hazards present, i.e., obvious leaks or materials stored inappropriately.
- Any concerns associated with the CCA are communicated to the CCA Owner.

Incidences of non-compliance with contamination control requirements are reported including: the condition or behaviour observed; the location; and the individuals knowledgeable of the incident. The WIS allows entry into the WIS database for tracking and the initiation of action by the Area Owner.

Types of inspections include:

- Housekeeping Inspections are those conducted as part of a normal work routine or those assigned by Facility Management (e.g., Manager in the Field Day, Housekeeping Days and outages).
- Planned inspections are Area Inspectors where Owners complete an inspection of their assigned area once per calendar month. Joint Inspections with the Area Owner should be performed whenever possible.
- Manager Unit Inspections are those inspections completed by Unit Owners, at a frequency determined by facility Senior Management.
- The JHSC completes an inspection of their assigned area/facility once per calendar month.

- Operator Field Inspections and Rounds per GRP-OPS-00047 [166] are Inspection Tours/Rounds in any area of the facility while completing assigned tasks.

Substandard conditions classified as Class A or B (i.e., likely to cause permanent or excessive losses and serious injury) are immediately made safe and brought to the attention of the Duty Shift Manager/Boiler and System Supervisor. Class A or B conditions are eliminated or reduced to a Class C rating (may cause minor injury and non-disruptive property damage).

BP-PROC-00439 [161], Seasonal Readiness, aligns with the Long Range Cycle Planning Process and BP-PROC-00329 [160], On-Line Work Management Process, to provide guidance for the planning and scheduling of preventative maintenance activities and select component deficiencies which may impact the station operation in the upcoming season.

BP-PROC-00329 [160], On-Line Work Management Process, is an industry best practice used for the coordination and integration of all on-line station work activities including scoping, planning and preparation efforts into a single schedule for the safe and efficient execution of On-Line work ([160] Section 1.0).

Regulatory requirements outlined in RD/GD-210, Maintenance Programs for Nuclear Power Plants, are satisfied by ensuring work group interfaces are established to direct the planning and scheduling of the seasons' maintenance work.

Efforts combine to promote optimum equipment reliability, system health and safe, reliable plant operation through a broad range of seasonal changes in temperatures, weather patterns and grid operating conditions. The response to the Seasonal Readiness process ensures enhanced management, monitoring, and nuclear risk assessment of Safety Related work activities through to completion.

BP-PROG-12.02 [170], Chemistry, establishes the optimum conditions for system chemistry and mitigate conditions that could lead to an adverse effect. The program fosters nuclear safety by managing chemistry related control parameters forming part of the Safe Operating Envelope to ensure safe operation ([170], Sections 1.0 and 3.1).

SEC-CHD-00001 [171], Guidelines for Preparing/ Revising System Chemistry Specifications and Associated CYSs Documents, promote chemistry control to maximize equipment life, reliability and long term economic performance whilst contributing to safe and environmentally friendly operation. Appropriate chemistry control minimizes conditions such as reduction of heat transfer coefficients, corrosion of components, radiolytic decomposition, activation product formation, and unplanned changes in reactivity ([171], Section 1.0).

DPT-CHM-00003 [172], Control of Chemistry, defines the chemistry control processes followed during all plant states, to minimize corrosion and performance degradation, and to maximize equipment life and reliability. It defines requirements for chemistry lab monitoring of system chemistry, documentation supporting chemistry control, data trending and evaluation, performance monitoring and reporting, and measures used to evaluate program effectiveness ([172], Section 1.0).

BP-PROG-12.03 [173], Nuclear Fuel Management, provides an effective framework that supports the safe and efficient execution of activities related to nuclear fuel and isotope production. It is a roadmap describing how all aspects of the program fit together and how to

conduct business. This framework is established by six implementing processes, which are accountable for delivering the program objectives and meeting program expectations, standards and requirements. The implementing processes achieve these goals by specifying how work activities are planned, performed, monitored and controlled. The program is committed to fostering a healthy nuclear safety culture. Reactor safety is upheld by requiring adherence to the safe operating envelope; radiation safety by advocating for the timely removal of defective fuel; industrial safety by following approved procedures; environmental safety by requiring fuel to be protected from damage.

BP-PROC-01032 [174], Fuel Performance Management, specifies how nuclear fuel performance management is achieved. The objective of this process is to strive to achieve and maintain failure free nuclear fuel performance during its use in the reactor, handling and storage. This procedure is intended to facilitate satisfying CNSC REGDOC-3.1.1, Requirement 3.8 with respect to maintaining and reporting on a fuel monitoring and inspection program. Execution of the activities to meet this requirement is managed under BP-PROC-00926, Fuel Performance Monitoring [185] ([174], Section 1.0).

4.5. Operating Experience

Safety performance is determined from an assessment of operating experience, including safety related events, and records of unavailability of safety systems, radiation doses and the generation of radioactive waste and discharges of radioactive effluents.

Safety Factor 8 includes several objectives and criteria that tie into Bruce Power's program for Internal and External Operating Experience. Safety Factor 8 restricts the review of safety performance to operating experience internal to the Station. Other plants and research findings external to the Station are addressed in Safety Factor Report 9 (Bruce A [17] Bruce B [5]).

BP-PROG-01.06 [107], Operating Experience Program, defines processes to meet the requirements of the CSA Standard N286-05 (e.g., Sections 5.4, 5.11 and 5.14), by making improvements via: Processing Internal and External Operating Experience information; conducting Focus Area Self-Assessments; Benchmarking others; and by attending industry Conferences and Workshops.

Bruce Power's processes governing Operating Experience are described in its implementing procedure BP-PROC-00062, Processing External and Internal Operating Experience [108]. The Operating Experience program and Corrective Action Program are closely inter-connected.

BP-PROC-00062 [108] (Section 1.0), Processing External and Internal Operating Experience, identifies the processes used to identify, evaluate and take action based on internal and external lessons learned to improve nuclear safety including reactor safety, radiation safety, industrial safety and environmental safety management. This is achieved by using the lessons learned information to improve processes, procedures, training, and system and equipment design. Bruce Power communicates internal experience from the Bruce Site to others in the Nuclear Industry to improve nuclear plant safety, reliability and commercial performance around the world.

BP-PROC-00137 [109] (Section 1.0), Focus Area Self-Assessment, provides support in identifying and documenting lessons learned from internal sources to continuously improve performance by identifying weakness, strengths, threats and opportunities to make improvements to Processes/ Procedures, Training, or System/Equipment Design. It specifies the requirements and describes the process for collecting business intelligence through Comprehensive Focus Area and Quick Hit Focus Area Self- Assessments.

The Focus Area Self-Assessment (FASA) process is a tool that focuses on specific areas of a Functional Area's activities, processes or performance. It is used by Functional Areas to assess the adequacy and effective implementation of their programs. The results of the assessment are then compared with business needs, the management system, industry standards of excellence and regulatory/statutory or other legal requirements. This procedure describes the planning, preparation, execution, and reporting of performance improvement opportunities identified during Self Assessments. The FASA process provides the capability to review the effectiveness of the processes utilized to support the identification of degraded performance and effectively track, trend, prioritize, and correct subtle problems.

BP-PROC-00147 [110], Benchmarking and Conference Activities, provides guidance in identifying and documenting lessons learned from external sources to continuously improve performance by making improvements to processes/procedures, training or system/equipment design. Benchmarking and conference activities foster the use of diverse information sources to understand performance gaps and implement corrective actions to improve performance. This is discussed further in Safety Factor Report 9 (Bruce A [17] Bruce B [5]).

BP-PROC-00892 [111] (Section 1.0), Nuclear Safety Culture Monitoring, provides the framework to monitor nuclear safety culture between formal assessment activities, in particular to have mechanisms to identify and correct potential gaps in nuclear safety culture. The approach is collegial and supports the development of a common understanding of safety culture within senior and middle levels of leadership at the nuclear power stations and describing the traits and attributes of the desired safety culture. This monitoring and adjustment process facilitates the desired behaviours of a learning organization – one that places nuclear safety as its overriding priority and relentlessly seeks ways to continuously improve itself.

This process provides an approach for monitoring nuclear safety culture using the framework described in INPO 12-012, Traits of a Healthy Nuclear Safety Culture, and based on the approach described in NEI 09-07, Rev 1, Fostering a Healthy Nuclear Safety Culture (March 2014). See Safety Factor Report 10 for more information. This supports assuring that Bruce Power meets the WANO Performance Objective for Nuclear Safety Culture (SC.1) and associated criteria: “The organization’s core values and behaviours reflect a collective commitment by all nuclear professionals to make nuclear safety the overriding priority” [WANO PO&C, p. 54].

This process attempts to characterize the health of nuclear safety culture rather than trying to directly measure culture. Judgment and subjectivity by experienced leaders are applied to derive insights from this process using data elements (e.g., aspects of plant conditions, human resource issues, behavioural observations, process weaknesses, etc.) which, when considered against a framework such as the ten Traits of a Healthy Nuclear Safety Culture, reveal cultural issues that require to be addressed. ([111], Section 4.1)

The aforementioned information addresses Section 1.2 Review Task 3.

4.6. Corrective Action

Bruce Power processes related to Corrective Action are governed by the Corrective Action program and related implementing procedures. A Corrective Action Review Board, consisting of senior management, performs a review of all significant events.

BP-PROG-01.07 [55], Corrective Action, identifies and eliminates or mitigates adverse conditions that could negatively impact nuclear safety (including reactor safety, radiation safety, industrial safety and environmental safety), business loss or corporate reputation ([55], Section 1.0). Adverse conditions and non-conformances are to be promptly identified, documented and reported. For most events, significant events and significant conditions adverse to quality, the causes are determined and corrective action is taken to correct, and where appropriate, prevent their recurrence. Corrective actions taken to address identified causes are tracked to completion. Effectiveness is verified for actions taken to prevent recurrence. Adverse conditions are trended and periodically analyzed for adverse trends. Corrective actions are implemented to address adverse trends where warranted. Periodic assessment of the effectiveness of the program is done based on the results and recommendations obtained from verifications and audits ([55], Section 4.0).

BP-PROC-00019 [112] (Section 4.0), Action Tracking provides an integrated online means of tracking actionable events and ensuring actions are taken to respond to each action item. An Action Request (AR) may be initiated as a result of a reported problem, a licensing requirement, an internal procedure or any other event that requires a response in a timely manner. This procedure governs how Action Tracking is used at Bruce Power to ensure accountability, data integrity and audit requirements. Different AR types have different process owners. These owners specify requirements in their area of responsibility such as requests for due date extensions and actions to provide oversight for completion of those assignments and the type of action they wish completed.

BP-PROC-00059 [54], Event Response and Reporting, defines the process for preliminary response and reporting to internal contacts and external agencies, to ensure compliance with both Bruce Power and Regulatory requirements ([54] Section 1.0).

This procedure describes the process of Incident Response and Reporting which consists of the following major steps ([54] Section 4.0):

- Immediate response.
- Rapid Learning.
- Internal and external notifications.
- Initiation of an investigation to determine the cause of the incident.

External agency reporting is discussed further under BP-PROG-06.03 [57], in Section 4.7 of this report under Compliance Reporting.

BP-PROC-00060 [113] (Section 1.0), Station Condition Record Process, is used to document adverse conditions, investigation results and corrective actions related to people, plant, environment and process. The SCR process is used by staff, including contractors, to document adverse conditions, investigation results and corrective actions related to people, plant, environment and process. Investigations into events where there is the likelihood of regulatory charges or commercial litigation where legal privilege needs to be maintained are handled separately.

A consistent reporting and evaluation process for identified adverse conditions, including but not limited to non-conformances, minimizes undesirable impacts on nuclear safety, business loss, and corporate reputation. This is accomplished by ensuring the following:

- Events, incidents, and error-likely situations are documented.
- Cause(s) are determined.
- Corrective action(s) are implemented.
- Lessons learned are identified for communication to internal and external organizations.

For non-conformances (typically a documentation deficiency) which could but have not yet resulted in a nonconforming item (typically a deficiency in an SSC), BP-PROC-00060 [113], Station Condition Records applies rather than BP-PROC-00252 [114], Control of Nonconforming Items. An SCR is required, but the Tagging and Segregation steps do not apply. In this case, it is very important to control the nonconformance to ensure that no nonconforming item is produced. This might include actions like quarantining a procedure, ceasing work using faulty equipment or process, ensuring that non-qualified staff do not work on tasks requiring qualification. The means taken to control the nonconformance should be described in the SCR BP-PROC-00060 [113] (Section 1.0).

In parallel with the SCR process, an Event Review Board (including Corporate or Station level reviews) may be held so the leadership can provide greater scrutiny than the initial rapid learning exercise. These reviews confirm items such as: the response to the event was prompt and adequate; correct interim actions are in place, all commensurate with the Significance Level related to the Four Pillars of Nuclear Safety and Production; the current state of the investigation; the indentify barriers in the way of proper execution of work have been identified and removed ([113] (Section 4.2.3).

BP-PROC-00252 [114] (Section 1.0), Control of Nonconforming Items describes the process used to identify, document, segregate, evaluate and disposition nonconforming items. BP-PROC-00252 is used only when acceptance of the problem disposition by an external inspection/oversight agency needs to be documented (e.g., pressure vessel issues preventing recertification of the vessel). Adherence to this procedure ensures items that do not conform to specified quality requirements are controlled to prevent further processing, use or installation, pending disposition by the authorized personnel. Personnel involved in this process are adequately free of cost and schedule considerations. This procedure describes the generic corporate process for identifying, controlling and evaluating nonconforming items.

BP-PROC-00412 [115] (Section 1.0), Trend Identification and Reporting of SCRs determines whether performance is improving, declining or stagnant; and corrective actions are initiated to

address adverse performance before a break-through event occurs. Trend identification entails reviewing and analyzing the data in SCRs to identify these trends and assigning and recommending corrective actions and investigations to mitigate adverse trends.

BP-PROC-00506 [116] (Section 1.0), Effectiveness Reviews defines the process for performing effectiveness reviews of corrective actions and the corrective action management effectiveness oversight. The objective of the Corrective Action Program is to identify and eliminate or mitigate adverse conditions that have, or could have, resulted in undesirable impacts on Nuclear Safety (including reactor safety, radiation safety, personnel safety and environmental safety management), business loss, and corporate reputation.

For Root Cause Investigations BP-PROC-00518 [117], an Effectiveness Review is conducted to determine if the corrective action was implemented as written, that it was challenged and met the success criteria, and there have been no similar events since the corrective action has been implemented which should have been prevented. For Apparent Cause Evaluations BP-PROC-00519 [118], and Common Cause Analyses BP-PROC-00644 [119], an Effectiveness Review is conducted to determine if barriers have been strengthened or the frequency of similar events has decreased or the severity of similar events has decreased ([116] Section 1.0).

Other types of reviews may include reviews of the functional line response to WANO and INPO directives and recommendations, for example, Significant Operating Experience Reports.

BP-PROC-00518 [117] (Section 1.0), the Root Cause Investigation process is used to identify the root cause of an event (which includes accidents) and incidents so proper corrective action is initiated to prevent the future reoccurrence of similar events and incidents. It defines the process for performing a Root Cause Investigation (RCI) and an Equipment Root Cause Investigation (ERCI).

BP-PROC-00519 [118] (Section 1.0), Apparent Cause Evaluation (ACE), defines the process for performing an ACE and an Equipment Apparent Cause Evaluation (EACE). The ACE/EACE processes are used to identify the likely cause of an event and propose corrective actions that strengthen barriers or reduce the frequency or reduce the severity of similar events. The ACE/EACE processes may not prevent recurrence.

BP-PROC-00644 [119], Common Cause Analysis, is used on adverse trends so corrective action can be taken to reduce the probability of the adverse trend continuing. It provides instructions for performing Common Cause Analysis. Conducting a Common Cause Analysis is not an exact science. Although intended for analyzing adverse trends linked to the Corrective Action Program, the methodology described can be used to analyze data from other sources as well ([119] Section 1.0).

4.7. Compliance Reporting

Several objectives and criteria listed for “Safety Performance” relate to information that Bruce Power is required by its operating licence to report at specified frequencies and in specific detail to the CNSC. Compliance reporting requirements are described in CNSC Regulatory Document REGDOC-3.1.1 [32]. Internal Bruce Power processes that support these reporting requirements are described in this section.

BP-PROG-06.03 [57] (Section 1.0), CNSC Interface Management defines the overall business need, functional requirements, constituent elements and key responsibilities associated with managing the interface between Bruce Power and the CNSC. This is achieved by establishing and implementing standards and processes that meet the expectations of both parties and facilitate conformance to the NSCA, applicable regulations and other CNSC requirements and expectations.

The program supports the achievement of excellence in nuclear safety as the overriding priority and a healthy nuclear safety culture by assuring that processes and practices are defined and managed to ensure that the requirements arising in the PROL are understood, implemented and reported on in a controlled manner throughout the management system [57] (Section 1.0). The program was updated to confirm the need for compliance against CNSC REGDOC-3.1.1 as stated in the PROL ([122] Clause 4.5 item 3).

The CNSC regulatory framework consists of a mix of requirements and guidance. Requirements are set out in legislation, regulations, licences and CNSC regulatory documents invoked in licences. Guidance on how applicants and licensees can meet regulatory requirements is provided in CNSC guidance documents. CNSC INFO-documents provide more general information on the regulatory regime and processes for the broader public ([57] Section 4.1). CNSC interface management processes are structured to facilitate compliance with CNSC requirement and to conform, where practicable, to CNSC guidance or expectations with the understanding compliance to a CNSC Regulatory Document is mandatory when the document is referred to in a CNSC licence. Deviations from a licence-referenced regulatory document and transitional arrangements, where necessary, are addressed on a case by case basis in accordance with the applicable Licence and/or LCH ([57] Section 4.1).

BP-PROC-00058 [123] (Section 1.0), CNSC Commitment Management, establishes and describes a graded approach process for documenting, tracking, managing, changing and monitoring commitments made to the CNSC and CNSC-related actions that have specific deliverables, due dates and/or require additional interface transactions with the CNSC. It establishes and describes actions required to ensure commitments made verbally (e.g., at CNSC public hearings, meetings) are identified and documented so as to assure the same level of management oversight as those originating in formal written communications.

BP-PROC-00165 [56] (Section 1.0), Reporting to CNSC – Power Reactor Operating Licences, describes from Bruce Power's perspective the information that the CNSC requires of a licensee who operates a nuclear power plant, and how, when and to whom the information is to be provided. It establishes standardized practices, format and content for unscheduled and scheduled formal reporting to the CNSC per Regulatory Document REGDOC-3.1.1 [32]. REGDOC-3.1.1 specifies scheduled and unscheduled reports depending on the situations which arise.

BP-PROC-00833 [125] (Section 1.0), Reporting to the CNSC, expands upon requirements established in BP-PROG-06.03, and establishes in more detail functional requirements, constituent elements and key responsibilities required for managing formal reporting to the CNSC and to facilitate conformance to the NSCA, applicable regulations and other CNSC requirements and expectations. It describes the general requirements applicable to preparation, review, approval, submittal, handling and filing of all scheduled and unscheduled reports of

situations, events and other information to the CNSC. This procedure has several implementing procedures such as BP-PROC-00509 [126], BP-PROC-00837 [128], BP-PROC-00839 [129] ([125] Section 5.3). These are described next.

BP-PROC-00509 [126], Bruce A and B Quarterly Report on Safety Performance Indicators, establishes standardized practices, format and content for Quarterly Reports of Safety Performance Indicators (QRSPI), and describes the process for preparation, review, approval, transmittal, handling, distribution and filing of the reports including the timing and content of the QRSPI (per REGDOC-3.1.1 [32], Section 3.1).

Initiation, preparation, and issue of the Quarterly Reports on Nuclear Operations Personnel and QRSPIs are in accordance with the general requirements of BP-PROC-00833 [125] (e.g., subsection 4.2.3 and 4.2.5), Reporting to the CNSC.

BP-PROC-00837 [128], Reporting to CNSC – Class II Nuclear Facilities Licences is an implementing procedure of BP-PROC-00833 [125] and assigns responsibility for reporting to the CNSC for the Class II Nuclear Facilities Licences to the Class II Radiation Safety Officer. Bruce Power's Class II Nuclear Facility Licences include items such as the Irradiator Facility (Bruce B, Building B05, Room S021) and Irradiator Facility (Central Maintenance and Laundry Facility (CMLF), Building B12, Room M224) ([128] Section 1.0).

This procedure defines the responsibilities and provides instructions to complete formal reports to the CNSC including Unscheduled Reports, Scheduled Reports, and Sealed Source Tracking Reports with a focus on Radiation Protection Regulations, Prescribed Equipment Regulations and Licences, Annual Compliance Reports, and Sealed Sources (Section 4.0).

BP-PROC-00839 [129] (Section 1.0), Reporting to CNSC/IAEA – Safeguards establishes standardized practices, format and content of formal reports to the CNSC on information on the inventory and transfer of fissionable and fertile substances pursuant to REGDOC-3.1.1 and on the Design Information Questionnaire, Additional Protocol and Operational Program to comply with the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons. Also it establishes standardized practices, format and content of non-formal reports and information transfer to the CNSC/IAEA on the internal transfer of fissionable and fertile substances, on Core Discharge Monitors, Bundle Counters and any additional reports as requested by the CNSC/IAEA made pursuant to Article 72 of the Agreement between Canada and the IAEA for the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons.

DPT-NSAS-00007 [135] (Section 1.0), Processing of REGDOC-3.1.1 Reportable Conditions Arising from Safety Analysis or Research Findings describes the process to follow in processing REGDOC-3.1.1 reports made pursuant to Section 5 of REGDOC-3.1.1 when nuclear safety related issues are discovered from new research findings, review of operating experience and review of submitted safety analysis. Discoveries associated with the licensing basis, design basis, research findings and safety analysis may indicate a safety problem exists. Such discoveries are to be assessed based on the criteria identified in Appendix A, Table A.1, Number 14, Item 14b of REGDOC-3.1.1 [32].

BP-PROC-00836 [127], Reporting to CNSC – WNSL and NSRD Licences, is an implementing document of BP-PROC-00833 [125] and the reporting is managed by the Corporate Radiation

Safety Officer. Standardized practices, format and content for unscheduled formal reports, Sealed Source Tracking, and the Annual Compliance Report (ACR) to the CNSC made pursuant to Bruce Power's Waste Nuclear Substance (WNSL) and Nuclear Substances and Radiation Device (NSRD) licences are covered by this procedure.

The aforementioned information addresses Section 1.2 Review Task 2.

BP-PROC-01024 [4], Periodic Safety Reviews, describes the PSR process. The first Section establishes general requirements. Each of the following sections describes the processes for specific elements of the PSR or additional administrative requirements for the process.

The purpose of the procedure is to establish and describe the requirements and processes for the conduct of PSRs, for the purpose of plant life cycle management, in accordance with licence condition 15.2 of the Bruce A and B PROL [1] and Section 15.2 of the LCH [2].

Most but not all Bruce Power Programs readily map to a Safety Factor Report. For clarity, completeness and understanding, a mapping of each program relevant to reactor safety to the respective Safety Factor Reports (e.g., in Section 4.6 of the procedure) should be considered. Examples of programs loosely affiliated with BP-PROC-01024 are: BP-PROG-12.03 Fuel Management [173]; BP-PROG-05.01, Supply Chain [186]; and BP-PROG-12.02, Chemistry Management [170]. Fuel Management is briefly covered in Safety Factor Report 1 as part of the code clause-by-clause comparison for a Regulatory Document for new Nuclear Power Plants and in Safety Factor 2 as part of condition assessment. Similarly, BP-PROG-12.02 Chemistry Management is identified in Safety Factor Reports 1, 2 and 4, but no in-depth discussion is provided. Every SFR uses the Nuclear Oversight and Regulatory Affairs (NORA) Audit and FASA processes but IAEA SSG-25 (and thus, the Bruce B PSR Basis Document [5]) does not include a review of the safety importance of the NORA oversight role. This issue is flagged as gap SF8-7 in Table 10.

In addition to the day-to-day compliance reporting, as part of the renewal of the Power Reactor Operating Licence extensive reporting is completed. BP-PROG-06.01, CNSC Licence Acquisition [121], establishes and describes the process framework to acquire the CNSC licences that are necessary to achieve business and operating objectives. A set of general requirements that are applicable to all implementing processes are defined and then each of the implementing processes is defined.

BP-PROC-00114, Power Reactor Operating Licence Amendment or Renewal [122], defines the process to compile quality, technically accurate licence applications to renew or to amend the PROLs, to establish requirements and expectations for interfacing with the CNSC in support of PROL renewal or amendment applications, and to establish requirements and expectations for attendance and participation at public Commission Hearings in support of PROL renewal or amendment applications. CNSC decisions related to applications for PROL renewals are made based on the reported evidence presented and heard in public hearings before the Commission. The material usually includes of a compilation of Safety Performance and Feedback from experience during the past licence period. Both Bruce Power and the CNSC staff provide objective evidence to support their positions on the items identified in Section 1.2 and described more fully in the subsections of Section 5.

BP-PROG-00.06 [95], Health and Safety Management, defines the requirements, implementing approaches and key responsibilities associated with Occupational Health and Safety Management. Employees play a key role in the success of the Bruce Power Occupational Health and Safety Management System (OHSMS). The goal of the OHSMS is to ensure employees, contractors, and visitors are safe in a healthy and injury-free workplace by reducing the risks associated with the activities, products, and services ([95], Section 1.0 and 4.0). An implementing procedure of the program is BP-PROC-00651 [96], Safety Performance Metric and Monitoring. It defines conventional safety performance metrics to enable consistent, accurate internal and external reporting of occupational injuries and illnesses. This reporting includes some conventional health and safety regulatory reporting to the CNSC (REGDOC-3.1.1 Appendix B s.21 [32]).

4.8. Radiation Protection, Waste Management and Environmental Management

Bruce Power has a mature Radiation Protection program that provides radiation protection services to staff and contractors. The program requirements are described in Radiation Protection Program [87]. Waste management activities are described in the Environmental Safety Management program [78]. Final processing and storage of solid radioactive waste is performed by Ontario Power Generation (OPG)'s Western Waste Management Facility (WWMF) located at the Bruce site. Wastes are packaged and delivered to the OPG WWMF according to specified waste acceptance criteria.

BP-RPP-00008 [175], Access Control, is an implementing document to BP-PROG-12.05 [87], Radiation Protection Program, and outlines the requirements to access areas of the plant where high radiation fields may exist. Hazardous radiation and conventional safety hazards exist as the result of both normal and abnormal reactor operation and irradiated fuel transfer. The access control system controls the movement of personnel into and out of potentially hazardous areas to prevent accidental high exposure to radiological hazards. Also, the access control system prevents significant increases in radiological hazards for people in or about to enter an Access Control Area. The access control system reduces the risk to personnel from the conventional safety hazards associated with the operation and fuelling of reactors.

BP-RPP-00010 [43], Segregation and Handling of Radioactive Waste, details how staff shall segregate and dispose of routine solid waste and disposition contaminated liquid wastes as per governing document BP-PROC-00878, Radioactive Waste Management [178]. Staff ensures that equipment and materials do not become radioactive waste unnecessarily and minimizes radioactive waste produced. To minimize radioactive waste, the following are applied when performing radiological work:

- Do not take items that will not be used into radiological zones or contaminated areas.
- Wrap or bag material/equipment taken into contaminated areas.
- Use reusable Personal Protective Equipment (PPE) where there is a choice between it and disposable PPE.

- Only take the required amount of liquids into radiological zones or contaminated areas and use dispensers to prevent liquids becoming contaminated.
- Do not generate liquid mixed radiological wastes containing hazardous components.

Waste reduction, segregation and handling are considered in work plans involving radioactive work as per BP-PROC-00714, Low Level Radioactive Waste Minimization [177]. When a job is expected to produce significant waste quantities, Waste Management Section is contacted in advance to arrange for a waste can, bin or pick-up of active waste. Bins delivered to Waste Management include a detailed log with dose rates and description of material.

BP-RPP-00015 [176], Zoning, details the requirements for movement of personnel and equipment around the Zoned Areas of Station facilities, and specifies the requirements for the transfer of radioactive material outside the zoned areas but within the site boundary fence.

BP-RPP-00020 [44], Dosimetry and Dose Reporting, documents the processes for use of radiation dosimetry devices per Regulatory Standard S-106 Revision 1, Technical and Quality Assurance Requirements for Dosimetry Services.

BP-RPP-00022 [45], Contamination Control, is an implementing document of BP-RPP-00041, Executing Radiological Work [46], and describes the Radiation Protection (RP) work practices, measures, and techniques used to control radioactive contamination at the source, including Discrete Radioactive Particles (DRPs) to prevent contamination spreading to workers, equipment and areas between work locations and to maintain exposures ALARA.

BP-RPP-00041 [46], Executing Radiological Work, defines the expectations of Radiation Protection Qualified workers and their supervisors assigned to execute radiological work.

Planning of radiological work is performed prior to the start of the work ensuring:

- Radiological hazards have been considered.
- Worker dose is controlled ALARA.
- Contamination of equipment, radiological work areas and to personnel is minimized and controlled.

Section 4.7 covers Post-job ALARA reviews that are conducted following work completion to ensure lessons learned are captured so they can be implemented in future radiological work planning. ([46], Section 4.7)

BP-RPP-00044 [187], ALARA Programs, provides requirements and responsibilities to ensure that occupational radiation exposures, both individually and collectively are maintained ALARA as per BP-PROG-12.05, Radiation Protection Program [87]. It identifies planning strategies to control dose and minimize exposure ALARA. To achieve this, the following processes are in place to ensure effective ALARA planning prior to work execution:

- ALARA Program Management.
- A 5 Year Dose Reduction Plan.
- Processes for establishing dose goals and targets consistent with the 5 year dose reduction plan.

- Standards and processes for managing individual doses below exposure control levels and ALARA.
- Pre work ALARA planning, including the preparation and control of Radiation Exposure Permits.

BP-PROC-00714 [177], Low Level Radioactive Waste Minimization, is an implementing document of BP-PROC-00878, Radioactive Waste Management [178], and defines the principles to be applied by personnel who influence or control the selection, procurement, usage and subsequent management of materials that may become low level radioactive waste.

BP-PROC-00878 [178], Radioactive Waste Management, defines the fundamental business needs, constituent elements, functional requirements, implementing approaches and key responsibilities associated with implementing the Radiation Protection Waste Management Program, for radioactive waste.

This is achieved by establishing and implementing standards and processes for the conduct of radioactive waste activities to ensure the following objectives are met:

- Radioactive waste activities are controlled in a safe and environmentally, financially and socially responsible way to ensure full compliance with regulatory requirements.
- Public and occupational exposures to ionizing radiation during radioactive waste activities are controlled such that individual and collective doses are maintained at levels ALARA, social and economic factors being taken into account.
- Ensure decisions on management of radioactive waste are based on minimizing risk to the environment, public and staff and minimizing total life cycle costs for radioactive waste storage and disposal.
- Ensure compliance with CNSC Regulations, Licences and Standards and CSA requirements pertaining to radioactive waste management.
- The achievement of high standards of radiation protection performance in accordance with industry best practices and WANO GL 2004-01 (Section 1.0) [83].

BP-PROC-00080 [92], Effluent Monitoring Program, provides information on the design, implementation, and management of the effluent monitoring program that meets legal and business requirements and incorporates best practices and technologies used internationally. It expands on the basic regulatory requirements and provides specific details on the airborne and liquid effluents monitoring program under normal and abnormal operating conditions. The companion implementing procedure related to Radiological Emissions Monitoring is BP-PROC-00171 [47].

BP-PROC-00094 [93], Environmental Objectives, Targets, and Management Plans, defines objectives, targets and plans ([93] Section 4.3) which are trended and as appropriate acted upon if adverse ([93] Section 4.1 item 2).

BP-PROC-00793 [94], Environmental Performance Index Indicator, is a composite performance indicator which measures the environmental performance and provides routine matrix for performance trending purposes.

The aforementioned information addresses Section 1.2 Review Tasks 4 and 5.

4.9. Design, Design Basis and Configuration Management

BP-PROG-10.01 [66], Plant Design Basis Management, describes the program to maintain the Design Basis and to ensure the plant can operate safely for the full duration of its life. The implementing procedures provide consistent methods for performance of the Engineering work and other activities required to meet the program objective. The program ensures that the plant design meets safety, reliability, and regulatory requirements including pressure boundary quality assurance requirements described in BP-PROG-00.04, Pressure Boundary Quality Assurance Program. The program sets out requirements for engineering analysis and documentation so the adequacy of the design can be demonstrated and the Safe Operating Envelope is maintained for the full duration of the plant design life [66] (Sections 1.0 and 4.0).

BP-PROC-00335 [130], Design Management, specifies the design activities and outputs that define and manage the Plant Design Basis such that the nuclear operating stations can operate safely and reliably for the duration of their lives. Design Management relies upon the implementing procedures of BP-PROC-00363 [133], Nuclear Safety Assessment, to ensure nuclear safety requirements are met by the design.

BP-PROG-10.02 [66], Engineering Change Control, ensures design changes and modifications are defined, planned, implemented, and controlled. The Engineering Change Control 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 original or updated design life [66] (Section 1.0).

BP-PROC-00539 [139] (Section 1.0), Design Change Package, process specifies the control of modifications to plant SSCTs, including temporary modifications. The overall objective is to meet regulatory requirements, ensure safety, and minimize loss to the company through appropriate risk management activities.

BP-PROC-00542 [140] (Section 1.0), Configuration Information Change, governs the acceptance, creation, revision, obsolescing and superseding of design information when one or more of the following apply:

- Design information is being corrected to restore configuration management equilibrium.
- No new inspection/testing/commissioning activities are required to verify the field against the new design information, and operations acceptance of the new design information is not required.
- The required installation, inspection/testing/commissioning and operations acceptance activities are covered by approved operating/maintenance procedures and/or Pre-Engineered Replacement Instructions at the time they are performed.

This process is used to correct and issue design information to ensure that the SOE is maintained current. This process is also used to identify design, operations and maintenance impacts due to new or revised deterministic safety analysis.

BP-PROG-10.03 [141], Configuration Management, is a disciplined approach to control the physical plant configuration, design requirements, and the facility configuration information.

The CM Program objective is to ensure:

- Modifications to the plant, operation, maintenance and testing of the physical plant configuration are in accordance with the design requirements as expressed in the facility configuration information.
- This consistency is maintained throughout the operational life-cycle phase, particularly as changes are being made.
- The SOE is maintained for the full duration of the plant operational life.

The physical plant configuration conforms to the facility configuration information based on the design requirements. The facility configuration information, which includes, as-built drawings and operating procedures (including maintenance procedures) accurately reflect both the physical plant configuration and the design requirements. Changes to design requirements are reflected in both the physical plant configuration and the facility configuration information. Changes to either the physical plant configuration or facility configuration information are supported by, and are consistent with the design requirements. This process ensures the physical configuration of the plant is maintained within the design and licensing basis ([141], Section 1.0 and 4.0).

BP-PROC-00638 [142], Temporary Configuration Change Management, prescribes a method to control Temporary Configuration Changes (TCCs) made to facilities. Objectives include ([142] Section 1.0):

- Ensure that temporary changes do not adversely impact safe reliable plant operation or design basis;
- Ensure that temporary changes are adequately controlled;
- Provide for management oversight of the quantity of installed TCCs and their duration; and
- Demonstrate compliance with regulatory requirements.

BP-PROC-00786 [89], Margin Management, is a systematic process to identify, prioritize and resolve margin issues to ensure the operating configuration is conservatively maintained within the design requirements and those are conservatively maintained within the design bases. Conceptually the normal operating range is to be well within the specified operating limits and these operating limits are to be well within the design/safety analysis limits ([141], Section 4.1).

BP-PROC-00261 [188], Environmental Qualification, outlines the EQ process to be followed and lists the documentation that must be created and maintained to ensure the EQ Process meets regulatory standards. It provides references to supporting procedures to be followed in the creation of this documentation. 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 Design Basis Accidents, in accordance with the plant design and licensing basis and that this capability is preserved over the life of the plant ([188] Section 1.0).

DPT-PDE-00019 [132], Steam Protection Barriers, identifies physical barriers required to mitigate harsh conditions and/or maintain mild conditions in areas of the plant, consistent with the EQ program assessments of equipment and components. It also provides the design of signs required to identify these barriers in the field, instructions for controlling temporary and permanent modifications to barriers, inspection requirements for barriers to ensure that they are maintained in their credited configuration, and maintenance requirements to restore barriers to their original configuration where inspection results show deficiencies in a barrier ([132] Section 1.0).

Operating Policies and Principles – Bruce BP-OPP-00001 [91], requires that modifications to station systems and procedures are controlled to ensure they do not invalidate the licensing basis, particularly in the areas of:

- Health and safety of station staff and the public,
- Environment,
- National security,
- Compliance with international obligations to which Canada has agreed.

BP-PROC-00734 [169], Plant Status Control, provides a common process for capturing methods and requirements for maintaining status control of plant components. It provides direction and guidance for manipulations, verification, and checking position of components for the purposes of system operation to ensure that components are positioned to maintain personnel safety and operational configuration. It applies to personnel involved with activities affecting or controlling component configuration. It is the responsibility of personnel involved in an activity that may affect the configuration of positionable components to follow the requirements of this procedure ([169], Section 1.0).

4.10. Nuclear Oversight Management

BP-PROG-15.01 [180], Nuclear Oversight Management, identifies the processes required to independently oversee the Management System. It contributes to the development and growth of Nuclear Safety Culture by communicating the Nuclear Safety message, setting the example for nuclear safety, and demonstrating this commitment and serves meeting the PROL requirements for oversight of Pressure Boundaries and Environmental Protection. Oversight is accomplished by the Planning, Scheduling, Conducting, Reporting, and Overall Evaluation of Audits and Assessments.

BP-PROC-00295 [181], Planning and Scheduling Audits, describes the process for Planning and Scheduling Audits by identifying audit topics, annual plans, schedules and controls. It implements the process objective from BP-PROG-15.01, Nuclear Oversight Management, Section 4.1, by ([181] Section 1.0):

- Providing a prescribed method for ensuring the subjects of audits are the optimal choice for checking the Management System to determine its effectiveness in achieving the expected results and to identify opportunities for improvement [CSA N286-05, s5.1(e), s5.14.2 [34]].
- Identifying required audits, developing annual audit plans, change control methods, associated schedules and an overall evaluation of the audit program's adequacy.
- Developing annual and multi-year audit plans to ensure all aspects of the Management System, regulatory/statutory requirements and adopted industry standards are assessed to the appropriate degree and frequency [CSA N286-05, s5.14.2 [34]].

Under the Operating Experience Program, BP-PROG-01.06 [107] discussed in Section 4.5, BP-PROC-00892 [111] (Section 1.0), Nuclear Safety Culture Monitoring provides the framework for Bruce Power to monitor nuclear safety culture via the review of the results of the formal assessments and surveys of staff. Greater insight from staff feedback can be explored to provide additional oversight direction. Similarly, the Nuclear Safety Review Board [179] discussed further in Section 5.14.1 provide additional opportunities for oversight directly through their interviews with Station Staff and through their communication with Bruce Power executive management.

5. Results of the Review Tasks

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

In addition to the assessment of the review tasks listed in Section 1.2, Section 5.1 provides an overview of safety performance assessments and Section 5.14 augments the discussion, and addresses overall safety performance. Sections 5.1 and 5.14 provide introductory, common and summary information applicable to multiple sections thus avoiding repetition in each of the Section 5 subsections. Section 5.1 provides information and references to the numerous other reviews conducted on the Safety Performance of the Bruce reactors separate from this review. Section 5.14 discusses cross-task or functional area aspects important to the integration of safety performance. Moreover, because the review tasks are partially addressed in the subsections of Section 4, Table 7 provides a mapping of where each review task is addressed.

Table 7: Sections in Which Review Tasks are Addressed

Review Task	Section
1a	5.3
1b	5.4
1c	5.5
1d	5.6
1e	5.7
1f	5.8
1g	5.9
1h	5.10
1i	5.11
1j	5.12
1k	5.13
2	4.7, 5.2
3	4.3, 4.5, 5.10, 5.14.2, 7.1.4
4	5.8, 5.9, 5.10, 5.11, 7.1.6, 7.2, 7.2.1
5	5.12, 7.1.7, 7.2

This review is complementary to the routine and non-routine Bruce Power, and regulatory reviews, inspections, mid-term reports, event reporting and investigations, other CNSC compliance and verification activities, and Inter-governmental and International industry reviews.

5.1. Overview Safety Performance Assessments

Safety performance is determined from assessment of operating experience, including safety related events, and records of the unavailability of safety systems, radiation doses and the generation of radioactive waste and discharges of radioactive effluents ([73] Clause 5.84).

Safety performance is an area of continual focus and improvement across the site; Bruce Power strives to achieve world-class performance levels by embracing a philosophy of continuous improvement. The Bruce site achieved 22 million hours without a lost time injury in 2010, reached over 14 million hours without a lost time injury in 2013 ([189] Executive Summary, [183] page 80) and in 2015 it was reported no employee had suffered an acute lost-time injury in over 13 million hours and the all injury rate (injuries per 200,000 hours worked) continues to drop each year ([190], [183] page 47).

Likewise, diligent application of Bruce Power's RP Program has been effective at identifying and controlling radiological hazards. During the 2009-2013 licensing period Bruce Power consistently maintained worker radiological exposures below regulatory limits and enhancements to the RP Program were implemented and are yielding positive results. The online dose trend line continues to decrease showing workers are receiving less annual dose [183] pages 48, 211 and 214). These are discussed further in this section with further details in the Performance Report ([189] Section 3.7).

Environmental performance remained strong over the past licence period with no major events. The 2012 dose to public demonstrates the maximum dose received by a member of the public due to Bruce Power site operations continues to be a very small percentage of the annual legal limit of 1000 µSv/Year; less than 0.12% for 2012 ([189] Section 3.7.3 and Executive Summary). Bruce Power is continuing to adopt best industry standards as a framework for achieving continuous improvement and sustainable performance excellence, while minimizing environmental impact and preventing pollution. The progress made in achieving these to meet the December 2018 date from the LCH ([2] Section 9.1) is discussed further in Section 7, and Bruce Power plans to implement CSA N288.4-10 on environmental monitoring programs and its companion standards, CSA N288.5-11 and CSA N288.6-12 on effluent monitoring programs and environmental risk assessments. These are discussed further in Safety Factor Report 14.

Bruce Power provides an annual Environmental Monitoring Program update describing its effluent monitoring program related to Operations in compliance with PROL Licence Condition 1.7 [191]. The latest reports stated for the 23rd and 24th consecutive year Bruce Power's calculated dose to a member of the public is less than 10 microSv/year regarded as the lower threshold for significance (the de minimus) ([192][193] Executive Summary).

Bruce Power adopts applicable best industry standards as a framework for achieving continual improvement and sustainable performance excellence, while minimizing environmental impact and preventing pollution. Bruce Power complies with the Environmental Compliance Approvals and Permits issued by the Ontario Ministry of Environment ([192][193] Executive Summary).. Bruce Power continues to monitor site/offsite groundwater. Bruce Power complies with the Federal Regulations and programs which protect human health and the environment under the Canadian Environmental Protection Act [191]. Specific data on effluent emissions (airborne,

iodine, carbon, and water), radiological dose and waste are provided yearly in the annual reports including figures on trending over a 10-year period.

The CNSC performs an annual review of safety performance for each Station ([194] [195] [196] Table 2). The reviews for 2013 and 2014 showed Bruce A and B's performance was improved from the previous year. For both Bruce A and B, the Operating Performance, Conventional Health and Safety, Waste Management and Security Safety and Control areas were fully satisfactory, while all others were satisfactory, except at Bruce B where the integrated plant rating was Fully Satisfactory. The Environmental Assessment (EA) monitoring program related to the Unit 1 and 2 refurbishment continued to verify the conclusion of the EA that there were no significant adverse environmental effects due to the project ([195] Section 3.1). The CNSC highlighted that Bruce Power continued to make gains in the area of human performance [195]. No significant operations-related compliance issues were identified during CNSC inspections ([195] Section 3.1.1.3). These inspections are detailed in Section 7.3.

Similarly Bruce Power performed a Performance Review of the Stations as part of a supplemental submission in support of the Licence Renewal, in October 2013 [189]. It highlighted over the past 10 years, Unit 4 has consistently been one of the top Canada Deuterium Uranium (CANDU) units in the world. It states as Bruce Power moves forward to renew and modernize its nuclear fleet it plans to build on the lessons learned and the experience gained over the last decade to ensure greater certainty and predictability in its refurbishment and asset management projects. The report [189] discusses numerous SCAs applicable to this Safety Factor, including the complete discussion in Sections:

- 3.2.1 on SCA 2, on the Human Performance Program (continuous improvement);
- 3.2.2 on Personnel Training,
- 3.2.3 on Personnel Certification;
- 3.2.4 on Certification and Requalification Tests;
- 3.2.5 on Work Organization and Job Design, including specialized staffing;
- 3.3 on SCA 3, Operating Experience;
- 3.4.5 on Management of Safety Issues;
- 3.5 on SCA 5, on Physical Design which covers Configuration Management;
- 3.6 on SCA 6, on Work Management;
- 3.7 on SCA 7, on Radiation Protection;
- 3.8 on SCA 8, on Conventional Health and Safety;
- 3.11 on SCA 11, on Waste Management.

Each of these sections provides information on the relevance and management of the SCA, past performance, future plans, challenges (if any) and requests (if any). Overall the report shows Bruce Power has moved forward to renew and modernize its nuclear fleet and is building on the lessons learned and the experience gained over the last decade to ensure greater certainty and predictability in future projects.

From November 29 to December 13 of 2015, an Operational Safety Review Team (OSART) of 14 international reviewers representing the IAEA visited Bruce B to perform an extensive review of 12 specific focus areas including several which are part of Safety Performance ([183] Appendix C). At the exit meeting with Bruce Power on December 17th, the OSART identified 10 good practices including several related to Safety Performance (e.g., Visual Management Boards, Training facilities, use of a Gamma Camera, Implementing off-site Radiation Monitoring sites powered by batteries and solar panels, developing an Emergency Mitigating Equipment strategy and developing a comprehensive strategy to manage Major Component Replacement for long term operation). The team included five recommendations (e.g., protecting onsite personnel by providing continuous radiation monitoring in assembly areas for emergency situations should they arise) [197][198].

5.2. Safety Performance Indicators

This section addresses Section 1.2 Review Task 2.

Bruce Power has defined a set of Operational Safety Performance Indicators designed to monitor the safety of plant operation. Integrated, these indicators give Management an enhanced perspective on the condition of the plant, while the instantaneous numerical value of an individual indicator may be of little significance if treated in an isolated manner. Indicators are trended over a period of time to provide early warning to investigate the causes of the observed changes. The indicators are compared to set goals to identify strengths and drive improvement, recognizing an indicator is selected based on the importance to the plants unique situation and are dynamic, not static indicators as the plant environment changes.

The list of performance indicators used at Bruce A and B was identified in Reference [199]. A number are relevant to the Safety Performance of the station including, Chemistry, Health and Safety [96], Plant Status, Audits and Assessments, Corrective Action, Human Performance, Reactivity Management, Operator Experience, Radiation, Staff Qualification, Security, Maintenance and Reliability, and Emergency Preparedness, while others are related more to other Safety Factor Reports or business objectives. Quarterly Reports of Performance Indicators have been provided to the CNSC since before 2009 [200] [201], including ones covering industrial accidents, chemistry, change control, emergency preparedness, non-compliances, preventative maintenance, radiation, SSTs, unplanned transients, unplanned capability loss factor and power history. With the application of REGDOC-3.1.1 starting in 2015, additional Performance Indicator results were provided to the CNSC, adding 13 more sections to the new reports and changing some of the PIs [202] [203] [204].

The standard Performance Indices in the Bruce A and B Quarterly Reports include:

1. Collective Radiation Exposure
2. Personnel Contamination Events
3. Unplanned Dose/Unplanned Exposure
4. Loose Contamination Events
5. Environmental Releases – Radiological

6. Environmental Releases - Spills
7. Mispositioning Index
8. Number of Unplanned Transients
9. Reactivity Management Index
10. Unit Capability Factor
11. Unplanned Capability Loss Factor
12. Forced Loss Rate
13. Reactor Trip Rate
14. Corrective Maintenance Backlog
15. Deficient Maintenance Backlog
16. Deferral of Preventative Maintenance
17. Safety System Test Performance
18. Preventative Maintenance Completion Ratio
19. Chemistry Index
20. Chemistry Compliance Index (Non-Guaranteed Shutdown State and Guaranteed Shutdown State)
21. Conventional Health and Safety
22. Radiological Emergencies Performance Index
23. Emergency Response Organization Drill Participation Index
24. Emergency Response Resources Completion Index
25. Low and Intermediate Level Radioactive Solid Waste Generated.

In addition to the Bruce B Station performance indicators, for comparative purposes the CANDU industry shares information through the CANDU Owners Group to allow Bruce B management to compare the station safety performance with other stations and review trends against comparably designed reactors [205] [206]. Also, CANDU Station Performance Annual reports are assembled [207]. These provide overviews of outage and unplanned loss of production events for CANDU stations.

Separately, BP-PROC-00651 [96], Safety Performance Metric and Monitoring, defines conventional safety performance metrics to enable consistent, accurate internal and external reporting of occupational injuries and illnesses. BP-PROC-00651 [96] is an implementing procedure of BP-PROG-00.06 [95], Health and Safety Management, which was discussed in Sections 4.1 and 4.7. Formal reports of Bruce Power injury data that are submitted to internal and external parties are based on COG-recordable injury data. Examples include WANO submissions, CNSC reporting and station injury reporting ([96] Section 1.0 and 4.1). The Bruce Power data are compared to Stations world-wide. Bruce Power has consistently shown better

than industry average worker safety and has been recognized for its commitment to the safety of its workers.

These reports show Bruce Power is recording and evaluating Safety Performance continually since the previous Integrated Safety Reviews were conducted in 2008 and the data is being trended against the performance of other stations. Trends are reviewed and as appropriate are captured through the Station Condition and Corrective Action processes to deal with adverse conditions or to share positive performance so as to reinforce the learning. Therefore, Bruce Power meets the requirements of this review task.

5.3. Safety-Related Incidents, Low Level Events and Near Misses

This section addresses Section 1.2 Review Task 1a.

Bruce Power has defined processes for routine recording and evaluation of safety-related incidents, low level events and near misses. These include:

- Operating Policies and Principles – Bruce, BP-OPP-00001 [91];
- Event Response and Reporting, BP-PROC-00059 [54]; and
- CNSC Interface Management, BP-PROG-06.03 [57].

Section 04.2 of the Operating Policies and Principles document states that reports are to be made to the CNSC in the specified format and within the specified time frames, as required to meet regulatory requirements. It the identifies the aforementioned event reporting procedures for guidance on reporting, in accordance with CNSC Regulatory Document REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants, and identifies the key procedure from the CNSC Interface Management Program: BP-PROC-00165, Reporting to CNSC – Power Reactor Operating Licenses.

This program and its implementing procedures define the steps on how events are reported, by when and to whom.

As part of the CNSC interface, compliance reporting processes elaborate on reporting to the CNSC [125] [56] [127] [128] [129] and meet the reporting requirements of CNSC REGDOC-3.1.1. They identify when scheduled and unscheduled reports of incidents, events and near misses are due [125][134]. Until the end of 2014 Quarterly Operations Reports [208] listed the reportable events and identified inconsistencies between the safety analysis and licensing documents. They used to be reported via the process defined in BP-PROC-00139 [208], Bruce A and B Quarterly Operations and CMLF Quarterly Technical Reports however they have been removed from BP-PROC-00139 with the application of REGDOC-3.1.1 ([209] Revision History) and the information consolidated into the Station Performance Index Reports [202] [203] [204].

On a daily basis as events arise they are recorded for all staff via the SCR process [113]. These SCRs are reviewed by Management at the daily Morning Review Meetings, and addressed through the Corrective Action Program [55].

Separately, Safety Factor Report 9 (Bruce A [17] Bruce B [5]) covers the processes in place for Bruce Power to factor in experience from events and incidents at other plants and from research findings.

Based on the Quarterly Operations Reports for Bruce A and B from 2011 to 2014 [210] [211] about 23 events are reported to the CNSC quarterly.

These reports identify a significance level[9] with the events. For Bruce B for the 16 quarters from 2011 through to the end of 2014, based on the reportable events in Tables 3.1.2 and 3.1.3 from the Operations Quarterly Reports, there were zero Level 1 events, 80 Level 2 events and 179 Level 3 events for an average of 0, 5 and 11.2 respectively per quarter. The maximum number of Level 2 events in a quarter was 9 and for Level 3 events was 22, occurring in 2011. The data shows an improving trend in 2014 [211].

An example of a safety-related incident, low level events and near misses arises arose at Bruce A as part of the refurbishment work at Units 1 and 2, where the functional organization for refurbishment and major component replacements was responsible to resolve an issue which arose. An important trend of events was flagged with respect to unanticipated SDS2 Trips in Units 1 and 2 on Steam Generator Low Level [212] following the refurbishment of the units. Bruce Power investigated these thoroughly as they impacted both safety and production. These are being tracked under Action Item 2014-07-5442 [213]. The original boilers were replaced with boilers having a smaller shell side inventory. As part of this modification, the boiler level trip setpoints were raised for both shutdown systems and lowered for the Reactor Regulating System to: maintain the safety margins that were affected by the reduction in shell side inventory for the boiler low and very low level trips; and maintain the operating margins to the Reactor Regulating System boiler low level stepback setpoint, which was also affected by a larger bias between indicated and actual level for wide range boiler level instrumentation due to the higher down-corner velocity. Since the return to service of Units 1 and 2, there have been a number of unexpected unsealed channel trips on SDS1 and actuation of SDS2 on boiler low level during turbine trip and loss of line events. Data analysis concluded that the observed change is with wide range boiler indicated level and not the actual boiler level. Bruce Power is assessing a potential solution to install a time delay of up to two seconds for the boiler low level trip parameter that would be sufficient to prevent seal in of the shutdown system trips following these level indication spikes. Preliminary reviews showed that the boiler replacement safety analysis was conservative and sufficient safety margin exists for this solution to be feasible. Bruce Power has requested CNSC consent for a proposed modification to install a time delay on the trip logic on the boiler low level trip parameter for Shutdown System One and Two on Units 1 and 2. This modification was proposed to mitigate the unsealed channel trips on SDS1 and actuation of SDS2 during turbine trip and loss of line events [214] and accepted by the Regulator [215].

The Large Loss of Coolant Accident Safety Margin Restoration Project was established in 2008 to explore design changes that can provide improvements to safety margins during large break loss of coolant accidents [49] [216] while discussions with the CNSC have been held to consider

[9] Level 3: Potential reduction in margin to the health and safety of persons, security or the environment; Level 2: Some reduction in margin to the health and safety of persons, security or the environment; Level 1: Major reduction in margin to the health and safety of persons, security or the environment.

the reclassification of large break loss of coolant accidents from design basis to beyond design basis events similar to the practices of similar type of events in other jurisdictions [217]. Previously a generic action item GAI 95G04 had existed to review positive void reactivity uncertainty and its treatment in Large Loss of Coolant Accidents and another GAI 99G02 reviewed the replacement of reactor physics codes used in Safety Analysis (INFO-0745 [218] Sections E.9 and E.15). In the interim, since the last PSR was completed, additional reactor core physics findings impacting the core void reactivity and uncertainty in the analysis have arisen, thus the available margin continues to be challenged [219]. Bruce Power considered whether a trend has arisen with these adverse events in the area of reactor physics and/or thermal-hydraulics based on the discovery issues. It evaluates and prioritizes these events on a quarterly basis following DPT-NSAS-00003, Guidelines for Evaluating and Prioritizing Safety Report Issues [134]. Bruce Power has concluded the Large Break Loss of Coolant Accident (LBLOCA) analysis continues to have sufficient margin [20].

In addition to the deterministic safety analysis updates on LBLOCA, the CNSC and Bruce Power, along with Industry Partners have been discussing a proposed a Composite Analytical Approach to showing the additional margin in the LBLOCA analysis. The CNSC staff provided review findings for each of the four CAA Technical Areas being managed under a LBLOCA Joint Project. These areas include [220]:

- Qualify reactivity feedback coefficients (especially coolant void reactivity) kinetics parameters and their uncertainties for use in LBLOCA analyses.
- Define and formalize the performance limits for fuel, pressure tube and calandria tube behavior under various accident conditions.
- Perform pilot analysis to demonstrate adequacy of LBLOCA safety margins using CAA and also show the impact of Best Estimate Analysis with Uncertainties in confirming the adequacy of the calculated margins.
- Define failure probability and break opening characteristics for LBLOCA.

The CNSC has requested clarification on the proposed path forward to close the gaps they have identified and meetings to discuss the remaining CANDU safety issues impacting LBLOCA [220] [221].

For completeness, this issue is flagged as a gap as the Safety Report Improvement Project [222] will need to capture changing LBLOCA analysis in future Safety Report updates as part of the Safety Report Framework update and the Safety Analysis Improvement Program [223] after the delivery of the 2017 update of the Safety Report. This is identified as gap SF8-2 in Table 10, and is an update of the similarly numbered gap identified in the Bruce A Safety Factor Report 8.

An Action Request 28508028 was raised to address a potential gap between the Safety Analysis – Analysis of Record and the allowable operating states. Bruce Power extended this AR review to confirm the links between the safety analysis and operations documents was comprehensively captured in the safe operating envelope as documented by the set of limits and allowable operating configurations in the OSRs, including the DCRs raised against these documents. This review of whether there were unidentified gaps between the safety analysis and OSRs published since 2005 is to be completed in 2016. The high priority OSRs include: Fuel and Physics, Shutdown Systems, Heat Transport System, Moderator System, Containment

System and Emergency Coolant Injection System. These OSRs are to be reviewed as they constitute the majority of the updated analysis. Others like the Negative Pressure Containment System are to be reviewed after the high priority ones. A Safety Analysis Mapping Results Spreadsheet will be produced to capture all the safety analysis produced since the OSRs were issued. It will capture the changes to various parameters and limits as new analysis was produced which superseded the earlier analysis. This will then be compared to the parameters and limits in OSRs to ensure completeness and identify gaps and whether they can be fully dispositioned or make recommendations for improvement [224]. This investigation is identified as gap SF8-12 in Table 10.

With the exceptions noted as gaps SF8-2 and SF8-12, Bruce Power programs and processes meet the requirements of this review task.

5.4. Safety-Related Operational Data

This section addresses Section Review Task 1b.

Bruce Power has a wide range of processes in place for routine recording and evaluation of safety-related operational data mainly under the Equipment Reliability Program, BP-PROG-11.01 [51], but other Programs contribute to this review as well. These include:

- Operations inspections and monitoring, GRP-OPS-00047 [166];
- Station Condition Record reviews by Operations, BP-PROC-00060 [113];
- Safety System Testing, BP-PROC-00268 [143];
- Routine System, Structure, and Component performance and health monitoring by System Engineers, DPT-PE-00008 [150], DPT-PE-00009 [151], DPT-PE-00010 [152], DPT-PE-00011 [153];
- Fault Data Collection for Probabilistic Risk Assessment, BP-PROC-00943 [225]; and
- In-Service Inspection Programs for Safety-Related Structures NK29-PIP-20000-00001 [226].

These processes provide detailed information on the Safety-Related System, Structures and Components condition and performance on a shift, daily, weekly and less frequent basis. For example, SCRs are reviewed daily by the Shift Manager to assess operability concerns either preferably on the shift the SCR was initiated and in all cases within 24 hours. If an operability concern is found, the requisite response per the Operation's Impairments Manual is followed to ensure the SSC is placed in a safe state and/or a Technical Operability Evaluation is performed ([113], Section 4.2.2).

The processes capture the reliability and unavailability data used in the Bruce A and Bruce B Annual Reliability Reports [227] [228] as part of the Reliability Program input and used in the Safety Analyses to ensuring ageing is appropriately modeled [136][151]. The Reliability Program complies with the CNSC Regulatory Document RD/GD-98 Reliability Programs for Nuclear Power Plants. For example, the Operational Data captured in the Annual Reliability Report includes Human Performance data covering human error events observed involving the

systems important to safety, inputs from the SSTs, Safety Related Operator Routines, and the System Health Reports.

On a daily basis routine SSC and equipment-related issues found through plant monitoring, maintenance, walk-downs and operator routines are more widely identified via the SCR process [113]. The SCRs are reviewed by Management at the daily Morning and/or Station Leadership Review Meetings, and addressed through the Corrective Action program [55]. Similarly the Station Plant Health Committee, as described in BP-PROC-00559 [155], meets regularly to determine the actions in response to the inspection, walk-down and maintenance findings. Component failure data is fed back into the Station Probabilistic Safety Assessments as part of the implementation strategy discussed in Section 6.1 of the LCH [2].

Safety-related Operational Data is also collected for the fuel via the BP-PROG-12.03, Nuclear Fuel Management [173]. The fuel constitutes the first two lines of defence with respect to controlling the release of radionuclides from reaching the public and/or the environment in an accident. This program advocates for the removal of suspected fuel defects from the reactor in a timely manner and verifies the reactor is operated with fuel of an approved design, manufactured in accordance with quality assurance requirements.

Heat Transport System (HTS) vibrations originating from the HTS pump impellers are carried via the coolant through the HTS to the individual fuel channels. These vibrations cause infrequent limited extent end-plate cracking in a small number of fuel bundles in a small percentage of the outer zone fuel channels. Bruce Power has developed, and is implementing, an action plan to mitigate endplate cracking, and reporting progress to the CNSC [229] [230] [231] [232] [233] [234] [235].

Safety-Related Operational Data are collected, reviewed and trended by Bruce Power in compliance with CNSC REGDOC 3.1.1 and consistent with WANO expectations, guidance provided in IAEA-TECDOC-1141, Operational Safety Performance Indicators for Nuclear Power Plants [74] was considered in deriving the operational performance indicators.

Bruce Power has an extensive program of monitoring and recording safety-related operational data consistent with Canadian requirements and international best practices. Specific performance indicators are discussed in Section 5.5.

Bruce Power programs and processes meet the requirements of this review task.

5.5. Maintenance, Inspection and Testing

This section addresses Section 1.2 Review Task 1c.

Bruce Power has processes in place for routine recording and evaluation of maintenance, inspection and testing under the Equipment Reliability program [51]. Appendix C of that program maps the regulatory requirements to the program implementing procedures. Life Cycle Management Plans and Fitness for Service practices are used to monitor and track the performance of SSCs. Extensive analytical processes (assessments) are in place for key components such as Steam Generators, Fuel Channels, and Feeders which interface with and are part of the HTS, and for the Turbine/Generators which are a key component for continued long-term operation. These are augmented by maintenance and empirical means (inspections)

performed during outages ([236] Issues C1, PF19). Often further investigation and confirmatory testing is done to support the on-going understanding of the aging of these components, including co-operative investigations with Industry Partners under the CANDU Owners Group. These are discussed more fully in Safety Factor Reports 4 and 9.

Numerous SSC-specific items are documented (e.g., Infrared Inspection of Indoor Electrical Equipment BP-PROC-00764 [237] and Inspection and Monitoring of Once-Through Service Water Systems SEC-ME-00010 [238]). Others cover multiple SSCs including:

- Operations inspections and monitoring, GRP-OPS-00047 [166];
- In-Service Inspection Programs for Safety-Related Structures, NK29-PIP-20000-00001 [226];
- Safety System Testing Program Procedures, BP-PROC-00268 [143]; and
- Maintenance information comes from Routine System, Structure, and Component performance and health monitoring by System Engineers DPT-PE-00008 [150], DPT-PE-00009 [151], DPT-PE-00010 [152], DPT-PE-00011 [153].

Each of these is also a source of Operational Data, discussed in Section 5.4.

In addition to the testing programs, Bruce Power tracks incomplete testing via the Safety System Testing Program. Up until 2014 this was tracked in Section 9.0 of the Quarterly Report of Performance Indicators [239] and since 2015 it is tracked and trended in Section 17.0 of the Bruce A and B Quarterly Report on Safety Performance Indicators, which complies with REGDOC-3.1.1 [202][204].

The assessments in Safety Factor Report 2 have discussed the progress on the maintenance backlogs as well so specific technical details are not reviewed in this Safety Factor; however from a trending and completeness perspective, this Safety Factor review noted the completion of this item had been slow. This trend was identified as gap SF8-7 in the Bruce A SFR 8. There were previously highlighted through the review of CNSC regular compliance and quarterly field inspections reported in Sections 7.3.1 (e.g., Action Item 1307-4229 – BRPD-AB-2013-008 – Preventative Maintenance Oversight Group (PMOG) Inspection and BRPD-B-2015-005 2015 Unit 6 Planned Outage) and 7.3.2 (BRPD-AB-2013-005 and BRPD-AB-2014-020). Similarly high backlogs were flagged in Bruce Power audits per Section 7.2 (e.g., AU-2009-00031, Bruce B - Corrective Maintenance Backlog).

Bruce Power and the CNSC have had long standing discussions on the growth of Maintenance Backlogs under Action Item 080707. This issue was flagged in the 2008 ISR[10] and the parties have been tracking it fully with some 15 correspondences on the topic. Bruce Power provided a detailed summary of the status and identified the numerous procedures and processes in place and identified future courses of action [240]. Bruce Power followed up with a status report which shows significant improvement on this issue as supplemental information to the PROL renewal application [20].

Since 2014, Bruce Power has been prioritizing the critical backlogs and has employed concerted effort to reduce backlogs at both Stations. As part of the REGDOC-3.1.1 reporting

[10] ISR and PSR have been used synonymously by Bruce Power and the CNSC.

requirements, Sections 14.0, 15.0 and 16.0, of the Bruce A and B Quarterly Report on Safety Performance Indicators cover Corrective Maintenance Backlog, Deficient Maintenance Backlog, Deferral of Preventative Maintenance [202][204]. This way it is easier to see the trends and importance of the backlogs. The trends from the last few quarter's show improvements have been made.

Recently during quarterly field inspections Control Room Deficiency type operator challenges had arisen along with an increase in the backlog of clearing them. However, a more detailed review of how the trend in these deficiency backlogs had arisen showed the work orders had been incorrectly flagged. Bruce Power is now confident the overall trend in backlogs has been reversed, but will provide the CNSC another update in 2016 [241].

Given the process is now well managed and improvements have been made, the previous gap has been removed. Bruce Power is complying with the requirements of this review task recognizing the progress on maintenance backlogs has been less effective than originally desired, but improvement actions have been taken. The station is now in line with or exceeds target backlog goals [20].

5.6. Replacements of SSCs Important to Safety Owing to Failure or Obsolescence

This section addresses Section 1.2 Review Task 1d.

Bruce Power has processes in place for routine recording and evaluation of replacements of SSCs Important to Safety Owing to Failure or Obsolescence. These include:

- Equipment Reliability, On-Line Work Management, Outage Work Management and Plant Maintenance Programs [51] [159] [163] [164];
- Aggregate Risk Assessment and Monitoring, BP-PROC-00849 [158];
- Integrated Aging Management for Safety Assessment, DPT-NSAS-00016 [136];
- Long Term Planning & Life Cycle Management, BP-PROC-00783 [156];
- Assessment Management Planning, BP-PROC-00936 [104];
- Scoping and Identification of Critical SSCs, BP-PROC-00778 [147];
- Continuing Equipment Reliability Improvement, BP-PROC-00779 [65];
- Obsolescence Management, BP-PROC-00533 [157];
- Environmental Qualification Sustainability Monitoring, SEC-EQD-00035 [131];
- Station Plant Health Committee, BP-PROC-00559 [155]; and
- Margin Management, BP-PROC-00786 [89].

As discussed in Sections 4.3 and 4.4, Equipment Reliability defines the fundamental needs, requirements, implementing approaches, and responsibilities of the plant equipment reliability integration process. The objective of equipment reliability is to develop, implement and revise

the approaches required for anticipating, identifying, preventing and resolving performance and condition problems with SSCs on the basis of risk, to support safe, reliable plant operation at optimum cost. A review of single point vulnerabilities and obsolescence are important aspects of Equipment Reliability.

BP-PROC-00779 [65], 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 SSCs identified in BP-PROC-0778 [147], Scoping and Identification of Critical SSCs. A review of the Operational Safety Requirements pertaining to the component in question is completed to ensure the maintenance and surveillance strategy remains consistent with the Safe Operating Envelope ([65], Section 1.0).

The Aggregate Risk Assessment and Monitoring process reviews the risk of degraded performance during normal and abnormal operation including plant transients to ensure continuing reliable operation [158]. If an important SSC fails or becomes obsolete, Plant and Station Engineering personnel take the appropriate actions based on an understanding of the risk. Results of assessments are provided to the Station Plant Health Committee, BP-PROC-00559 [155] via a risk ranking sub-committee report for their awareness and review to ensure a safe, integrated focus on aggregate risk. Factors considered include findings of degraded margin, safety system impairments, loss of redundancy, conditional single point vulnerabilities, backlogs, operator work-arounds, bill of material obsolescence, and Abnormal Incidents Manual equipment health.

The Integrated Aging Management for Safety Assessment process [136] links to ageing management as it requires that the condition of the plant be monitored and inspected so the results can be used to ensure that safety margins remain adequate. The dominant ageing mechanisms in the HTS are associated with pressure tubes, steam generators and feeders.

The Asset Management Planning process [104] involves a formal presentation and approval of the selected asset management scope and maintenance of the long term Asset Management Plan. It then directs the organization to implement the improvements. The procedure defines 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.

Scoping and Identification of Critical SSCs [147] ensures the safety important systems and components are identified.

Under the Obsolescence Management, BP-PROC-00533 [157], 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 life cycle management. A site obsolescence list has been assembled and this list forms the single prioritized listing of all obsolete items for the site. Obsolescence Monthly Metrics have been established to assist in determining which components should be prioritized as needing the most attention. On a monthly basis, metrics Obsolescence Management – Bruce B and Obsolescence Management-Top 100-Bruce B are reviewed and items completed are taken off the list and new ones added. Quarterly the list is reviewed by Stakeholders and changes are

concurred with by the Equipment Reliability Integration Steering Committee and SPHC ([157] Section 4.2.2).

The Bruce A and B Station Plant Health Committees are discussed more fully in Section 5.14 (See BP-PROC-00559 [155]). They are an effective management tool enabling the station leadership team to make informed and timely decisions in support of equipment reliability that results in safe and reliable plant operation. The SPHC provides management oversight regarding the status of Equipment Reliability issues that challenge safe and efficient plant operations.

The Margin Management process [89] describes the steps to manage the safe and reliable plant operation of the plant by maintaining margins, ensuring plant equipment configuration and performance are consistent with design and licensing requirements, and conducting day-to-day operations reflecting consideration of design and operating margins. The Margin Management document is aligned with the structure described in INPO 09-003-R0, Excellence in the Management of Design and Operating Margins.

Maintaining margin is a basic principle of nuclear plant design and operation. “Margin” is conservatism included in operating limits, design limits, analysis and fabrication of every SSC. Margin accounts for normal wear and ageing of equipment, degradation of safety analysis assumptions and analytical method uncertainties. Site organizations are aware of what margins exist and how they are controlled so margin concerns can be recognized and managed.

Examples that show Bruce Power continues to manage margins are illustrated through:

- Heat Transport Low Flow Trip. Initially adjustments were made to the Automatic Neutron Overpower Set Point Reduction (ANR) Low Flow Conditioning Setpoint to retain the margin [242], but subsequently a design change was proposed [243]. For the Shutdown System #1 (SDS1) Heat Transport Low Flow Trip change, Bruce Power is modifying the SDS1 Heat Transport Low Flow (HTLF) trip, and Part 3 of the Bruce B Safety Report [250] will be modified to include the safety case from Reference [243] which shows current safety margins are improved with the implementation of a SDS1 relative fixed-margin-to-trip. Furthermore, ANR was removed, as it was rendered unnecessary by the HTLF modification ([244] Section 1.0). This design change was accepted by the CNSC [245].
- Heat Transport High Pressure Trip [246] [247] [248] improvement projects. Bruce Power is relying on the highly reliable reactor stepback on pump breaker [249] while improvements in the shutdown systems are being finalized. The CNSC has performed a preliminary review of the information provided on the heat transport high pressure trip coverage improvements in Units 3 and 4 [250].

A review of these projects shows detailed up-to-date trip coverage maps for all loss of flow events have not been provided and are not included in the Safety Report. Bruce Power has flagged this shortcoming as part of its supplements to the PROL renewal application to support licence renewal [20]. Bruce Power has acknowledged improvements are necessary and they are updating their analysis models to compensate for ageing. The analyses using these models are planned to be captured in the Safety Report Improvement initiative [251] but recognizing

there are more significant gaps in the Safety Report, Bruce Power is planning to focus on the inclusion of Common Mode Failures in the Safety Report over the next two years [20].

Future improvements such as updating the extent of the changes to trip coverage windows for the key aged impacted accident scenarios of loss of flow, neutron overpower protection, small break loss of coolant accidents in compliance with R-10, while considering the use of the modified 37-element bundle to reduce the trip coverage window [247] will be captured later in the Safety Report Improvement project [252]. For completeness, this is identified as gap SF8-4 in Table 10. Regarding Common Mode Failures, Safety Factor Report 5 identified gap SF5-1, which stated that "…Common-mode failure events are not included in Part 3 of the Safety Report."

These analyses continue to show sufficient margin is available or in some cases identify improvements to restore margin. Bruce Power provided an update of their Aging Management Program as part of the PROL renewal process [253].

With the exception of the gap noted above, Bruce Power programs and processes meet the requirements of this review task.

5.7. Modifications to SSCs Important to Safety

This section addresses Section Review Task 1e.

Bruce Power has a process in place for routine recording and evaluation of temporary or permanent modifications to SSCs Important to Safety. These include:

- Operating Policies and Principles – Bruce B, BP-OPP-00001 [91];
- BP-PROC-00734, Plant Status Control [169];
- Engineering Change Control, BP-PROG-10.02 [138];
- Design Change Package, BP-PROC-00539 [139]; and
- Configuration Information Change, BP-PROC-00542 [140].

Operating Policies and Principles – Bruce BP-OPP-00001 [91], requires that modifications to station systems and procedures are controlled to ensure they do not invalidate the licensing basis. Change control programs include requirements for adequate review and approval of modifications to station systems or procedures. These programs are effectively implemented to identify the impacts of the modifications on the licensing basis. Station personnel who have been certified by the CNSC are kept informed of modifications which affect the ability to control reactor power, cool the fuel or contain radioactivity, or which otherwise have an impact on the licensing basis within the scope of responsibility of the certified personnel ([91], Section 1.6).

The Engineering Change Control process helps ensure the plant design basis is maintained so the SSCs continue to meet the design basis and the plant can continue to operate safely within its design basis [66]. It interfaces with the design process [66] and configuration management programs which ensure the design basis, plant documentation and the as-built and operated plant are consistent.

Design Change Package (DCP) BP-PROC-00539 [139] specifies the control of modifications to plant systems, structures, components, and significant tools, including temporary modifications. The overall objective is to meet regulatory requirements, ensure safety, and minimize loss to the company through appropriate risk management activities (Section 1.0) [139].

The DCP procedure describes how to:

- Prepare, issue, and close out DCPs.
- Prepare, issue, and close out Design Change Notices (DCNs) and Field Change Notices (FCNs).

The ECC process and DCP procedure are used to ensure changes to the design of the facility, facility operation, equipment or procedures are appropriately reviewed and approved, and that changes to the operational limits referred to in the Operating Policies and Principles or that would introduce hazards different in nature or greater in probability than those considered by the Final Safety Analysis Report and Probabilistic Safety Assessment receive the prior written consent of the Commission, or a person authorized by the Commission.

Configuration Information Change BP-PROC-00542 [140] governs the acceptance, creation, revision, obsolescing and superseding of design information when one or more of the following apply:

- Design information is being corrected.
- No inspection, testing, or commissioning activities are required to verify the field against the new design information.

BP-PROC-00734 [169], Plant Status Control is maintained in accordance with five principles centered on ensuring control and equipment manipulations are authorized by the Duty Authorized Nuclear Operator in the main control room. Individuals need to control and equipment manipulations are performed using an approved operating procedure (except “skill of trade”), and when control or equipment are intentionally left in an off normal position, then a Plant Status Control process is used to approve, document, and tag the affected control or equipment. When control or equipment is intentionally left in an off normal position and continued system operation is impacted, then operating procedures are in place to provide instructions for continued operation of the system in case of anticipated contingencies. If equipment or control is found positioned away from the normal alignment and not approved by a Plant Status Control process, the Authorized Nuclear Operator is immediately informed so that the mispositioned equipment is not be operated until approved operating instructions are given and it is confirmed that the system and equipment is in a safe state. After review of the system status, the equipment is returned to the correct alignment consistent with the design basis [169], Section 4.1.

An undocumented configuration change is a modification to the approved design of a system. If one is discoved, the applicable Control Room Operator is informed, and as soon as practicable the Responsible System Engineer, to confirm that the change is undocumented. If the change cannot be confirmed, or has been confirmed as undocumented, then a Temporary Configuration Change (TCC) category “Emergency TCC” is initiated per BP-PROC-00638, Temporary

Configuration Change Management [142]. A Station Condition Record is initiated to document the condition [169], Section 4.13.

In addition to these procedures of the ECC process, Business Risk Management BP-PROC-00162 [105] is followed to determine which systems may be enhanced.

An example which shows Bruce Power is modifying SSCs to account for ageing degradation is illustrated through the modified 37-element fuel bundle projects [247]. Extensive lists of other improvements for both Bruce A and B can be found in the Safety Report Improvement Plan (Section 4.2.4 of [222]) and the Integrated Station Implementation Plan [254]. Furthermore, the Safety Basis Report [6], Sections 4.1.7 and 4.2.2.3, discuss other modifications made to improve safety margins. Bruce Power has prepared an Integrated Implementation Plan for Bruce A, Bruce B and the Centre of Site [255]. Items discussed in that plan include improvements in Bruce B legacy registration, consideration of a Containment Venting Connection Point and Off-Site Monitoring improvements to name a few suggested future improvements.

Separately, as part of the Bruce Power response to the Fukushima Daiichi event in Japan in 2011, Bruce Power has developed a comprehensive action plan which responds to each of the CNSC Fukushima Action Items [254]. Bruce Power has initiated design changes to improve defence-in-depth and means to respond to severe accident events, including updates to operating documents and the severe accident management guidelines. Many of the action plan tasks have been completed and changes have already been implemented in the Units, recognizing more are underway. The actions in the plan are expected to be fully implemented by 2019, and a semi-annual action plan update is provided to the CNSC [256] [257] [258].

From a trending perspective it was noticed that some conceptual design modifications which are initiated via safety analyses to improve safety margins take a significant amount of time to move from the conceptual design phase to implementation, commissioning and available for service. For example, the heat transport high pressure trip has been discussed on Units 3 and 4 to restore safety margin since 2010 [248]. This improvement appears to take a significant time frame to implement, particularly when the conceptual design relies on collecting station data and outages to implement [257] and often can await investment funding via the Business Planning Program, BP-PROG-01.01 [103] process and its implementing procedures.

Therefore a trend has been identified pointing out the need to close the gap between the notifications to the CNSC of safety improvement to their implementation in the Units over time. This is identified as gap SF8-3 in Table 10. To improve the completion process, Engineering has developed standard timelines for the engineering phases (conceptual, preliminary, detailed design and close-out) and tracks completion performance recognizing Safety Improvements tend to be more complex than standard design changes and require Regulatory inputs and potentially acceptance by the Regulator.

A strength found during the reviews is the control Bruce Power took with respect to its modification of the 37-element fuel design (37M). Bruce Power staff was instrumental in the completion of the design, and Bruce Power owned the design and worked with the manufacturers to ensure the requirements were understood and incorporated. This strength was important in ensuring the safety improvement was completed on schedule and as committed to the CNSC.

Bruce Power modified low-pressure turbine generator stators as part of the Bruce A refurbishment project and successfully exchanged and upgraded them on Units 1 and 4 in August 2012. Six turbine generator rotors were safely moved from barges by a 600-ton crane and transported into the Bruce A station and these rotors have been utilized in planned outages in Units 2 and 3 [259] (e.g., in the 2016 A1621 outage low pressure turbines were upgraded in Unit 2). The new turbines will add 40 years of life to the generators in Units 2 and 3. As part of the move of the turbine generator stators it was noted the Safety Report Deterministic Safety Analyses does not cover moves of this magnitude and crane moves in general; neither does the Probabilistic Risk Assessment. Similarly, in 2013 a review was performed to ensure an appropriate Safety Case pertaining to Craning of primary heat transport system motors existed following action request 28373157. Finally, the Bruce B Location and Separation Design Guide, Section 6, explicitly mentions consideration of crane hazards [260].

It is unclear where postulated initiating events involving hazard analyses of this nature are documented to ensure the adequacy of protection of the NPP against internal and external hazards are registered as part of the analysis and assessments of records. Presently these safety assessments tend to be in various documents (e.g., Seismic, Pipe-whip and Fire [254] [257]) so it would be useful to provide an integrating document to confirm completeness, to ensure the hazard assessments remain current as knowledge is improved and modifications are made to the SSCs, and the integration and overlap with Deterministic Safety Analysis and Probabilistic Safety Assessments are well known. This suggestion is identified as gap SF8-6 in Table 10. The distinction between the Hazard Analysis and Deterministic Safety Analysis may become clearer with the inclusion of common mode analysis in the Appendix 11 of the Safety Report [251].

With the exception of the gaps identified above, Bruce Power programs and processes meet the requirements of this review task, and one strength was identified.

5.8. Unavailability of Safety Systems

This section addresses Section 1.2 Review Task 1f.

Bruce Power has processes in place for routine recording and evaluation of unavailability of safety systems. These include:

- CNSC Interface Management, BP-PROG-06.03 [57];
- Reporting to the CNSC, BP-PROC-00833 ([125] Section 4.2.1. sub-clause 1. b));
- Operating Manual, Impairment of Special Safety Systems and Other Safety Related Systems, NK29-OM-03500.1 [261];
- Bruce A and B Quarterly Report on Safety Performance Indicators, BP-PROC-00509 [126]; and
- Technical Operability Evaluations, BP-PROC-00014 [262].

BP-PROC-00833 defines the process for the Quarterly Operations Reports, the Quarterly Safety Performance Indicators Report and the Annual Reliability Report. Section 3.2 of the Operations and later the Safety Performance Indication Quarterly reports provides unavailability statistics

pursuant to REGDOC-3.1.1 Section 3.1. This covers S-99, Section 6.3.1 items (17)(18)(19)(20)(21)(a)(21)(b). Also, Unavailability of Safety Systems and Safety-Related Systems are reported in detail in the Annual Reliability Report.

As discussed in Section 5.2, Safety Performance Indicator 17 on Safety System Test Performance has been established to ensure the Safety Systems perform as designed. Until 2014, Section 9.0 of the Bruce A and Bruce B Quarterly Operations Reports (e.g., NK21-REP-09051.2-00058-R000 and NK29-REP-09051.2-00066) [210][211] could be reviewed to see how many missed mandatory safety system tests arose at the stations. For example in 2014-Q4 for Bruce B, 1382 Special Safety System tests were performed to confirm the availability of these systems and zero tests were missed. Tests of Standby-Related Systems and Safety-Related Process Systems showed all 254 and 355 tests were performed during the quarter [202].

In 2015 in compliance with REGDOC-3.1.1, these reports were reorganized. For Q3 of 2015, for Bruce B, all 4231 Special Safety Systems tests were completed, and 1740 Standby Safety-Related System and 500 Safety-Related Process Systems tests were conducted to confirm the availability of the Safety Systems [204]. Similar results arose for Q1 in 2015 for Bruce B where only 2 or 2727 tests were missed. The two missed tests were reported to the CNSC per REGDOC-3.1.1 Preliminary Report B-2015-28477525 ([203] page 43 of 57).

The Operating Manual, Impairment of Special Safety Systems and Other Safety Related Systems, NK29-OM-03500.1 [261] provides information so the Operator can determine the availability or unavailability of a Special Safety System and/or other important safety-related systems. These systems are often in a dormant or poised state and system failure usually has no immediate effect on plant operation. Nevertheless, when one of these systems is discovered to be outside the standard required configuration, the Operator responds to correct the impairment. The required degree of response is commensurate with the deficiency and the safety-related importance of the system ([261] Section 1.0).

Technical Operability Evaluation, BP-PROC-00014, [262], provides a uniform process for identifying and evaluating degraded station conditions when the ability of SSCs to perform their safety related functions, comes into question. A formal Technical Operability Evaluation 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). The determination may be used to provide a basis for continued operation of a reactor unit, but the primary objective of performing these evaluations are to verify operability of the SSC ([262], Section 1.0).

The Bruce A and B Annual Reliability Reports [227] [228] [263] [264] [265] are submitted to meet the CNSC annual reporting requirements. The CNSC reporting requirements, outlined in REGDOC-3.1.1, Section 2 and 3.7 (formerly S-99, Section 6.4.9) require a report on the reliability of the nuclear power plant. REGDOC-3.1.1 stipulates that systems which are determined to be “systems important to safety” are to be detailed in this report. Appendix C of that regulatory document provides details on required information to be submitted. In addition the special safety systems are included per CANDU Owners Group guidance to form the RD/GD-98 Systems Important to Safety. Bruce Power has aligned the format of this report with the CNSC Appendix C template for the Annual Reliability Report.

At Bruce B, systems important to safety met their unavailability targets except the Standby Class III Power System, Emergency Power System and Powerhouse Venting System in 2012. The CNSC requested follow-up on the latter two systems which Bruce Power provided, confirming the changes with respect to the use of generic versus station specific data would be included in the 2013 Annual Reliability report [266] [267]. The review of the 2014 Annual Reliability Report shows the modelling improvements for the Powerhouse Venting System and Emergency Power System were effective [265].

Nevertheless, when issues arise Bruce Power reviews the unavailability models, assumptions and data used in the analysis to see if they can be re-evaluated to see if more margin is available (e.g., by adjusting the testing frequencies).

The past issues with respect to unavailability of Bruce A and B systems up to the issuance of the 2014 Annual Reliability Report have been resolved with the Regulator except for an issue with respect to the Predicted Future Unavailability of three systems that are important to safety (i.e., Emergency Power System, Powerhouse Emergency Venting System, and Standby Class III System) are over the target. However, this issue continues to be addressed through the reliability program (Action Item 1214-3934) [263][266][267]. This issue was partially resolved as part of the 2013 to 2015 Annual Reliability Reports, as only the Class III System concern remains. No other action requests remain against the unavailability reports based on the submitted 2014 reports [264] [265]. (Note: the 2015 reports were submitted by May 2016 consistent with the REGDOC-3.1.1 requirements.)

Bruce Power programs and processes meet the requirements of this review task.

5.9. Radiation Doses to Workers

This section addresses Section 1.2 Review Tasks 1g and 4.

Bruce Power has a process in place for routine recording and evaluation of radiation doses to workers, including contractors. These include:

- Dosimetry and Dose Reporting, BP-RPP-00020 [44]; and
- BP-PROC-00509, Bruce A and B Quarterly Report on Safety Performance Indicators [126].

Since September 2003, Bruce Power has been producing Quarterly CNSC Performance Indicator Reports (e.g., B-REP-00531-00025 [200] and B-REP-00531-00055 [201]).

Section 8.2 of the earlier versions of these Quarterly CNSC Performance Indicator Reports provided Operational reports on the Total Station Whole Body Radiation Dose and identified the number of workers, including those with no dose [268]. The latest format of these reports complies with BP-PROC-00509, Bruce A and B Quarterly Report on Safety Performance Indicators [126], which has been revised to meet REGDOC-3.1.1 [32] Table A.1 (20a, b, c, d). Section 1.2 of these reports provides the collective radiation exposure at Bruce B, and breaks it down to show the number of workers who received a dose during the quarter. Section 2.1 identifies the Personnel Contamination Events to employees based on a tiered approach to dose received (e.g., Tier 1: > 50,000 cpm (counts per minute), Tier 2: > 5,000 cpm,

Tier 3: >= 100 cpm). Section 3.0 identifies the unplanned dose and unplanned exposures. Section 4.2 provides details on Bruce B Loose Contamination Events [201].

Until 2014, Bruce Power produced Bruce A and Bruce B Quarterly Operations Reports (e.g., NK21-REP-09051.2-00058-R000 and NK29-REP-09051.2-00066) [210][211] whose Sections 5.2 provided quarterly updates on Occupational Dose information in compliance with S-99. Sections 6.4.1 (m) and (n) provided a record to the CNSC of events or likely events where workers may receive a significant dose and provide information on whole body collective dose statistics and doses by work groups (operators, Projects and Modifications, Chemistry, various Maintenance groups) [269] [270] [271] [202] [272]. This information is now included in the Quarterly CNSC Performance Indicator Reports by REGDOC-3.1.1 and is reported as Collective Radiation Exposure to workers in Section 1.0 and Personnel Contamination Events in Section 2.0 [201][203][204].

Additionally Bruce B has an ALARA Committee which meets monthly and the Department Manager of Radiation Protection and Industrial Safety participates ([183] Section 2.0 page 27). The purpose of the Bruce B ALARA Committee is to provide oversight, approval and support to activities to maintain collective and individual radiation dose at Bruce Power to ALARA, given economic, social and other considerations. Participants include the Plant Manager, Department Manager of Outage & Maintenance Services, Section Manager of Safety Support, Emergency response team, Chemistry & Environment Manager, Plant Engineering Manager, Radiation Protection and Industrial Safety Program Manager, Maintenance Manager, ALARA Single Point of Contact, Section Manager of Radiation Protection Program, Operations Manager, Work Management Manager, Health Physicists, Project Management and Construction, Outage Manager, Section Manager of ALARA ([183] Section 2.0 General Information, page 27).

Worker dose control continues to comply with the regulatory requirements to measure and record doses received by workers. No worker or member of the public received a radiation dose in excess of the quarterly or annual regulatory dose limits or action levels established in the RP program ([195] Section 3.1.7) and its implementing procedures or during an occurrence of a situation or event reported during the last few quarters [211] such as:

- BP-RPP-00008 [175], Access Control, which outlines the requirements to access areas of the plant where high radiation fields may exist.
- BP-RPP-00015 [176], Zoning, which controls the movement of personnel, equipment and materials around the zoned areas to limit the spread of contamination.

The dose information for Bruce A and B was provided to the CNSC and collectively summarized by them in Section 2.1.7 and Appendix D which discusses Radiation Protection ([195] Section 3.1.1.7) These statistics are derived based on the information gathered by Station Health Physics to build the Quarterly Performance Indicator Reports and reported to the CNSC [204]. Bruce Power has worked aggressively to resolve the Unit 1 and 2 alpha issue discovered during the refurbishment project. As discussed in Section 7.3, Action Item 1107-2924 - BPRD-2011-AB-011 - Radiation Protection Alpha Monitoring and Control was raised by the CNSC to confirm the appropriate actions were taken by Bruce Power and Section 7.1.7 covers a FASA performed by Bruce Power.

CNSC staff did not identify any regulatory non-compliances or areas requiring improvement in 2013 in the application of ALARA. All areas for improvement identified in 2012 related to the implementation of Bruce Power's ALARA program were addressed in 2013. Bruce Power has established a five-year ALARA plan that includes numerous dose reduction initiatives. In October 2013, during the compliance inspection, CNSC staff noted the successful implementation of ALARA initiatives at Bruce A and B to reduce worker exposures ([195] Section 3.1.7).

Similar information is provided annually to the CNSC, for example, in 2014 the CNSC requested dose information as input for the Nuclear Power Plant Summary Report.

Bruce Power has effective radiation protection measures in place to protect the public and environment. Safety Factor Report 15 discusses specific improvements to the processes themselves.

Bruce Power programs and processes meet the requirements of this review task.

5.10. Off-Site Contamination and Radiation Levels

This section addresses Section 1.2 Review Tasks 1h, 3, and 4.

Bruce Power has a process in place for routine recording and evaluation of off-site contamination and radiation levels. These include:

- Reporting to CNSC – Power Reactor Operating Licences BP-PROC-00165 [56];
- Management of the Off-site Radiological Environment, BP-PROC-00076-R006 [184];
- Formal Correspondence with the CNSC, BP-PROC-00064 [124] and
- BP-PROC-00509, Bruce A and B Quarterly Report on Safety Performance Indicators [126].

Reporting to CNSC – Power Reactor Operating Licences [56], Section 4.2.2, the Reaching of an Action Level satisfies REGDOC-3.1.1, Table A.1 (21) (formerly S-99, Section 6.3.2.1) which requires the licensee to notify and report to the CNSC when the licensee becomes aware that an action level referred to in the licence for the purpose of Section 6(2) of the Radiation Protection Regulations has been reached. The Designated Representatives of the Licensee responsible for reporting when an action level has been reached are as follows:

- The Department Manager, Environment Oversight and Waste is responsible for Environmental Protection Action Levels. These action levels are listed in Section 8.3 of the LCH.
- The Department Manager, Safety Programs is responsible for Radiation Protection Action Levels. These action levels are listed in Section 9.2 of the LCH.

Once the responsible Designated Representative of the Licensee has determined a situation or event is reportable under REGDOC-3.1.1, Table A.1 (21) (S-99, Section 6.3.2.1), he or she shall:

1. Notify the designated CNSC contact within the time frame specified in the licence (7 days).

- The notification may be completed orally (by telephone) followed by e-mail, or by e-mail alone and should include all available information consistent with REGDOC-3.1.1, Table A.1 (21).
- The e-mail shall be assigned the appropriate CNSC Correspondence number(s) and shall otherwise be managed in accordance with the registered e-mail requirements provided in BP-PROC-00064 [124].

2. Ensure an investigation is conducted to determine the cause for reaching an action level in accordance with BP-PROC-00060 and associated corrective action and investigation procedures. Collectively, the investigations conducted shall obtain the information required by REGDOC-3.1.1, Table A.1 (21) for inclusion in the report.

3. Ensure an Action Level Report is filed with the CNSC designated contact(s) within 45 days of the date the Designated Representative of the Licensee determined that the action level had been reached. The Designated Representative of the Licensee shall ensure the following:

- The report shall be prepared, reviewed, processed and managed as formal correspondence in accordance with BP-PROC-00064 [124] however, due to the nature of this report, the details of the report shall be included as a signed attachment to a covering letter.
- The report shall contain the information described in REGDOC-3.1.1, Table A.1 (21).
- If the report was not prepared by the Authorized Health Physicist (AHP) for the station, then the AHP shall review the report and should also sign the report as a reviewer. AHP signature on the report is not required if the AHP's signature is included on the Correspondence Routing Sheet for the letter.

An off site REMP is in place in the vicinity of the Bruce Power site, where the Bruce Power site consists of all licensed facilities on site including: Bruce Power's Bruce A, Bruce B, Central Maintenance and Laundry Facility (CMLF), OPG's WWMF and the Canadian National Laboratories' Douglas Point. The requirements for the REMP are documented in BP-PROC-00076-R006, Management of the Off-site Radiological Environment ([184] Section 4.1.1).

The objectives of the REMP are to ([184] Section 4.1.1):

- Meet the applicable requirements for the "Radiological Human" quadrant of CSA N288.4-10 by providing data to estimate actual or potential doses to critical groups and populations from the presence of radiation fields or radioactive materials in the environment as a result of operations on the Bruce Power site.
- Provide data to confirm compliance of the facility or source with release guidelines and regulations and to provide public assurance of compliance.
- Provide a check, independent of effluent monitoring, on the effectiveness of containment and effluent control.
- Maintain a database to facilitate the detection of trends.
- Verify or refine the predictions of environmental models.

- Determine the fate of released radioactive materials to show whether any significant pathway to man has been overlooked.

The REMP is interconnected to other programs through the public radiation safety program ([184] Section 4.1.2.1). The public radiation safety program consists of four components:

1. Source Control Program.
2. Effluent Control Program.
3. Effluent Monitoring Program.
4. Environmental Monitoring Program.

The public radiation safety program exists to ensure that public health and the environment are adequately protected and that public radiation dose limits are not exceeded. Through implementation of the subprograms, sources of radioactivity are identified, emissions are monitored and controlled and radiological emissions are eliminated or minimized to levels as low as reasonably achievable, social and economic factors taken into account. Operating the REMP (which is part of the Environmental Monitoring Program) provides assurance the other components of the public radiation safety program are being maintained adequately ([184] Section 4.1.2.1).

Up until 2014 Bruce Power produced Bruce A and Bruce B Quarterly Operations Reports (e.g., NK21-REP-09051.2-00058-R000 [210] and NK29-REP-09051.2-00066 [211]) whose Section 4.0 provided quarterly updates on airborne contamination (tritium and particulate), loose surface contamination, and alpha and waterborne emissions. Subsequently, in compliance with REGDOC-3.1.1 Quarterly Performance Indicators 5 from Section 5.2 on Environmental Releases – Radiological provide information on compliance trends and PI 6 provides non-radiological Environmental Releases – Spills [203] [204].

Trend Analysis is reviewed against the past quarters. Adverse trends are reported through the SCR process as described in Section 4.6.

As reported in the CNSC Staff's Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014 ([195] Section 3.1.7)., from a radiological hazard control perspective there were no action level exceedances with respect to radiological hazards at either Bruce A or Bruce B in 2014, including surface contamination at Bruce A. In the 2014 report [195], CNSC staff confirmed that Bruce Power complies with the requirements for radiological hazard control.

From an estimated dose to public perspective the reported dose to a member of the public from the Bruce site (which includes Bruce A, Bruce B, Central Maintenance and Laundry Facility, Western Waste Management Facility, and the decommissioned Douglas Point reactor) was 0.002 mSv, well below the annual regulatory public dose limit (for a member of the public) of 1 mSv ([195] Section 3.1.1.7).

Bruce Power has effective measures in place to protect the public and environment. Bruce Power programs and processes meet the requirements of this review task.

5.11. Discharges of Radioactive Effluents

This section addresses Section 1.2 Review Tasks 1i and 4.

Bruce Power has a process in place for routine recording and evaluation of discharges of radioactive effluents. These include:

- Environmental Safety Management Program, BP-PROG-00.02 [78];
- Reporting to CNSC – Power Reactor Operating Licences, BP-PROC-00165 [56]; and
- BP-PROC-00509, Bruce A and B Quarterly Report on Safety Performance Indicators [126].

The Environmental Safety Management Program, BP-PROG-00.02, Section 4.7.1 and Appendix C, identifies supporting processes covering emissions management.

BP-PROC-00080 [92], Effluent Monitoring Program expands on the basic regulatory requirements and provides specific details on the airborne and liquid effluents monitoring program under normal and abnormal operating conditions and is implemented via Radiological Emissions Monitoring, BP-PROC-00171 [47].

The effluent monitoring program provides assurance on ([92] Section 4.3):

- Effectiveness of effluent control
- Data to assist in refining environmental models used to assess risk
- Meeting stakeholder commitment (N288.5-11, Section 4.0).

As part of the criteria for establishing an Effluent Monitoring Program, the Stations measure, or where measuring is not feasible, estimate the concentration or other characteristic of a nuclear or hazardous substance in an effluent where the substance or characteristic is required to demonstrate compliance, is identified as a potential concern in an Environmental Risk Assessment (CSA N288.6-12 [41]), provides an opportunity to identify unforeseen plant conditions requiring corrective actions, or supports dose/exposure assessment (CSA N288.5-11 [40], Section 5.0) ([92] Section 4.4). Effluent data are reviewed to ensure compliance and evaluated (may be graphical and/or statistical) to detect trends ([92] Section 4.6).

Objectives are developed per BP-PROC-00094 [93], Environmental Objectives, Targets, and Management Plans ([92] Section 4.3) and these are trended and where adverse trends in performance exist, they are evaluated as per the Corrective Action processes and procedures ([93] Section 4.1 item 2).

Radionuclide Effluent Monitoring System Requirements, B-ST-03480-10000 [273] provides more details on the system requirements.

Although the Environmental Performance Index Indicator BP-PROC-00793 [94] uses lagging performance indicators (for tracking spills to the environment, regulatory infractions, water and air emissions), the intent is to gauge compliance to legal and other requirements and to help set the appropriate objectives and targets for continual improvement in keeping with ISO 14001 requirements ([94] Section 1.0). Examples of the water emission indicators are: Derived

Release Level and Action Level exceedance and Active Liquid Waste loading on the supply tank ([94] Section 4.3 and 4.3.3, and [47] Section 4.7.1). Similarly, Air Emission exceedances are tracked ([94] Section 4.4).

From a review of the last few years of Quarterly Field Inspections: emissions were low and well below regulatory limits. Environmental monitoring equipment was observed to have no indications of impairments to functionality (see Section 7.3.2).

Up until 2014 Bruce Power produced Bruce A and Bruce B Quarterly Operations Reports (e.g., NK21-REP-09051.2-00058-R000 and NK29-REP-09051.2-00066) whose Section 4.0 provided quarterly updates on Environmental Monitoring of Airborne (Gaseous) and Waterborne (Aqueous) Radiological Emissions [269] [270] [271] [202] in compliance with S-99 Section 6.4.1 (i). Subsequently, in compliance with REGDOC-3.1.1 Quarterly Performance Indicator 5 from Section 5.2 on Environmental Releases – Radiological provides information on compliance trends and PI 6 provides non-radiological Environmental Releases – Spills [203] [204].

Bruce Power updated its DRLs and action levels in accordance with CSA N288.1-08 [37], Guidelines for calculating DRLs for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities. The new DRLs were reviewed and accepted by CNSC staff in May 2013. In January 2014, the Commission approved and issued amended operating licences to Bruce Power with the updated DRLs ([274] Section 3.1.9). Subsequently CSA N288.1-14 was issued [37], so as is the standard practice Bruce Power is working with Industry Partners to determine how these changes impact airborne and effluent chronic environmental release reporting and performance (SFR 14 Section 5.5).

Groundwater monitoring at the Bruce site indicated no adverse impact on the groundwater environment due to radiological operations ([195] Section 3.1.1.9).

Bruce Power continued to make satisfactory progress with respect to limiting releases based on the activity at the site, i.e., hydrazine releases into the environment. The Ministry of the Environment and Climate Change (MOECC) reviewed the 2013 discharges at the Bruce Site and reported concentrations of hydrazine were below levels of concern for aquatic life. The MOECC had no environmental concerns ([195] Section 3.1.1.9).

Bruce Power has implemented and maintained an environmental monitoring program that meets applicable regulatory requirements. Based on the review of the licensee's reports, CNSC staff concluded that the radiological releases from Bruce A and B remained below their regulatory limits and action levels. (Also see Section 7.3.1 under Environmental Monitoring Program [191].) Bruce Power provides an annual Environmental Monitoring Program update [191] [192] [193] describing its effluent monitoring program related to Operations in compliance with PROL Condition 1.7.

Bruce Power programs and processes meet the requirements of this review task.

5.12. Generation of Radioactive Waste

This section addresses Section 1.2 Review Tasks 1j and 5.

Bruce Power has a process in place for routine recording and evaluation of solid wastes. These include:

- Environmental Safety Management, BP-PROG-00.02 [78];
- Segregation and Handling of Radioactive Waste, BP-RPP-00010 [43];
- Low Level Radioactive Waste Minimization, BP-PROC-00714 [177];
- Radioactive Waste Management, BP-PROC-00878 [178].

The Environmental Safety Management Program, BP-PROG-00.02, Section 4.7.4 and Appendix C, identifies supporting processes covering Waste Management.

Data on the generation of radioactive waste are reviewed to determine whether operation of the plant is being optimized to minimize the quantities of waste being generated and accumulated, taking into account the national policy[11] on radioactive discharges and international treaties, standards and criteria. CNSC staff concluded that the waste management Safety Control Area at Bruce B met performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, improved from the 2013 rating of satisfactory. Bruce Power's nuclear waste management program sets requirements for the minimization, segregation and handling, assessment of hazard levels, monitoring and processing of radioactive waste. During 2013 and 2014, radioactive waste was disposed of properly in accordance with regulations and Bruce Power's operating procedures. Waste management practices were in compliance with the requirements for management and control of radioactive waste in 2013 and 2014. A compliance inspection of hazardous waste management on Bruce A and B was conducted in September 2013. Results of the CNSC Type II inspection indicated that Bruce Power's hazardous waste management program met CNSC requirements ([189] Section 3.11.1) in 2013 and met or exceeded performance objectives and applicable regulatory requirements in 2014 ([195] Section 3.1.1.11).

Up until the 4th quarter of 2014, Quarterly Operations Report Section 5.3.4 reports on Radioactive Wastes and Shipments while Fuel is covered in Section 5.3.1 of the quarterly reports [270] [271] [202] [211]. With the introduction of REGDOC-3.1.1, low and Intermediate Level Radioactive Solid Waste Generation statistics are reviewed and trended as part of the Performance Indicators submitted to the CNSC as discussed in Section 5.1. These are typically reported in Section 25.0 of the Bruce A and B Quarterly Reports on Safety Performance Indicator [203][204].

During the CNSC Quarterly Field Inspections reviews, the CNSC staff routinely review Waste Minimization – Radioactive Waste Control since it is a Safety and Control Area. The results are often recorded in these reports (e.g., Section 4.10 of the inspection report attached to NK29-CORR-00531-12715). Examples of CNSC letters where Waste Minimization was reviewed is provided in Section 7.3.2 (Table 9). These show Bruce Power met the waste minimization requirements.

[11] There is no overall national policy on waste, because wastes typically fall under provincial jurisdiction. However, NRCan issued a "radioactive waste policy framework" in 1996 (http://www.llrwmo.org/wp-content/uploads/Policy_Framework.pdf).

Final processing and storage of solid radioactive waste is performed by Ontario Power Generation's Western Waste Management Facility located on the Bruce Nuclear Power Development Site. Wastes are packaged and delivered according to agreed waste acceptance criteria.

Bruce Power programs and processes meet the requirements of this review task.

5.13. Compliance with Regulatory Requirements and Guidance Documents

This section addresses Section 1.2 Review Task 1k.

Bruce Power has processes in place for routine recording and evaluation of compliance with Regulatory Requirements. These include:

- Reporting to CNSC – Power Reactor Operating Licences, BP-PROC-00165 [56]; and
- Power Reactor Operating Licence Amendment or Renewal, BP-PROC-00114 [122].

The CNSC staff performs Regulatory Compliance and Field Inspections as discussed in Sections 7.3.1 and 7.3.2 to confirm Bruce Power meets Regulatory Requirements. Routinely Section 4.1 in the Type II Compliance Inspection Reports covers Regulatory Requirements and documents whether Bruce Power activities comply with them (e.g., [275] [276]). Similarly in Field Inspections multiple SCAs are reviewed and the standard template for these reports contains the following statement in Section 1.0 of these inspection reports: The inspections routinely assessed compliance with regulatory requirements listed under each inspection topic in section 4 of the inspection report and documents the level of compliance in each quarterly report as summarized in Table 9.

The CNSC reviews Bruce Power's compliance with the Licence as part of the Licence Renewal process as discussed in Section 5.1. These CNSC staff inspections and reviews have not identified significant regulatory issues or non-compliances based on the reporting requirements.

The following observations support the conclusion of safe operation ([195] Executive Summary Overall performance highlights):

- there were no serious process failures at the NPPs
- no member of the public received a radiation dose that exceeded the regulatory limit
- no worker at any NPP received a radiation dose that exceeded the regulatory limits
- the frequency and severity of non-radiological injuries to workers were minimal
- no radiological releases to the environment from the stations exceeded the regulatory limits
- licensees complied with their licence conditions concerning Canada's international obligations.

When amending or renewing the PROL, Regulatory Affairs staff consult with CNSC staff regarding their expectations related to implementation of existing and new requirements

including, regulations, licence conditions, codes, standards and Regulatory Documents coming into force in the forthcoming licensing period [122], and:

- Determine CNSC staff expectations regarding implementation requirements and the extent of transitional arrangements that need to be included within the licence renewal applications.
- Consult with internal stakeholders regarding the stated CNSC staff expectations and ensure any positions ultimately taken have senior management endorsement, including acceptance of any impacts on the five year business plan and provision of the resources necessary to implement the changes.
- In consideration that forward looking transition plans may be subject to change, ensure that any positions established (that will be included in the licence application) include sufficient flexibility to facilitate future changes if necessary.

The Integrated Safety Review and Systematic Review of Safety performed for: the return to service of Bruce A Units 3 and 4 [7]; the Life extension of Units 1 and 2 [9][10][277]; proposed refurbishments of Units 3 and 4 [12] [13] [14]; and the more recent Safety Basis Report and Periodic Safety Review for Units 1-8 [6] are tools which can be used to confirm the extent of Regulatory Requirement Compliance and to assist in ensuring the CNSC and Bruce Power are in agreement on new or amended requirements.

The Bruce A 2013 Environmental Compliance Approval (Water) Compliance Report for Bruce A [278] provides explanations for the exceptions taken including whether limits are exceeded, non-compliances arise and provides the annual reporting information required to ensure Environmental Compliance Approvals. No environmental penalties were issued.

The reported dose to a member of the public from the Bruce site (which includes Bruce A, Bruce B, Central Maintenance and Laundry Facility, OPG's Western Waste Management Facility, and the decommissioned Douglas Point reactor owned via the Canadian National Laboratories) was 0.0013, 0.0020, and 0.00278 mSv, for 2013, 2014 and 2015, respectively, well below the public dose regulatory limit (for a member of the public) of 1 mSv ([195] Section 3.1.1.7) [191][192][193].

Bruce Power's Radiation Protection program performance satisfies the requirements of the Radiation Protection Regulations and includes performance indicators to monitor RP program performance. The RP program documents and supporting procedures are maintained current, taking into consideration operating experience and industry best practices. In 2013, there were no regulatory findings in this area. The oversight applied in implementing and continuously improving this program has been effective in protecting workers ([195] Section 3.1.1.7).

Bruce Power proactively and effectively conducted ISRs and PSRs against the IAEA Safety Guide NS-G-2.10 [279] and SSG-25 [73] and has developed procedures defining how to conduct the Periodic Safety Reviews (BP-PROC-01024 [4]) and the process of following REGDOC-2.3.3 (which is consistent with SSG-25) has been established with the Regulator. Bruce Power has been progressively updating its regulatory documentation through updates of the implementing procedures of BP-PROG-06.03 and ensuring it has the processes and documentation in place to show it is meeting Regulatory Requirements in anticipation of the new Regulatory Requirements in the PROL.

Bruce Power and the CNSC recognize a PSR is a systematic way to review of the processes in determining the design, condition, and operation of a nuclear power plant are managed in an effective way to obtain an overall view of the plant safety and to determine reasonable and practical modifications to ensure continued safe operation.

Recent beyond design basis improvements have been introduced as part of Bruce Power's response to the Fukushima event. From an integrated Licensing Basis, Design Basis and Safety perspective, no Canadian Design Basis and Configuration Management regulatory document exists and no CSA Standard has been written (the CANDU Owners Group had compiled a document on Design Basis and Recommended Principles for Managing it (COG-11-9024) ([6] Section B.5), but it is not used in the Bruce Power governance). The Bruce Power Plant Design Basis Management Program, BP-PROG-10.01 [66], references among its external standards, ANSI/NIRMA CM 1.0-2000, Configuration Management of Nuclear Facilities [79] and IAEA-TECDOC-1335, Configuration Management in Nuclear Power Plants, January 2003 [75] which touch upon Design Basis and its integration with the Licensing Basis and Safety. Design Basis and Configuration Management standards strive to ensure licensing requirements, design requirements and the as-built physical plant and operation of the plant are consistent. CNSC REGDOC-2.5.2, Design of Reactor Facilities: Nuclear Power Plants, which sets out the CNSC's requirements and guidance for the design of new water-cooled NPPs, is a design regulatory document with limited discussion on Design Basis.

It would assist staff in future modifications and licensing assessments if design documentation clearly explains the relationship and impact of the licensing-driven changes on the design basis, safety analyses and assessments. Although a review was done against WANO SOER 2013-2 ([280] Enclosure 1, Section 2.0, footnote 3), it is unclear how the Design Basis Assumptions were reviewed and updated in the design documentation. The review shows what changes were made from a detailed design and operational perspective, but does not identify how the design guides or design requirements were changed, particularly the guides covering the nuclear safety philosophy. For example, this would help ensure that the Safety Design Guides [260] and Design Requirements/Manuals are systematically revised to incorporate the Fukushima type design changes. Deviations from the Design Guides and changes were provided to the Regulator who raised an Action Item if they did not agree with the rationale [281]. This gap has been identified as SF8-6 in Table 10.

Bruce Power programs and processes meet the requirements of this review task, noting improvements have been suggested.

5.14. Overall Safety Performance

In addition to the aforementioned processes, Bruce Power has other processes and the companion methodology to evaluate and assess operating experience to ensure safe performance. These include means to integrate the Station condition as multiple degraded conditions may be arising simultaneously and there needs to be a method to prioritize which issue is dealt with first. These processes are discussed in the following three subsections on: Safety Performance Integration; Prioritization of Safety Issues; and Safety Performance Communication.

5.14.1. Safety Performance Integration

Bruce Power has processes in place for routine recording and evaluation of the integration of safety performance. These include:

- Plant Operational Review Committee (PORC), BP-PROC-00136 [167];
- Station Plant Health Committee, BP-PROC-00559 [155]; and
- Nuclear Safety Review Board ([179] Section 7.2).

The aforementioned committees and boards are over and above the separate diverse and continuous day-to-day Operational responses to plant conditions from the line organizations. These integrated practices are focused on reinforcing the Nuclear Safety Culture and Training practices taught to all employees. They ensure management awareness, communication and direction on items as: Response to Transients; Abnormal Incidents Manual; Conservative Unit Operating Modes – Safety Related System Impairments Manual; Operating Memos; Operational Decision Making; Emergency Response; Environmental Protection; Spill Response; Handling Potentially Rabid or Contaminated Wildlife; Severe Weather Response; High Risk Evolutions; and Technical Operation Evaluations and the companion Training documents that educate Operators about these processes are re-iterated when abnormal and upset situations arise. These committees and boards report back to the respective Bruce Power managers responsible for the committees and boards as outlined in the respective procedures to ensure open, independent communication.

The PORC was established to ensure a high level multidisciplinary oversight, and conducts reviews of issues that have the potential to impact on reactor safety. These reviews provide assurance these issues are being addressed in a timely and safe manner. These reviews may include:

- Plant transients or equipment problems and decisions associated with these problems.
- External OPEX events to ensure appropriate compensatory actions have been implemented as necessary.
- Proposed pro-active plans for future or anticipated events (such as outage maintenance or adverse system health events).
- Proposed Operations/Maintenance/Engineering activities.

The PORC consistently supports the basis of conservative decision making as outlined in the Bruce Power Nuclear Safety Policy, the Bruce Power Policy on Conduct of Operations and the Procedure on Conservative Decision Making. The PORC serves as a forum for challenging the safety culture of the organization and fosters open constructive criticism in the spirit of continuous improvement. Due to the senior diverse makeup of the PORC, the group can consider the integrated aspect of issues.

The Bruce A and B SPHCs are an effective management tool enabling the station leadership team to make informed and timely decisions in support of equipment reliability that results in safe and reliable plant operation. The procedure [155] takes authority from BP-PROC-00782

[154], Problem Identification and Resolution, and BP-PROG-11.01, Equipment Reliability [51]. The SPHC:

- Provides management oversight regarding the status of Equipment Reliability issues that challenge safe and efficient plant operation;
- identifies additional issues that require increased management attention needed to improve plant performance, ensuring these items are tracked to completion (repeat failures, rework, corrective actions, bridging strategies);
- ensures the proper prioritization, ownership, organizational alignment, resources and accountability are in place to resolve station issues affecting system/component performance;
- proactively look forward to known issues that can impact the ER Index and ensures the proper prioritization, ownership, organizational alignment, resources and accountability are in place to mitigate the effects;
- reports out on status of SPHC-endorsed work orders at each meeting; and
- acts as the primary filter for investment proposals that affect the station, ensuring that capital projects align with key station priorities, risks and strategic direction.

The Nuclear Safety Review Board has the responsibility for considering and advising the Board of Directors on the extent that affairs are conducted in a manner that promotes reactor, radiological, industrial and environmental safety and for continuing to emphasize the long-term effort required to improve safety culture permanently, including changing management behaviours and demonstrating leadership. Items include advising on the extent that plant operations are within the PROL and Safety Analysis and the effectiveness of reactor, radiological, industrial and environmental safety practices.

5.14.2. Prioritization of Safety Issues

This section provides further information to address Section 1.2 Review Task 3.

Bruce Power has processes in place for routine recording and evaluation of the risk associated with safety issues and the prioritization of those risks. The specific processes involved are extensive, and only a subset is presented in this section to show the extent of the involvement of various groups. Some processes include:

- Business Risk Management, Risk Management – Business Risk Register Bruce Power Procedure BP-PROC-00162 [105];
- Safety Related System List, BP-PROC-00169 [182];
- Systems Important to Safety (SIS) Decision Methodology, DPT-RS-00012 [137];
- Preparation and Maintenance of Operational Safety Requirements, DPT-NSAS-00012 [184];
- Integrated Aging Management for Safety Assessment, DPT-NSAS-00016 [136];

- Station Plant Health Committee, BP-PROC-00559 [155];
- Aggregate Risk Assessment and Monitoring, BP-PROC-00849 [158];
- Scoping and Identification of Critical SSCs, BP-PROC-00778 [147];
- Long Term Planning & Life Cycle Management, BP-PROC-00783 [156];
- Trend Identification and Reporting of SCRs, BP-PROC-00412 [115];
- Risk-Informed Decision Making, B-REP-03611-00004 [282];
- On-line Work Management Process, BP-PROC-00329 [160];
- Operational Decision Making, GRP-OPS-00030, [283];
- Engineering Evaluations, DIV-ENG-00004 [284]; and
- Observation and Coaching, BP-PROC-00271 [98].

The overall Risk process is defined in Business Risk Management – Business Risk Register, BP-PROC-00162 [105], which provides necessary guidance and tools to:

- Identify threats and opportunities,
- Reinforce the management of risk is one of the primary accountabilities,
- Maintain a comprehensive and up-to-date register (i.e., Risk Register) of threats and opportunities,
- Monitor the effectiveness of risk mitigating and optimizing activities, including ensuring that actions are developed and executed in a timely fashion and that risks are managed to an acceptable level, and
- Facilitate the Executive Team's review of risks and quarterly reporting of top risks to the Board of Directors.

Risk owners assess the impact of the risk by multiplying the probability of occurrence by its impact (Probability x Impact = Net Impact). In addition to ranking the risks based on their Net Impact, risk owners develop action plans that "mitigate the threat to an acceptable level of exposure".

The Risk Status Rating used in this process includes four levels:

- Green, which indicates that either the risk has been reviewed and accepted and no response plan is required or that the risk response plan is complete;
- White, which indicates that the response plan is defined and approved;
- Yellow, which indicates that the response plan is defined and is being implemented However, an improvement is needed to maintain the course; and
- Red, which indicates that either the threat has materialized or that the response plan is not effective.

Guidance is provided for risk identification and includes sources such as asset life cycle management, system and component health assessments, and SCRs.

The following procedures, referenced in BP-PROC-00162 [105], are in place to ensure that staff are cognizant of the Safety-Related Systems, the Risk Importance of those Systems, what Operational Limits are important to Safety and how the Operators need to maintain the reactor systems to stay within the Safe Operating Envelope from a safety analysis perspective and finally how the safety analysis and assessments use information on ageing of key SSCs:

- Safety Related System List, BP-PROC-00169 [182];
- Systems Important to Safety (SIS) Decision Methodology, DPT-RS-00012 [137];
- Margin Management (Design and Operating Margins), BP-PROC-00786 [89]; and
- Safety Performance Metric and Monitoring, BP-PROC-00651 [96].

Reactor Safety Management leadership attends the SPHC meetings to reinforce Nuclear Safety's position and to provide greater understanding of the requirements. The proper prioritization, ownership, organizational alignment, resources and accountability are put in place to resolve station issues affecting system/component performance ensuring compliance with the four pillars of Nuclear Safety.

Under the Equipment Reliability Program [51] as described in Safety Factor Report 2, Condition Assessment of Generating Units in Support of Life Extension, BP-PROC-00498 [144], evaluates the physical condition, functionality of, and remaining service life of SSCs. The assessment leads to two determinations:

- First, are there any SSCs which are not practical to replace that would prevent a life extension project from being undertaken. (An example might be vault concrete deterioration.)
- Second, which structures, systems and components are recommended for replacement or repair during a contemplated refurbishment outage and the identification of the repairs which may be made during future outages.

Station Engineering then follows its procedures such as BP-PROC-00778, Scoping and Identification of Critical SSCs [147]; BP-PROC-00849, Aggregate Risk Assessment and Monitoring [158]; and BP-PROC-00783, Long Term Planning & Life Cycle Management [156] to implement the equipment improvements.

The On-Line Work Management Process, BP-PROC-00329 [160], defines a graded approach to scheduling to identifying, categorizing, scheduling and monitoring work activities within the target work week that are timing sensitive (i.e., due to reactor safety, logic or work performance issues) and those that do not. Graded scheduling allows for the monitoring consistent with the risk priority of the work. ([160] Section 1.0, 4.5.1 and Appendix G)

Operational Decision Making, GRP-OPS-00030 [283], provides a structured approach for making operational decisions to support safe, reliable plant operation. The focus is on the response to degraded/degrading equipment or plant conditions that are inside OP&P limits and are not clearly defined by procedures. These are situations typically involving reductions in

safety margins that evolve over days or weeks. Although immediate action is not required, the condition represents a potential threat to continued safe, reliable plant operation. Some issues may be manageable in the short term, but further deterioration may force the Unit into an undesirable state, such as an unexpected transient or unplanned shutdown. Monitoring, Control, Conservatism, Teamwork, and Knowledge are considered through the decision making process consistent with Operator Fundamentals. ([283] Sections 1.0, 4.1 and 4.2).

Engineering Evaluation, DIV-ENG-00004 [284], describes the process followed by Engineering Division staff when responding to degraded equipment or plant conditions; to ensure that adequate risk evaluation is given during the analysis prior to making any such decisions/advice. Such responses that impact on plant equipment need to be carefully considered using appropriate Fundamental Human Performance tools (self checking, questioning attitude, technical task pre-job briefing, validating assumptions and signature). Use of this procedure helps reinforce a culture where Engineering performs thorough, rigorous evaluations (commensurate with risk) as an input to the Operational Decision Making process and decisions in general.

Finally, staff, including contractors and consultants, are encouraged to identify when adverse conditions arise and report these in SCRs. Many have the knowledge to identify trends based on their experience and can utilize the Trend Identification and Reporting of SCRs [115] process. Managers ensure a continuing awareness of the importance of safety and risk mitigation through the various Human Performance improvement procedures, including the Observation and Coaching [98] process.

The Risk Informed Decision Making (RIDM) process ([133] Section 4.3.2) is applied when assessing potential gaps against modern codes and standards. The RIDM process determines the increase to risk of plant operation (i.e., Δ risk) from design, operational, or programmatic issues, assesses the significance of that Δ risk, and provides guidance on the course of action and overall level of resource expenditure that would be commensurate with mitigation of the change (Δ) in risk. Where risk control is considered necessary, or prudent, the RIDM process then guides determination of the decrease in risk achievable through specific design, operational, or programmatic change(s) identified as options to address the issue, assesses the significance of that decrease in risk, and provides guidance on the practicability (i.e., benefit commensurate with resource expenditure) of the risk reduction options as a function of the Δ risk of the issue. Options determined to be practicable are then considered for implementation following application of Bruce Power's existing procedures for business risk management.

Older plants are licensed to standards at the time of construction to achieve an acceptable level of safety. Modern codes and standards are introduced by the regulator over time to improve upon that level of safety. Therefore, while gaps arise against more recent and modern standards due to the evolving benchmarks, the level of safety provided by the older codes and standards is still considered to be fully acceptable. However, the gaps are examined with the RIDM process to determine whether there are practicable design, operational, or programmatic changes which can be instituted to close or reduce the gaps. The first consideration is the Δ risk inherent in the gap between the modern standard and the current licence requirement. If that Δ risk is sufficiently low, and/or changes to provide a meaningful reduction in the gap are determined to be impracticable, the process should be halted and documented at this stage. However, if the assessment is that risk control should be examined, the next consideration is

the Δ risk inherent in the gap between the modern standard and the current measure (as opposed to the current licence requirement). The need to examine risk control measures are then based on the actual level of Δ risk and the practicability of making design changes to provide a meaningful reduction in the actual gap.

As a follow-up to the audit under Action Item 2014-07-4687 - BRPD-AB-2014-002 - Condition Assessment Inspection in Section 7.3.1, BP-PROC-00498 [144] Bruce Power was reviewing this procedure for continuing applicability given the revised Ageing Management governance that Bruce Power was implementing. Bruce Power stated it is to be revised, superseded or cancelled and the process requirements defined in BP-PROC-00166 [285] is to be applied to the resulting product. Afterwards CNSC staff noted some continuing deficiencies with this condition assessment procedure, BP-PROC-00498 [144]. Bruce Power reaffirmed this procedure is to be incorporated into the aging management suite of procedures under the Equipment Reliability Program, BP-PROG-11.01 [51] and the items identified during the inspection will be considered during these revisions [286][234]. This is identified as gap SF8-2 in Table 10.

5.14.3. Safety Performance Communication

In addition to the Integration and Prioritization processes, Bruce Power reviews the day-to-day safety performance with staff via daily, weekly, monthly and annual communications updates such as: Managers Review Meetings, local Visual Management Boards [120], Our Week in Review, Outage Status Updates, and the Chief Nuclear Operator Safety Reminders, the Monthly Safety Review Meetings and Continuous Training. These cover the four pillars of nuclear safety and inform staff on the performance of the stations. Each day the Managers Review Meetings reinforce items on such topics as Achieving High Equipment Reliability, the Plant Operational Focus, First Indications of Degrading Performance, Conservative Decisions Making and Nuclear Safety. The terms of reference and time table of the most significant regular meetings are provided in the Advanced Information Package for the OSART (Reference [183] page 26 to 30).

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 4.2, addresses the plant design basis management program to maintain the design basis and ensure the plant can operate safely for the full duration of the operating life of the plant.
- “Safety Factor 2: Actual condition of SSCs” in Section 4.0, addresses the plant design basis and equipment reliability programs. In Section 5.10, Safety Factor 2 also addresses the progress on maintenance backlogs and in Section 5.1, discusses SSCs important to safety and their classification.

- "Safety Factor 4: Ageing" provides further information on the Ageing processes which are discussed briefly in Sections 5.4, 5.6, 5.7, and 5.14.2 of this SFR.
- "Safety Factor 5: "Deterministic Safety Analysis" in Appendix A, includes a high-level review of CSA N288.2-14.
- "Safety Factor 6: "Probabilistic Safety Analysis" in Section 5.5.1, addresses risk-based safety goals used by Bruce Power in the PRA to assess the acceptability of risk and the Probabilistic Safety Assessment work produces the Annual Reliability Reports discussed in this Section 5.4 under Safety Related Operational Data.
- "Safety Factor 7: Hazards Analysis" in Section 5.1.1, addresses resulting CNSC Action Items from the Fukushima event.
- "Safety Factor 9: External OPEX and R&D" in Section 5.3, addresses the use of other plants' operating experience and research findings external to the station, including elements of event investigations and the Corrective Action Program not addressed in the current report.
- "Safety Factor 11: "Procedures" in Appendix B.2, includes a clause-by-clause review of Bruce Power's compliance with the Industry Standard CSA N292.3, Management of Low- and Intermediate-Level Radioactive Waste.
- "Safety Factor 12: The Human Factor" in Sections 5.2 and 5.3, records the review the Bruce Power programs for worker qualification and training in terms of adequacy.
- "Safety Factor 14: Radiological Impact on the Environment" in Appendix A, reviews Bruce Power's compliance with CNSC Regulatory Guide G-228 2001 [26] and Bruce Powers implementation of industry standards regarding effluent monitoring programs and environmental risk assessments, as well as specific CSA N288 series N288.1-14, N288.3.4-13, N288.4-10, N288.5-10, N288.6-12 and CSA N288.7-15 standards.
- "Safety Factor 15: Radiation Protection" in Appendix B.1, has assessed the state of Bruce Power's Radiation Protection Program guidance against applicable Regulatory guidance CNSC G-129 Rev 1 (2004/10) [25]. In Appendix B, it includes a clause-by-clause review of the Industry Guideline WANO GL 2004-01 (2004) [83].

7. Program Assessments and Adequacy of Implementation

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

- Self-Assessments;
- Internal and External Audits and Reviews;
- Regulatory Evaluations; and

- Performance Indicators.

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

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

Taken as a whole, these methods 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.

7.1.1. General Self-Assessments

General assessments of performance improvement were conducted by the Performance Improvement (PI) department following the Operating Experience Program, BP-PROG-01.06 [107] processes. These include:

- SA-PI-2015-09, NORA Assessments, Performance Improvement
- SA-PI-2015-04, BP-PROC-00506 Actions MFIX, Performance Improvement
- SA-PI-2015-03, BP-PROC-00059 Rapid Learning, Performance Improvement
- SA-PI-2015-02, Corrective Action Program Effectiveness as related to Pressure Boundary, Performance Improvement
- SA-PI-2015-01, Effectiveness of OPEX Implementation, Performance Improvement
- SA-PI-2014-04, Effectiveness of FASA Process Improvements, Performance Improvement.
- SA-PI-2013-06, FASA Program Effectiveness, Performance Improvement.

These assessments are relevant as they examined the state of the Focus Area Self-Assessment (FASA) process to confirm the oversight enhancements and initiatives to increase awareness of the FASA process and revisions to the procedure have been effective and embedded into the procedures for each program. An Annual Self Evaluation Plan worksheet tracks FASA completion requirements. To improve the independent oversight and effectiveness of FASAs the Nuclear Oversight and Regulatory Affairs organization developed quarterly nuclear oversight reports and the Focus Area Self-Assessment Status and Summary Reports (see Section 7.1.11). Past FASA actions are reviewed in the quarterly reports to ensure they are completed. The improved effectiveness of FASAs was confirmed in SA-PI-2014-04, Effectiveness of FASA Process Improvements.

The FASAs show Bruce Power continues to improve the Performance Improvement process and procedures in general however, one area of repeat findings is the repeat findings within the pressure boundary findings where repeat events have arisen (SA-PI-2015-02). Improvements in Oversight, Engagement and Processes have been recommended. Similarly Effectiveness Reviews (SA-PI-2015-04) discuss the need to improve effectiveness reviews at each Station. Since then the quality of Effectiveness Reviews has improved as has the fidelity of the information (SA-PI-2015-02 Conclusions) but more improvement is needed so management does not have to return them to rework them. Safety Factor Report 9 (Bruce A [17] Bruce B [5]) addresses the OPEX related FASAs in greater detail.

The biggest improvement is the effectiveness of NORA issue escalation processes (SA-PI-2015-09) to ensure management is aware of trends. FASA Metrics are reviewed by NORA on a regular basis with monthly FASA completions versus plan recorded along with the actions generated. Deferrals and cancellations are included in the reviews. These are discussed with the line organizations as discussed in BP-PROC-00137, Focus Area Self-Assessment [109].

7.1.2. Equipment Reliability Program Self-Assessments

The following FASAs are relevant to Equipment Reliability:

- SA-ERI-2015-17, Station Engineering Setting and Reinforcing Standards, Equipment Reliability;

- SA-ERI-2015-13, Evaluating Pipe Support Inspection Scope and Resourcing, Equipment Reliability;
- SA-ERI-2015-11, System Performance Monitoring Plan Effectiveness, Equipment Reliability;
- SA-ERI-2015-09, Rapid Response Engineering Trending Indicators, Equipment Reliability;
- SA-ERI-2015-08, Inspection Service Department's Governance Review, Equipment Reliability;
- SA-ERI-2015-07, Engineering Mentoring Benchmarking, Engineering;
- SA-ERI-2015-03, Asset Management Program Assessment, Equipment Reliability;
- SA-ERI-2015-02, Use of Condition Based Maintenance for Scheduling Decisions, Equipment Reliability;
- SA-ERI-2015-01, Review of Criticality Categorization Basis Information Quality and Clarity, Equipment Reliability;
- SA-ERI-2013-02, Effectiveness of Engineering Programs, Equipment Reliability;
- SA-ERI-2013-03, System and Component Performance Monitoring Program Compliance, Equipment Reliability;
- SA-ERI-2013-04, Equipment Reliability;
- SA-ERI-2013-05, Equipment Reliability Performance Review Meeting, Station Engineering;
- SA-ERI-2013-08, Effectiveness of ERCOE Implementation in Reducing Equipment Failures, Equipment Reliability;
- SA-ERI-2013-09, Ensure FH Software Documents Verified and Approved, Plant Engineering;
- SA-COM-2013-10, Critical Systems (SG, EPG, and QPS) – Maintenance Readiness, Procurement & EQ Engineering;
- SA-ERI-2014-05, ER Interface with PB Program; and
- SA-ERI-2014-07, Quality of System Health Reporting, Quick Hit Self-Assessment, Station Engineering.

Of the aforementioned FASAs, the ones relevant to Safety Performance and the reason for their relevance follow:

FASA SA-ERI-2013-02 is relevant to Safety Performance as it highlighted the Engineering Programs have not been fully consistent with the 14 principles of CSA N286-05 and the Engineering Programs were not aligned fully with the Equipment Reliability Centre of Excellence (ERCOE), resulting in less than sustainable performance. Corrective actions were completed

that improve the PROG-11.01, Equipment Reliability [51] documentation. This program is discussed further in Safety Factor Report 2.

FASA SA-ERI-2013-03 is relevant to Safety Performance as it included a review of equipment reliability root cause investigation reports and included a review of long term reliability and repeat issues.

FASA SA-ERI-2013-04 is relevant to Safety Performance as it notes the software to log performance improvement is missing operating and design limits which can be compared to system conditions, so system engineers can quickly speak to margin management concerns.

FASA SA-ERI-2014-07 is relevant as it points out the need to improve the System Health Report content so it is a better communication tool for the System Plant Health Committee so they can be driven through the work management process and better align changes for success. These changes were scheduled to be implemented and impact BP-PROC-00559 [155] and have resulted in a revision from the earlier version of DPT-PE-00010 to the current version [152].

FASA SA-ERI-2015-07 (Section 2.0) is a recognition of the need to improve knowledge transfer, coaching, provide backup support, and leadership development.

FASA SA-ERI-2015-17 (Section 8.2) identifies a general deficiency in the overall quality of the Component and System Performance Monitoring Plans a lack of acceptance criteria and the need to improve walk-down plans so they cover all critical system parameters.

7.1.3. Chemistry Limits and Processes

The following FASAs are relevant to Operating Limits:

- SA-CHEM-2015-04, Chemistry Control Administrative Limits Review
- SA-CHEM-2014-02, Chemistry Control Administrative Limits Review.

These FASAs reviewed the spread or variability of analytical data for a selection of Control and Regulatory Chemistry parameters in relation to action levels and administrative limits. The assessment concluded that most of Chemistry Control and Regulatory parameters are bounded by acceptable administrative limits to prevent action level violations. A corrective action was initiated to document opportunities to improve chemistry monitoring and control following both FASAs.

- SA-CHEM-201506, BP-PROC-00197, Chemistry Control Event Management
- SA-CHEM-2015-03, Chemistry Control Health Reports
- SA-CHEM-2015-01, Outage Chemistry

These reports show the integrated impact Chemistry has on the System Health of many other systems and components. They point to necessary improvements in the Chemistry Health reporting processes and procedures.

7.1.4. OPEX

The following FASA is relevant to Operating Experience:

- SA-PI-2014-02, Evaluation of Significant Operating Experience Reports (SOERs & SERs).

SA-PI-2014-02 is relevant to Safety Performance as it was done to confirm whether the Significant Operating Experience Report (SOER) evaluation process was being implemented properly. BP-PROC-00062 [108] was revised to account for the findings.

Additional OPEX FASAs are reviewed in Safety Factor Report 9. (Bruce A [17] Bruce B [5])

The aforementioned information addresses Section 1.2 Review Task 3.

7.1.5. Corrective Action

The following FASAs are relevant to the Corrective Action Program:

- SA-PI-2013-01, CAP – CAPCO Job Description and Role, Performance Improvement.
- SA-ERI-2013-07, CAPE Department Section Manager Training Effectiveness, Station (Component) Engineering.
- SA-COM-2013-11, CAP Effectiveness in Engineering.
- SA-PI-2014-03, Root Cause Process, Performance Improvement.
- SA-PI-2014-07, Serious and Systemic Problems as per CSA 286-05 Clause 5.11.

SA-PI-2014-07 is relevant to Safety Performance as it investigates whether issues are resolved within the Corrective Action process. Not identifying and resolving serious and systemic issues could impact the four pillars of nuclear safety. This FASA revealed there are no clear definitions for serious and systemic leading to different interpretations of the meaning and inconsistent implementation. A corrective action was initiated to resolve this issue.

The other FASAs identified corrective actions and opportunities to further improve already effective processes and procedures. In one case it was noted Section Managers were not fully kept up-to-date on procedural changes and the Equipment Reliability procedures were not effectively rolled out, thus a quarterly review of the FASAs was rolled out, as discussed in Section 7.1.11, to improve the communications and lessons from key FASAs.

Additional Corrective Action FASAs are reviewed in Safety Factor Report 9. (Bruce A [17] Bruce B [5])

7.1.6. Environmental Safety Management

The following FASAs are relevant to Environmental Safety Management:

- SA-ENV-2015-04, Evaluation of the Effectiveness of the Environmental Performance,

- SA-ENV-2015-02, ISO 14001:2015 New Standard Evaluation,
- SA-ENV-2013-01, Transition to CSA N288.6 Environmental Risk Assessments at Class 1 Nuclear Facilities and Uranium Mines and Mills,
- SA-TRGD-2013-07, Assess the Non-Licensed Operator Training Program Against the Significant Environmental Aspects, and
- SA-ERI-2013-06, Execution of 2013 Buried Piping Inspection Scope – Lessons Learned.

FASA SA-ERI-2013-06 shows no adverse conditions were identified with respect to buried piping, but opportunities for improvement were numerous.

FASA SA-TRGD-2013-07 showed the nuclear operators needed to be more familiar with significant environmental aspects.

FASA SA-ENV-2013-01 discusses the steps to ensure compliance to the new CSA N288.6 and the impacts on the implementing procedures.

FASA SA-ENV-2015-04, Evaluation of the Effectiveness of the Environmental Performance, reviewed the effectiveness of the environmental performance improvements initiated since 2007. A total of 48 assignments were accepted. It was determined numerous changes had occurred since then. No adverse conditions or opportunities for improvement were identified. The organization had changed dramatically since 2007

FASA SA-ENV-2015-02, ISO 14001:2015 New Standard Evaluation, reviewed the latest ISO standard to define how Bruce Power could successfully adopt and embrace its implementation by September 2018.

The aforementioned information addresses Section 1.2 Review Task 4.

7.1.7. Radiation Protection Program

The following FASAs are relevant to the Radiation Protection Program:

- SA-RPR-2015-08, Business Impact Analysis,
- SA-RPR-2015-03, ALARA Programs,
- SA-RPR-2015-06, Radiation Protection Program Gap Analysis – CSA N286.05 to N286.12,
- SA-RPR-2013-02, Bruce Power CANDU Radiological Protection Benchmarking Project Assessment, Radiation Protection Programs Department,
- SA-RPR-2013-05, Discrete Radioactive Particle Control Evaluation for Bruce A, Radiation Protection, and
- SA-RPR-2014-01, EPD Alarm Follow-up at Bruce A and Bruce B, Quick Hit Self-Assessment.

Numerous other Radiation Protection self-assessments have been performed (e.g., FASA SA-RPR-2013-03 against WANO RP Guidelines, FASA-Locked High Radiation Area Controls

SA-RPR-2013-04). These are captured in Safety Factor Report 15, as they are more programmatic related and do not focus on Safety Performance.

In particular, the following Radiation Protection self-assessment focus on Safety Performance aspects:

FASA SA-RPR-2015-06 (Section 5.0) identified 4 document change requests to improve the documentation and close gaps to achieve N286.12 compliance, including closer links to the implementing RPPs.

FASA SA-RPR-2015-08 focused on the critical functions and the required recovery time objectives after an abnormal event has occurred and identified minimum critical resources required. For the program these resources are more important than most from a Safety Performance perspective as they support the post-event and accident management activities.

FASA SA-RPR-2013-02 is relevant to Safety Performance as it shows Bruce Power is interested in improving their RPP, thus it meets WANO Good Practices and the review provides an indication of Bruce Power wishes to make continuing improvements in RPP and is proactively learning from other CANDU utilities.

FASA SA-RPR-2013-03 is relevant to Safety Performance as outages represent in excess of 80% of the collective radiation exposure on site (SA-RPR-2013-03 Section 2.0). The ALARA planning process is aligned programmatically with regulations and industry guidelines. There is a need to improve the alignment between outage preparation and planning with Radiation Protection program implementing procedures to create more flexibility due to the dynamic nature of discoveries and the objectives of outages to achieve Bruce Power's goal of excellence (SA-RPR-2013-03 Section 5.0).

The aforementioned information addresses Section 1.2 Review Task 5.

7.1.8. Work Management Program

The following FASAs are relevant to the Work Management Program:

- SA-WMSI-2015-07, Seasonal Readiness
- SA-WMSI-2015-03, Scheduling and Planning of Major Evolutions
- SA-WMSI-2015-02, Work Order Priority Assessment

FASA SA-WMSI-2015-07, Seasonal Readiness, was a systematic review of the seasonal readiness process to ensure scope completeness and correctness, consistent with the condition and importance of the systems and components.

FASA SA-WMSI-2015-03, Scheduling and Planning of Major Evolutions, covers non-Project Management and Construction work that spans multiple weeks as it is more difficult to track and plan to meet milestones (SA-WMSI-2015-03, Section 2.0). Major evolutions are covered under BP-PROC-00735, Long Range Cycle Planning [162]. This procedure needs to be upgraded to clearly define major evolutions, provide additional guidance to staff and ensure an appropriate assignment of resources (SA-WMSI-2015-03, Section 7.0).

FASA SA-WMSI-2015-02, Work Order Priority Assessment, identified too many high priority work management tasks were incorrectly identified and can be re-assigned to a lower priority based on the requirements of BP-PROG-11.03, Outage Work Management [163] and BP-PROC-00328, Work Prioritization and Approval [88] which aligns with INPO AP-928, Work Management Process Description industry guidance [82]. This ensures the right work is performed at the right time.

7.1.9. Work Protection

The following FASA is relevant to the Work Protection Program:

- SA-OCP-2015-08, Work Protection

FASA-SA-OCP-2015-08 was a review of the improvements in work protection. The Work Protection Program was deemed a primary area of improvement. Fifty four high level events occurred in 2012, followed by thirty-eight events in 2013 and seventeen high level Work Protection events in 2014. A comprehensive review in 2014 determined 94% (16 of the 17 high level events) were caused by Human Performance errors as a result of procedural use and adherence problems (SA-OCP-2015-08 Section 2.0). Improvement in performance is expected to continue with the institution of high standards and staff acceptance of holding themselves and each other responsible for their performances.

7.1.10. Miscellaneous Self-Assessments

7.1.10.1. Maintenance

- SA-MPR-2014-03, Quick Hit Self-Assessment.

This FASA is relevant to Safety Performance as it reviews how well post-maintenance testing procedures meet the guidance of RD/GD-210 Section 3.5.5 [30]. It concluded Bruce Power documents comply with this Regulatory Document as well as the Electric Power Research Institute and INPO testing guidance.

7.1.10.2. Operator Fundamentals and Operations

- SA-OCP-2015-09, Bruce A and Bruce B Plant Condition Reports, Operations

This FASA showed there were insufficient procedures to help produce consistent Plant Condition Reports. Some of the station differences were due to oversight responsibilities on major projects, but others appeared arbitrary. Governance is being improved to standardize the reports to maintain alignment in reporting.

- SA-OCP-2015-17, Operator Fundamental Review, Operations

This FASA showed the industry insight on Operator Fundamentals had not yet been adopted in the Bruce Power Operator Fundamentals document. Lessons learned include better

understanding on safety margin versus the normal operating range and trending to identify potential failures.

- SA-OCP-2014-01, Evaluate the Health of Operator Fundamentals Program – WANO SOER 2013-1 REC #2 “Operator Fundamentals Weaknesses”, Operations.

This FASA showed there were strengths in the overall improvements that had been made to the Operator fundamentals from 2012, but there was a weakness in the application of the Operator Fundamentals. Field and control room supervisors are not sufficiently identifying any weaknesses for follow-up. Operations need to provide improved indicators to measure the state of Operator Fundamentals [287]. Corrective actions were raised to drive further improvements.

7.1.10.3. Post Maintenance Testing

- SA-MPR-2014-03, Post Maintenance Testing

This FASA concluded the procedures meet the Post Maintenance Testing requirements and guidance in RD/GD-210 [30] and the EPRI Post-Maintenance Testing Guidance, and INPO’s post-maintenance testing guidance. Four corrective actions ensured improvements were made to low tier Maintenace Procedures (BP-PROC-00669 and -00685).

7.1.10.4. Configuration Management and Nuclear Fuel Management

- SA-COM-2015-03, Configuration Management Engineering Governance Review, Engineering Support Services
- SA-NFM-2015-05, Outage Performance Indicators, Nuclear Fuel Management
- SA-NFM-2015-08, Severe Accident Management Guidelines, Nuclear Fuel Management
- SA-OCD-2015-15, Emergency Mitigating Procedures

FASA SA-COM-2015-03 Section 2.0 points out the need to ensure the interface between safety analysis and design processes be revised to ensure clarity.

FASA SA-NFM-2015-05 Section 7.2 points out the need to better identify inputs from all areas of Safety Analysis to the Fuel and Fuel Channel Program to ensure integration and consistency.

FASA SA-NFM-2015-08 is a review of Severe Accident Management processes following the Fukushima lessons learned.

FASA SA-OCD-2015-15 Section 2.0 mentions SST revisions are not being thoroughly reviewed by Reactor Safety; either they are not always requested or documentation is lacking.

7.1.10.5. Regulatory Affairs

- SA-RA-2015-01, Assessment of the Timeliness of REGDOC-3.1.1 Reporting

- SA-RA-2015-03, BP-PROG-06.01 and -06.03, CNSC Licence Acquisitions and Interface Management

FASA SA-RA-2015-01 Section 7 shows Regulatory Affairs is meeting timeliness requirements.

FASA SA-RA-2015-03 shows the Licence and Interface Management requirements are being met.

7.1.10.6. CSA N286-05 vs. N286-12 Requirements

- Various FASAs SA-XXX-2015-0Y, Assessment of PROG document and compliance to CSA N286.05 versus CSA N286.12. For example, SA-RPR-2015-06, Radiation Protection Program Gap Analysis - CSA N286.05 to N286.12

Each program area conducted a FASA comparing the requirements of CSA N286.05 versus CSA N286.12 to ensure a smooth transition to the new CSA Standard.

7.1.11. Performance Improvement Quarterly Review of FASAs

Increased oversight of the FASA completion and effectiveness process was implemented in 2014 with the introduction of Quarterly Focus Area Self Assessment Status & Summary Reports [287][288][289][290]. These reports provide on a quarterly basis an integrated summary view of the FASAs performed across the site by each Functional Area, with the major findings and gap closing measures initiated to close them and provide management with insight on the health of the FASA process so program improvements can be implemented. The reports were instituted in response to weaknesses discovered in the FASA Program Effectiveness SA-PI-2013-06.

The February 2015 [290] report identifies 66 FASAs were completed during the quarter. It highlights the early 2014 self-evaluation and improvements resulting from it provided increased oversight of the FASA completion and deferral process. This provided greater insight for the Corrective Action Review Board on how the self-assessment processes can be improved. A 20% improvement in the FASA completion rate was accomplished. The completion rate has been near 90% for the last two years. The December 2015 monthly FASA metric shows 223 were completed in 2015 and 801 actions were generated ([290] Section 1.1 and [291]).

An analysis of the SCRs that were generated as a result of FASAs in quarter 4 identified the following as the most frequently identified issues ([290] Section 1.1):

- General environmental performance
- Long-term strategies for equipment vulnerabilities and obsolescence in equipment reliability strategy and maintenance optimization feedback on equipment performance by station management organizations
- Pressure boundary equipment, program or processes
- Part or Material Obsolescence issues or the management of the Obsolescence program

- Inadequate or lack of job briefings including pre-job, post-job or just in time and Job Safety Analysis
- Design Engineering Work Practices
- Environmental Qualification issues including Steam protection or steam containment issues
- Modifications or projects that alter Station Systems, Structures or components
- Procedural use or adherence including place keeping.

This knowledge could then be used to better focus the FASAs for 2015.

7.2. Internal and External Audits and Reviews

The objective of the audit process as stated in BP-PROG-15.01, Section 4.2 [180] 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 [35]).

Audits are planned and scheduled on an annual basis and tracked to ensure they are performed regularly. Over 145 independent audits were performed covering the Bruce Power Programs over the period 2009 to 2013, with a focus on those which improve the Equipment Reliability, Plant Maintenance, Emergency Measures, and Radiation Protection. Requirements and the frequency of audits for specific areas generally range from annually to every three calendar years, as given in documents such as CSA N286, the PROL based on CSA N285, N288.4, N288.5, N288.7, N293, and S-296 (superseded by REGDOC-2.9.1) ([181] Appendix B).

From a Safety Performance perspective the key audits by PROG for Bruce A include:

Equipment Reliability BP-PROG-11.01

AU-2014-00024, Compliance Evaluation: BP-PROC-00603 and -00789, December 12, 2014.
AU-2014-00009, Component Categorization, October 1, 2014
AU-2013-00005, Relief Valve Field Repairs, March 17, 2014
AU-2012-00007, Relief Valve Field Audits, February 1, 2013
AU-2012-00006, Equipment Reliability, December 11, 2012
AU-2011-00028, Performance and Condition Monitoring, February 3, 2012
AU-2011-00025, Preventative Maintenance Deferral Process, October 13, 2011

AU-2011-00018, Steam Generator Life Cycle Management, August 4, 2011
AU-2011-00017, SST Scheduling and Completion, June 7, 2011
AU-2011-00007, Relief Valve Program and Field Repair, September 2, 2011
AU-2010-00037, Relief Valve Field Repairs, January 18, 2011
AU-2010-00027, Primary Heat Transport Feeder Management, June 16, 2010
AU-2009-00034, Relief Valve In-Situ Testing, August 23, 2009
AU-2009-00010, Containment Leakage Rate Test, December 4, 2009

On-Line Work Management BP-PROG-11.02

AU-2015-00008, Seasonal Readiness, August 26, 2015
AU-2012-00014, On-Line Work Management Program, May 23, 2012
AU-2011-00019, Summer Readiness, September 28, 2011
AU-2010-00022, H1/H2 Work Prioritization Surveillance, November 16, 2010

Outage Work Management BP-PROG-11.03

AU-2013-00008, Outage Management, November 25, 2013
AU-2010-00026, Forced Outage Management, June 15, 2010
AU-2009-00043, Outage Management, November 4, 2009
AU-2009-00035, Validation of Outage Milestones, August 13, 2009

Plant Maintenance BP-PROG-11.04

AU-2013-00018, Fluid Leak Management Program, March 21, 2013
AU-2013-00006, Maintenance Program, May 15, 2013
AU-2011-00027, Foreign Material Exclusion, February 28, 2012
AU-2010-00008, CMLF ISO 9001, April 16, 2010
AU-2009-00031, Bruce B - Corrective Maintenance Backlog, May 20, 2009
AU-2009-00003, CMLF ISO 9001-2000 Program, May 11, 2009

Corrective Action BP-PROG-01.07

AU-2014-00013, Effectiveness Reviews, September 29, 2014
AU-2011-00010, Performance Improvement, October 31, 2011
AU-2010-00024, Root Cause Investigation, March 19, 2010
AU-2010-00007, S99 Reporting, January 11, 2011
AU-2009-00017, Effectiveness Review of Fact Finding Process, March 13, 2009

Operating Experience Program BP-PROG-01.06

AU-2011-00010, Performance Improvement, October 31, 2011
AU-2009-00025, Benchmarking Program, July 16, 2009
AU-2009-00023, Forced Outage: Root Cause Review Assessment, July 16, 2009

Environmental Safety Management BP-PROG-00.02

AU-2015-00001, Environmental Safety Management, November 26, 2015
AU-2014-00004, Radiation Environmental Monitoring, September 17, 2014
AU-2014-00003, Environmental Safety System, July 29, 2014
AU-2013-00003, Environmental Safety Management, August 8, 2013
AU-2012-00004, Radiation Environment Monitoring, February 11, 2013
AU-2012-00003, Environmental Safety Management, August 2, 2012
AU-2011-00002, Environmental Management System and Environmental Compliance, August 11, 2011
AU-2010-00035, Radioactive Environmental Monitoring Program, November 18, 2010
AU-2010-00005, EMS and Environment Compliance Audit, September 14, 2010
AU-2009-00001, EMS and Environment Compliance Audit, September 21, 2009

Radiation Protection Program BP-PROG-12.05

AU-2014-00022, Radiation Protection Waste Management,
AU-2013-00011, Dosimetry Program - Health Physics Lab, November 25, 2013
AU-2012-00010, Dosimetry Program - Health Physics Lab, November 5, 2012
AU-2011-00013, Radiation Protection and Alpha Radiation Recovery Plan, November 18, 2011
AU-2011-00012, Dosimetry Program - Health Physics Lab, November 4, 2011
AU-2010-00030, Radioactive Shipments, June 15, 2010
AU-2010-00006, Dosimetry Program, January 26, 2011
AU-2009-00042, Health Physics Lab – Dosimetry, March 2, 2010
AU-2009-00013, Radiation Protection Practices, May 19, 2009

CNSC Licence Application and Interface Management BP-PROG-06.01 and BP-PROG-06.03

AU-2014-00015, Power Reactor Operating Licence Amendment and Renewal, May 14, 2014
AU-2014-00014, Formal Correspondence with the CNSC, January 20, 2015

Configuration Management and Design Basis BP-PROG-10.01 to -10.03

AU-2015-00018, Temporary Configuration Change Management, July 13, 2015.
AU-2015-00015, Safe Operating Envelope, November 25, 2015.
AU-2015-00010, Technical Operability Evaluation, May 4, 2015.

The key findings from the Safety Performance perspective are:

Equipment Reliability and Plant Maintenance 11.01 and 11.04

AU-2012-00006 on Relief Valves highlights 17 audits in the last 3 years identifying and resolving program issues, however ineffective use of the SCR and the Corrective Action Processes have hampered full compliance of the identified issues.

AU-2011-00025 shows the Preventative Maintenance (PM) Work Order deferral process has not been effectively managed to ensure that equipment performance meets industry standards. This condition was identified as an issue (WANO Evaluation 1999). Although some performance

improvement has been experienced, the Equipment Reliability Index performance continued to be in the Red despite the numerous improvement plans that have been developed and implemented. Improvement initiatives had shown some improved performance in reducing the number of PMs going past their late date, an increasing number of PMs going to completion and improved timely completion of PMs based on the assignment of strong PM Coordinators and the development of the Preventative Maintenance Oversight Group with an altered focus on removing barriers that prevent completion of PMs prior to the late date, are the main drivers. Since the findings from audits performed in 2011 and 2012 Bruce Power has, and continues to make, improvements in the PM procedures and processes.

The Equipment Reliability Integration Engineering Department is making good use of industry benchmarking to develop the program and effective use of evaluations to determine program issues.

AU-2009-00010 showed co-ordination and understanding of the Containment Leakage Test is not well communicated and responsibilities for CSA N287.7 implementation was poorly defined making it more difficult to effectively complete the 5-year cycle of this important safety testing.

AU-2011-00019 showed the Summer Readiness program was ineffective when initially rolled out based on industry leading External Experience.

AU-2013-00006 showed BP-PROG-11.04 is generally compliant with S-210, but not fully compliant. These are captured in other documents. Work has subsequently been done to ensure more effective compliance. Compliance for S-210 (superseded by RD/GD-210) is now captured in other subordinate procedures to BP-PROG-11.04, as identified in Appendix B of BP-PROG-11.04 [164].

AU-2013-00018 showed the Fluid Leak Management Program is not fully compliant so leaks are not always identified as spills and not included in Station leak inventories. Leak codes are not always flagged in the System Health reports.

The Seasonal Readiness, AU-2015-00008 [292], determined that BP-PROC-00439-R005 [161], Seasonal Readiness, in general, has clear instructions for the activities to complete milestones; however, it was not complete as the procedure contained inconsistent or insufficient instructions, inaccuracies, and inadequate interlace establishment. The seasonal readiness process at each station is not completely effective at eliminating station operational challenges to promote optimum equipment reliability, system health and safe, reliable plant operation through a broad range of seasonal changes in temperatures, weather patterns and grid operating conditions. There are two adverse conditions with respect to: procedure non-adherence in the areas of the Seasonal Readiness Team functions, milestone dates, and retention of records and inconsistent or insufficient instructions, inaccuracies, and inadequate interlace establishment.

AU-2014-00024 [293], Compliance Evaluation: BP-PROC-00603 and -00789 shows BP-PROC-00603 [145] Preventative Maintenance Program “Just in Time” (JIT) Review Process, is not followed as written. The JIT PM Process Review has evolved since June 2014. Bruce B has not yet implemented the JIT PM Process as envisioned in the procedure. The Bruce B JlT meeting is solely for the purpose of engineering review and does not include the other stakeholders. These conditions have been self-identified and are captured in SCRs to drive the

corrective behaviour. The Asset Challenge Team does not follow BP-PROC-00789 [294], Maintenance Strategy including the guidelines set out in Appendix B. They rely instead on procedures that were developed by Asset Challenge Team during the Unit 1 & 2 project which are not controlled and in most cases were Vendor initiated. Documented evidence of Review and Approval for PM Maintenance Strategies is not always clear. Although documents are attached in the Electronic Document Management System of PassPort they do not clearly state what was reviewed and the outcome of that review. A sample of 72 component PMs ("Maintenance Strategies") were compared to Bruce Power's Maintenance Templates. Several instances were found where required statements were not recorded. The reason for this was explained to be due to a change in requirements since the beginning of the project. Finally some inconsistencies in regards to PM frequencies were found; a few were confirmed to be errors. Two Adverse Conditions have been identified: Non-compliance to BP-PROC-00603; and Governance of the Maintenance Strategy process (BP-PROC-00789 [294]) is not fully established and implemented. Subsequently, BP-PROC-00603 [145] was revised in 2015 to R003; the BP-PROC-00789 revision for R002 is late.[12] Gap SF8-10 in Table 10 identifies a number of governance documents that have not been revised within the required 3 year timeframe per BP-PROC-00166, General Procedure and Process Requirements. For the governance documents listed in SF8-10, a review of the PassPort action requests does not always provide evidence that the standard 3-year review has been completed and recommended no changes or whether the review has been deferred to a later date. Further SF8-11 was raised as the audit raised ARs against the BP-PROC-00666 [146] to change the document, but this was not flagged in PassPort. Users of the document would not know the document had errors or planned improvements.

AU-2014-00009 [295], Component Categorization shows BP-PROC-00666 [146] Component Categorization states that its purpose is to provide the basis for categorizing components at Bruce Power, consistent with the recommendations in INPO AP-913 [81]. The overall conclusion of the Audit is BP-PROC-00666 - Component Categorization is generally effective at achieving its purpose. However a lack of procedural compliance and deficiencies in the implementation has resulted in gaps between the expectations stated in the procedure and PassPort data for the Master Equipment List. There are 4 Adverse Conditions and 1 Opportunity For Improvement (OFI) as identified below: Personnel do not always comply with the requirements of BP-PROC-00666, and Equipment Information input into PassPort does not always comply with the requirements stated in BP-PROC-00666. There are conflicting processes that have resulted in non-compliances with the requirements of BP-PROC-00666.

Definitions provided in BP-PROC-00666-R002, do not completely align with INPO AP-913 [81], in the areas of Power De-rates of less than 10%, Emergency Mitigation Equipment, and Maintenance Rule Requirements. BP-PROC-00666-R002 contains some errors, omissions, and misalignments with interfacing Controlled Documents, and information provided in PassPort. BP-PROC-00666 has been revised to correct some shortcomings with the issuance of R003 and then with R004 [146]. The four ARs from the audit 28456027, 28456029, 28456034 and 28456045 were completed.

[12] BP-PROC-00789 R002 was issued in August 2017.

Corrective Action and Operating Experience Program BP-PROG-01.06 and -01.07

AU-2014-00013 [296], Effectiveness Reviews shows in general terms, each review was found to not comply fully with the requirements of BP-PROC-00506 [116] in varying degrees. Most of the instances of non-compliance were deemed administrative in nature and would be considered minor. Cumulatively, they become significant in that attention to detail, difficulty in understanding the necessary cross referencing and links to associated ARs limits the assurance that due diligence in correcting adverse conditions is satisfied. Non-adherences to the procedure include:

1) Inappropriate signatories for approval
2) Absent linking and cross-references to associated SCRs and FORMs
3) Failure to complete CARB/MRM actions.

Absent follow through of changes to the AR; e.g., cancellation of assignments has not affected the subsequent assignments. This carries a tendency to trivialize them individually; however when an active Root Cause Investigation (RCI) has no review assignment, then the (potential) risk to Bruce Power business becomes elevated.

The audit identified two adverse conditions and one opportunity for improvement:

1) Non-adherence to BP-PROC-00506
2) BP-PROC-00506 is not entirely aligned with its program document and contains unclear and incomplete instructions.
3) Training and qualification to conduct Effectiveness Reviews is not defined.

Environmental Safety Management BP-PROG-00.02

In 2010 the Radiation Monitoring Program was shown not to be in full compliance with the Environmental Monitoring Program, per AU-2010-00035, illustrating non-compliance with CSA N288.4-10, in areas of documentation, sampling procedures and practices and reporting. Past corrective actions were insufficient to improve the program. Audit AU-2012-00004 identified there was a transition from the Radiation Environmental Monitoring Program to the more integrated Environmental Monitoring Program. These audits were proactive reviews against more modern codes not presently in the licensing and design basis. As discussed in Reference [191] (page 5), Bruce Power is continuing towards the implementation of CSA N288.4-10, N288.5-11 and N288.6-12 as agreed with the CNSC. Annual audits of the REMP were performed showing the program has continued to make improvements and full compliance to the majority of items is complete:

- Audits AU-2012-00003 and AU-2013-00003 concluded that Bruce Power's Management System generally meets the requirements of ISO 14001 and in the vast majority of cases is compliant with legislation. There were no gross absences in the requirements of any of the ISO Elements. Some opportunities for improvement existed but these have been addressed through the SCR process but issues were identified as late as 2012 and 2013 (seven (AU-2012-00003) and eight (AU-2013-00003) of the eighteen areas had non-conformances, respectively).

- AU-2014-00003 [297], Environmental Safety System, showed general compliance with the requirements of lSO-1400.1 and other Regulatory and internal requirements, and 14 SCRs were raised.
- AU-2014-00004 [298], Radiation Environmental Monitoring, shows the REMP generally satisfies its main objectives and is managed in general accordance with CNSC Standard S-296 (superseded by REGDOC-2.9.1) and the applicable Bruce Power Management System requirements; however, some inadequacies in the implementation and compliance to requirements were identified. Also, non-conformances to CSA N288.4-10 [39] core elements were identified and expected as Bruce Power continues to progress its implementation plan for this CSA standard as it is now a licence requirement. The status of non-conformances were listed in Appendix E of the audit report. Three adverse conditions and two opportunities for Improvement on the REMP were identified: quality management requirements not adequately established; technical requirements not always met; and Ineffective Audit Corrective Actions; and non-conformances to CSA N288.4-10 (Core elements); External OPEX from COG should be formally reviewed for applicability.

  The implementation of CSA N288.4-10 [39] core elements has advanced since an audit last reviewed these elements in 2010. This was the third audit of REMP that reviewed conformance of the program to the requirements of the new standard and the second time core elements have been reviewed. Actions under self-assessment SA-ENV-2012-01, Environmental Monitoring CSA N288.4-10 [39] were still in progress. A systematic approach is being taken to complete Environmental Risk Assessments and technical reports that will collectively establish the basis that other requirements of N288.4-10 will be implemented in standards shortly.
- AU-2015-00001 [299], Environmental Safety Management, shows general compliance with the majority of legislative, regulatory and internal requirements associated with environmental management. A high level of compliance was observed with respect to regulatory reporting and documentation requirements; however, instances of non-compliance and potential non-compliance were noted. For the most part, non-compliances highlight specific areas where actions are required to ensure full compliance or improve due diligence and are unlikely to result in any consequential regulatory action. For example, no annual emergency drills for the storage of hazardous waste, conventional water emissions concerns away from the Stations, and conventional waste management. A total of six adverse conditions and five opportunities for improvement were initiated against the audit focus areas which included regulatory non-compliances or risks thereof. The Station impacts were limited to improvements in Radiation Waste Management to ensure consistency in reporting documentation for low- and intermediate- waste transfers and to segregate materials.

There audits show continuing improvement to full compliance.

The aforementioned information addresses Section 1.2 Review Task 4.

Radiation Protection Program BP-PROG-12.05

The Dosimetry Section meets the requirements of the Dosimetry Service Licence and ISO/IEC 17025:2005, S-106 Revision 1 and S-260 Revision 0 standards. Minor issues have decreased annually since 2009. Corrective actions were raised to improve the processes.

AU-2011-00013, showed improvements were necessary in the Radiation Protection documentation. Subsequent CNSC Field Inspections show these improvements have been made. See Section 7.3.

AU-2014-00022, Radiation Protection Waste Management, shows the Radioactive Waste Management process, as defined in BP-PROC-00878 [178], Radioactive Waste Management, was found to not be fully complete. Activities attributed to some implementing procedures under BP-PROC-00878 were found to not actually be defined in those procedures. In addition, non-compliances were identified with some of the requirements of BP-RPP-00010 [43], Segregation and Handling of Radioactive Waste, and some of the requirements for processing and monitoring likely clean waste and recyclable/compostable materials.
A total of five low significance (3) adverse conditions (SCRs) were identified:

- Free Release Criteria applied to Waste, Recyclables and Compostable Material
- Barrel Monitor/Bag Monitor Usage and Waste Processing Requirements not adhered to
- BP-RPP-00010 Non-adherences
- Waste Minimization Deficiencies
- Radioactive Waste Governance

Additionally two opportunities for improvement SCRs were identified:

- Consider purchasing a CMLF Barrel Monitor
- Bruce B Waste Handling Area/Waste Bin Signage Improvements

Separately, gap SF8-8 is identified in Table 10 to update the procedures to consider lessons learned from INPO 05-008 [80].

The aforementioned information addresses Section 1.2 Review Task 5.

Configuration Management and Design Basis BP-PROG-10.01 to -10.03

The audit findings for AU-2015-00010, Technical Operability Evaluation [300] were mostly administrative in nature with non-compliances related to poor recording, poor recording of deadlines for completion of actions and timeliness of sign-offs or the wrong individual signing.

AU-2015-00015 [301], Safe Operating Envelope discusses implementation of the requirements of CSA N290.15-10, Requirements for the Safe Operating Envelope of Nuclear Power [42]. The implementation activities have not been fully effective at ensuring the CSA N290.15-10 requirements are imbedded within governance. Incomplete governance includes missing documentation on how the requirements of the standard are met within BP-PROG-10.01, Plant Design Basis Management [66].

The terms Safe Operating Envelope and Safe Operating Limit have not been consistently defined or consistent alternatives have not been effectively documented within Bruce Power governance creating confusion regarding N290.15-10 compliance. Use of Surveillance Requirements, Surveillance Limits and Safe Operating Limits have not been consistent.

In addition programs and procedures that address compliance to N290.15-10 but are not identified as such as required by Bruce Power requirements. Some of these deficiencies have been identified and are being addressed through DCRs and others were not identified.

Reactor Safety Engineering has made extensive use of OPEX, Benchmarking and Self-Assessment activities to assist in the development and implementation of Bruce Power SOE governance. However the self-assessment and benchmarking activities were not completed in full compliance to Bruce Power requirements to ensure that activities are fully effective and documented.

The governance documents particularly in the Equipment Reliability Program, BP-PROG-11.01 [51] family have recently been updated to better integrate with the SOE project.

AU-2015-00018 [302] Temporary Configuration Change (TCC) Management shows the Temporary Configuration Change Management process is incomplete but generally effective in meeting the objectives and purpose of BP-PROC-00638, Temporary Configuration Change Management [142]. There are, however, 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 & Temporary Modifications, Chrono Logs, RSE Walkdowns, SCR initiation, Installation and Removal Work Order tasks, Tagging and other miscellaneous instructions. BP-PROC-00638 does 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. Failure to control changes can result in unknown/unexpected equipment status. TCC are more than six months old and System Engineers do not walk them down quarterly.

CNSC Licence Application and Interface Management BP-PROG-06.01 and BP-PROG-06.03

AU-2014-00015 [303], Power Reactor Operating Licence Amendment and Renewal shows the PROL amendment and renewal process is generally complete. Considerable effort has gone into streamlining the process and facilitating stakeholder interaction. The Licensing Section continues to make improvements and modify the process of licence amendment and renewal in response to dialogue with the Regulator. The Licensing Section measures their success as the Regulator's acceptance of the Renewal / Amendment submission.

Two adverse conditions record deficiencies related to the posting of the PROL and additional nonadherences to BP-PROC-00114 [122]. The PROLs and their associated required document notice are not posted per Section 4.9 of the procedure and a non-compliance of the General Nuclear Safety and Control Regulations (GNSCR) s14 (1) a). Excepting the PROL posting deficiency, none of the other procedure adherence instances were considered major and most would be categorized as improvements to the process which is evolving to the needs of the Regulator.

AU-2014-00014 [304], Formal Correspondence with the CNSC shows the licensing activities implemented in BP-PROC-00058 [123], CNSC Commitment Management, meet the objectives described in section 4.4 CNSC, Commitment Management, of BP-PROG-06.03, CNSC Interface Management [57]. The total number of completed Regulatory commitments from November 2012 through November 2014 without a missed action was 1493. BP-PROC-00058, CNSC Commitment Management, is complete in that it establishes and describes a graded-approach process for documenting, tracking, managing, changing and monitoring commitments made to the CNSC and CNSC-related actions that have specific deliverables, due dates and/or require additional interface transactions with the CNSC. In some instances, process instructions are inadequate. Instructions are missing for the documentation and approval of exceptions to the recommended owner by the Designated Licensing Authority. FORM-12555, Commitment Revision Template, includes instructions that do not align with the current revision of BP-PROC-00058 [123]. Inadequate process instruction increases the likelihood of errors and inconsistent results which can directly impact the process's objective/purpose. BP-PROC-00058 [123], CNSC Commitment Management, establishes and describes actions required to ensure commitments made verbally (e.g., at CNSC public hearings, meetings) are identified and documented so as to assure the same level of management oversight as those originating in formal written communications. Non-compliances were found to exist with the requirements of BP-PROC-00058 in the areas of regulatory action ownership, the referencing of source documents, the creation of sub-assignments and the use of FORM-12555, Commitment Revision Template, and the In Progress notes to cancel ARs. Failing to adhere to established processes increases the likelihood of errors and inconsistent results which can directly impact the reputation with the Regulator.

7.2.1. Internal Audits and Reviews

Bruce Power had an independent nuclear industry evaluation of their nuclear oversight program [305] and a NORA improvement initiative where NORA continuously reviews the effectiveness of Oversight against the WANO Performance Objectives and Criteria to learn the lessons from WANO 1 Stations around the world [306] [307]. The Nuclear Industry Evaluation Program (NIEP) evaluation is covered in Section 7.2.2 under external reviews, while the NORA oversight review is discussed next.

The NORA Nuclear Oversight Quarterly Reports [306] [307] were initiated in the second quarter of 2014. Their purpose is to follow the WANO assessment process which utilizes observations that are debriefed with line management, followed by the development of Problem Development Sheets (PDSs) or a detailed SCR, as applicable, for areas of strengths or improvement to identifying areas exceeding or lagging industry excellence. The PDSs are a compilation of

SCRs over a period of time to show trends which may be arising so they can be flagged to the line management. This information is aligned to provide Station managers with information needed for their quarterly meeting reviews. These reviews are important as WANO has published, and regularly updates as new information arises, a set of Performance Objectives and Criteria (POC) intended to provide a common set of high standards in nuclear performance for its member utilities. These POCs are used by WANO representatives during their independent peer reviews of member utilities, and are readily comparable to the Safety Performance reporting factors and corrective action reporting processes. These POCs are consistent with the purpose and intent of IAEA SSG-25 [73].

These NORA Oversight Quarterly Reports have continued but have been renamed as Independent Oversight Quarterly Reports [308][309][310][311][312].

In Q3-2014 ([307] Section 1.0) Bruce A completed 44 observations and published 8 PDSs related to assessments in fuel handling manual manipulations, adverse condition monitoring, plant status control, engineering daily monitoring, chemistry fundamentals, human performance advocates, and station traffic light communications. Nine SCRs were raised. One item noteworthy was at the start of the Bruce B, quarter one B1471 outage, supplemental staff were not receiving or being re-qualified in general employee training. The Bruce A management team accepted the insights and feedback provided by the Nuclear Oversight assessment team, and were proactively implementing the corrective actions.

A common theme from the assessments conducted in Operations, Engineering and Chemistry was personnel were rationalizing why the core procedural requirement of trending data to proactively predict problems is not as important as responding to emergent issues and the need to improve communication between groups. The Bruce A team launched a Step-it-Up campaign to bring focus to expectations and standards so an awareness of the importance of trending is permeating each group.

During the initial quarterly review [306] the Radiation Protection organizations were seen to be conducting beneficial practices during station outage. The organization change made in 2013 had a positive effect on dose control and dose reduction. Experience, both negative and positive, from the B1471 outage was applied to the quarter two A1431 outage and strengths were emulated and lessons learned incorporated in areas where improvements were needed.

In addition to these reviews Bruce Power has performed comprehensive reviews of its programs such as its Ageing Management Program to improve them. As part of these reviews, it objectively looks at the past audits to integrate the results and conclusions to get a more comprehensive understanding of their programs [313].

A review of the latest five quarters of the Independent Oversight Quarterly Reports [308] [309] [310] [311] [312] shows the gaps to excellence on a quarterly basis:

- Q4-2014 Bruce B published 5 Bruce B specific PDS reports and 3 common ones with Bruce A, including ones related to adverse condition monitoring and equipment alignment checks. ([312] Sections 3.1, 3.2, 3.3)
- Q1-2015 Bruce B published 5 Bruce B specific PDS reports and 4 common ones with Bruce A including ones related to Work Protection, Outage Preparation (Work Management), and Engineering, and a Performance Area Summary Sheet on

Equipment Apparent Cause Evaluation causal analysis to ensure the root cause is investigated further ([308] Sections 3.1, 3.2 and 3.3). Six SCRs were raised and corrective actions worked through the corrective action process.

- Q2-2015 Bruce B published 5 specific PDS reports but no common ones with Bruce A, and 2 Performance Area Summary Sheets including one related to post-maintenance testing rework which kept equipment out of service for longer than desired and delayed completion of maintenance. A further PDS was identified on Radiation Protection Practices for not consistently meeting the high standards of performance. One escalation occurred on foreign material exclusion and inconsistency in ensuring contractor behaviours with Bruce Power desires ([309] Sections 3.1, 3.2 and 3.3). Twenty-one SCRs were raised and corrective actions worked through the corrective action process. The high number was due to additional oversight during outages, including 7 for poor behaviours with respect to Radiation Protection.
- Q3-2015 Bruce B published 2 specific PDS reports and 1 common one with Bruce A on weakness of adherence to seismic standards and 1 Performance Area Summary Sheet. Only the foreign material escalation for Bruce B remained open ([310] Sections 3.1, 3.2 and 3.3). Five SCRs were raised and corrective actions worked through the corrective action process.
- Q4-2015 Bruce B published 1 specific PDS report, related to delays in Engineering Change Control - Available for Service delaying temporary equipment being utilized longer than anticipated due to poor teamwork between the Station and Project Management and Construction personnel, and 6 OSART gap assessments which showed improvement was needed prior to the arrival of the OSART inspectors. Sixteen SCRs were raised and corrective actions worked through the corrective action process. Only the foreign material escalation for Bruce B remained open and it would remain open until the next planned outage. A more formal oversight review can be conducted at that time ([311] Sections 3.1, 3.2 and 3.3).

SCRs were raised for adverse trends. Appendix A of the reports provides a trended listing of WANO Performance Objectives and Criteria and PDSs and SCRs raised.

The process shows Management Oversight is raising SCRs and open communication on opportunities for improvement are effective discussed with the Managers responsible for the work.

The aforementioned information addresses Section 1.2 Review Task 4.

7.2.2. External Audits and Reviews

The 2014 NIEP evaluation of Bruce Power found the Programs were effective in meeting the Nuclear Oversight Audit and Supply Chain Quality Services requirements. This assessment concluded all of the 6 areas audited were effective. Within those 6 areas, 75 factors were Satisfactory, although 9 areas which were Satisfactory had Recommendations, 3 had a Deficiency and 1 had a Strength. The deficiencies were in ensuring the reports were filed on time, to review the Nuclear Procurement reports on Suppliers, and the frequency of meetings of

the Plant Operations Review Committee. The filing of reports was the key deficiency with respect to Safety Performance as it delays the raising of the Action Requests and their actions to complete the audit report deficiencies. The other two items did not impact Safety Performance.

Each Deficiency and Recommendation was entered as an Action Request for follow-up in the Corrective Action and Action Tracking Programs.

The strength was that the audit organization has a well-developed Auditor Training program which used a Systematic Approach to Training based training design. Job Task Analysis is documented for knowledge and skill elements. The training program is documented and aligned to develop proficient auditors upon completion of qualifications. Auditors are professional and meet expectations of managers for performance as qualified auditors. This is important from a Safety Performance perspective as the Auditors are qualified to assist other groups in improving their performance.

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.

The CNSC regularly performs Compliance Inspections of wide aspects of the Bruce Power Programs to ensure continuing compliance with CNSC Regulations, Standards and Guidance documents, as well as the internationally recognized Codes and Standards Bruce Power has adopted in their management system. Also the CNSC conducts quarterly Field Inspections. Both these review process are done to ensure continued and improved Safety Performance. The Compliance Inspections are discussed first and then the Field Inspections.

The following information addresses Section 1.2 Review Tasks 1, 3, 4 and 5.

7.3.1. Regulatory Compliance Inspections

Over the last five years Compliance Inspections relevant to Safety Performance have included multiple reviews of the Radiation Protection, Chemistry, Human Performance, Environmental Monitoring, Corrective Action and Problem Identification, the Management System Manual, Operating Experience, Condition Assessments, REGDOC-3.1.1 (formerly S-99), the Safety-Related Systems Tests, Independent and Self Assessments, Wastes, Worker Dose, and the Preventative Maintenance process. Additionally audits are performed on individual SSCs, the Unit 1 and 2 Restart Effectiveness, Engineering Change Control, Environmental Qualification, Human Factors, Radiography, and the Abnormal Incident Procedures.

A review of these inspections with an emphasis on Safety Performance shows compliance with the majority of the requirements, continuing improvement, but also repeat occurrences of non-compliances and slowness to improve for example, with maintenance backlogs.

Examples of the Compliance Inspections relevant to Safety Performance are shown in Table 8. They show Bruce Power is meeting the regulatory requirements with some follow-up activities arising as Bruce Power strives for excellence and expectation increase.

Table 8: Examples of Compliance Inspections Relevant to Safety Performance

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-11382 / NK29-11785 NK21-11517 / NK29-11902 NK21-11706 / NK29-12095 NK21-12548 / NK29-12974 NK21-12708 / NK29-13142	Action Item 2014-07-5109: BPRD-AB-2014-004 – Assessment (Self and Independent)	Frequency, depth and width of audits; pressure boundary checklists; summary report on audits; tracking actions to completion	Improvements made to processes Implemented a risk-based audit methodology so Graded approach for Audits of the Management System by revising BP-PROG-01.02 [106] rather than creating a new procedure (BP-PROC-00955). Bruce Power requested closure of following the provision of additional information. Action Item 2014-07-5109 is closed

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-11508/ NK29-11890 NK21-11596/ NK29-11978 NK21-12007/ NK29-12392 NK21-12319/ NK29-12751 NK21-12142/ NK29-12553 NK21-12327/ NK29-12760 NK21-12526/ NK29-12953	Action Item 2014-07-5294: BRPD-AB-2014-007 – Problem Identification and Resolution – Corrective Action	Train staff performing trend analysis; improve common cause analysis reports; improve quarterly performance assessment reporting; perform more casual trend analysis	Problems identified and corrective actions assigned and tracked to completion As of September 17, 2015 4 of the action notices are incomplete but the CNSC is aware of the progress and the plan for completion. BP-PROC-00644 Common Cause Analysis updated How to Guides updated and reissued and Adverse Trends process improved Action Item 2014-07-5294 closed.
NK21-12559/ NK29-12984 NK21-12583/ NK29-13010	Action Item 2015-07-7343: BRPD-AB-2015-010 Problem Identification and Resolution Effectiveness Review	CNSC staff is satisfied that Bruce Power is complying with the license requirements; however some non-compliances with licensee procedures were observed and are documented. The non-compliances are related to the Safety Control Areas Management System - Management of Records and Operating Performance- Problem Identification and Resolution.	Bruce Power FASA SA-PI-2015-04 found similar findings to the CNSC review. A correction action plan was already raised and the actions are being tracked to completion. Process is needed to track the quality of records and Managerial training to support it, including quality assurance checks. The correction action plan was discussed with the CNSC. Computer Based Training modules 7742 and 17743 provide insight for Managers. The Performance Improvement Dashboard provides a coarse indicator of effectiveness quality. AF28543755 has been raised to factor in the changes highlighted. It is expected to be complete in early 2017.
NK21-08074/ NK29-08929 NK21-08165/ NK29-09005	Action Item 100712 - BRPD-2010-AB-002 Radiation Protection Compliance Inspection Report	5 action notices and 3 recommendations on radiation protection Update Restart Radiation Safety Plan and Procedures to become	

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-08380/ NK29-09166 NK21-08380/ NK29-10220 NK29-09485 NK21-10219 NK29-10589 NK21-10220/ NK29-10626 NK21-10221/ NK29-10627 NK21-10222/ NK29-10628 NK21-11040/ NK29-11436		consistent with Station procedures; perform FASA on contractor and employee onboarding; improve clearances of waste materials; posting and communication of hazards	Occupational ALARA Planning and Control meet regulatory requirements with areas and opportunities for improvement. 10 Post ALARA work reviews provided. E-mail information provided Action item closed
NK21-08487/ NK29-09256 NK21-08557/ NK29-09308	Action Item 110706 – BRPD-2010-AB-007 - Radiation Protection Program	4 action notices and 1 recommendation air purifying respirators; Radiation Exposure Permits; Housekeeping; monitoring at zonal boundaries; CCA requirement compliance; alpha monitoring; lunch room surveillance; dosimetry; waste removal; radiation instrument management; qualification; Contamination Control	Bruce Power requested closure of action item
NK21-09165/ NK29-09809 NK21-09245/ NK29-09869 NK21-09514/ NK29-10078 NK21-09721/ NK29-10217 NK21-09817/ NK29-10291 NK21-09869/ NK29-10331 NK21-09870/	Action Item 1107-2924 - BRPD-2011-AB-011 – Radiation Protection Alpha Monitoring and Control	A process establishing requirements for alpha monitoring is required; hazard posting frequency; personal air samplers; deficiencies with whole body monitor calibration data labels; procedure verification Alpha Gap analysis and corrective action plan follow-up	Worker dose activities in compliance with regulatory requirements but improvements have been suggested. Status update on improvements provided July 6, 2015 and November 24, 2015.

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK29-10332 NK21-10409/ NK29-10831 NK21-10786/ NK29-11163			All corrective actions completed, 4 revisions to procedures provided and
NK21-09851/ NK29-10317 NK21-11459/ NK29-11861	Action Item 2949	CNSC review of Bruce Power's effectiveness review, of the implementation of BP-RPP-00022, R009 Contamination Control	Action Item closed
NK21-09833/ NK29-10304 NK21-10282/ NK29-10687 NK21-10567/ NK29-10967 NK21-10624/ NK29-11017 NK21-10856/ NK29-11233 NK21-11141/ NK29-11547 NK21-11661/ NK29-12044 NK21-11989/ NK29-12376 NK21-12467 / NK29-12876	Action Item 1207-3516 – BRPD-AB-2012-009	Radiological Hazard Control Eight of ten action notices responded to satisfactorily.	Longer term corrective actions on two action notices checked by CNSC. Bruce Power requested closure of Action Item December 2015

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-11117/ NK29-11521 NK21-11521/ NK29-11909 NK21-11139/ NK29-11544 NK21-11436/ NK29-11836 NK21-11445/ NK29-11846 NK21-11513/ NK29-11896 NK21-12169/ NK29-12587 NK21-12256/ NK29-12683 NK21-12435/ NK29-12847 NK21-12574/ NK29-12998	Action Item 1307-4696 - BRPD-AB-2013-018 – Radiation Control - Worker Dose Control	Radiation Protection worker dose control 5 action notices raised and 7 recommendations Reviewed Radiation Exposures, Dose Assessments, Dose Targets, Tracking/Trending, Protection Action Levels, Administrative Dose Limits, Reporting on Performance Trending of Worker Doses, Radiation Work Planning and Radiation Dose Devices and Radiation Protection Instrumentation	Compliance against Bp-PROG-12.05 reviewed. Numerous letters discussing governance structure to include a process for establishing requirements for continuous alpha monitoring and alarming equipment to be used for work in areas with increased alpha hazards to ensure radiation exposure from airborne alpha hazards is controlled during work execution. As of December 22, 2015 the action notice on alpha monitoring remains open
NK21-11422/ NK29-11825 NK21-11704/ NK29-12092 NK21-12033/ NK29-12416	Action Item 2014-07-5397 – BRPD-AB-2014-010	Human Performance Management and Verification of Work Four suggestions for improvement: Change and Records Management, Application of ALARA	Meets requirements; two areas requiring improvement required corrective action. Plans submitted. Action Item closed
NK21-12110	BRPD-A-2015-003 Unit 1 Planned Outage Inspection (Section 4 Radiation Protection)	Radiation Protection – Worker Dose Control or Radiological Hazard Control	No issues
NK21-12187 / NK29-12609 NK21-12405 / NK29-12815 NK21-12445 / NK29-12856	BRPD-AB-2015-007 – Radiation Hazard Control Action Item 2015-07-7037	Radiological Hazard Control - Radiological Hazard Surveys and Control Programs and Radiation Monitoring Equipment and Instrumentation.	Status update on improvements made to processes and procedures provided on 8 action requests. Further replies expected by mid-2016

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-11507/ NK29-11891 NK21-11547/ NK29-11929 NK21-11684/ NK29-12074	REGDOC-3.1.1 (formerly S-99) Reporting	Improve preliminary report timeliness; improved detailed reports	Meeting S-99 reporting requirements
NK21-11025	BRPD-A-2013-008 – Human Performance	Management should focus on high priority tasks; consider involving HF design group in the performance monitoring of implemented design changes and including HF experience in the HU program	Significant gains in HU made; plans in place to improve further
NK21-08638 NK21-08673 NK21-08746	Action Item 110719 – BRPD-2011-R-010 – OPEX	Training qualification record deficiency;	Action Item closed as part of Unit 1 and 2 Return to Service.
NK21-11262 / NK29-11868 NK21-11380 / NK29-11783 NK21-11534 / NK29-11921 NK21-11913 / NK29-12294 NK21-12206 / NK29-12570	Action Item 2014-07-4687 - BRPD-AB-2014-002 - Condition Assessment Inspection	Improvement of BP-PROC-00498 to use a consistent list of systems important to safety and implementation of a risk-informed decision making process for opportunities for improvement Concerns with respect to Primary Heat Transport System vibration Small Project Refurbishments	Satisfactorily implemented BP-PROC-00498 not updated (see SF8-1 in Table 10) but meetings held with CNSC staff to discuss improvements and plans for BP-PROG-11.01 and -11.03 as part of SF reviews and asset management.
NK21-04168 / NK29-05976 NK21-06165 / NK29-07511 NK21-06776 / NK29-07948 NK21-08296 NK21-08643/ NK29-09378 NK21-11635 / NK29-12021 NK21-11765 /	Environmental Monitoring System (EMS) at Bruce Site Inspections of the Implementation BRPD-2010-AB-010 Action Item 1407-4709 – Refurbishment Annual Follow-up Inspection of establish EMS BRPD-AB-2014-013, Environmental Monitoring Effluent Monitoring Program	Radiological Environmental Monitoring Program review Improvements recommended for sampling outside of the Stations	Meeting requirements Section 5.11 discusses the EMS Report and CNSC annual review of the report.

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK29-12162 NK21-12094 / NK29-12504 NK21-12595 / NK29-13022	2015 Type II Compliance Inspection Planned Effluent Monitoring Program 2016 Type II Compliance Inspection Planned		
NK21-11653	Action Item 2014-07-5291 - Reactive Inspection of Bruce Power's Housekeeping and Fire Loading Practices During the 2014 Unit 3 Planned Outage - BRPD-A-2014-005	housing keeping and fire loading issues	Reactive Inspection Numerous Fire Inspections and Review of Drills in 2014 and 2015 showing improved compliance (e.g., NK21-12213/NK29-12641; NK21-12306/NK29-12736)
NK21-09539 NK21-09628 NK21-09735	Action Item 1207-3289 – BRPD-R-2012-0019 – Safety System Tests	Improvement to notification of commissioning testing	Advance notification required. No issues with test. Closure of Action Item 1207-3289
NK21-11802/ NK29-12190 NK21-11845 / NK29-12239 NK21-12501 / NK29-12925	BRPD-AB-2014-015 – Action Item 2014-07-5700 – Development, Maintenance and Use of Procedures	Verification Procedures particular maintenance ones Verification and changes to SSTs DCR Backlogs DCR categorization and corrective actions for ensuring technical changes correctly identified	Improvements to Procedures planned Changed procedures with Critical Steps to Continuous Use from Reference Use 4 categories of DCRs based on risk importance; trending the technical category Maintenance DCR backlog trend reversed in 2014 Operations backlog reviewed more closely in 2015.
NK21-10716 / NK29-11103 NK21-10899 / NK29-11274	BRPD-AB-2013-014 - Waste Management Program Hazardous Waste Management	Recommendations for improvement include: Dedicated chemical technician like Bruce B; official log book for waste accounting; inventory list be taken of chemical cabinets; separation of the oil and water within the hazardous waste facility.	Bruce Power responded to the audit via the completion of AR 28403812. The response was provided to the CNSC via an e-mail: February 28, 2014 11:40 AM, captured in the BNPD Informal Environmental Regulatory Communication folder.

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-10695 / NK29-11079 NK21-10857 / NK29-11326 NK21-11132 / NK29-11534 NK21-11251 / NK29-11658	Action Item 1307-4229 – BRPD-AB-2013-008 – Preventative Maintenance Oversight Group (PMOG) Inspection	BP-PROC-00501 consistency with S-99 and BP-PROC-00456; equipment risk justifications for deferrals; aggregate risk needs to be considered; multiple deferrals; high PM backlog	Deferral Technical Evaluation performed; SCR raised for multiple deferrals; procedures revised; PMOG or Operations Manager accepts responsibility for medium and high risk deferrals.
NK21-12024 / NK29-12407 NK21-12278 / NK29-12707 NK21-12317 / NK29-12749 NK21-12432 / NK29-12845	BRPD-AB-2015-004 Fukushima Verifications Action Item 2015-07-6855	Document Inconsistencies and non-compliances with procedures covering the writer's guide for station system procedures and human factors engineering program plan. DPT-PDE-00013, to be revised for mid-2016; ARs raised and on track. BP-PROC-00250 Sheet 009 to be created for EMEs DCRs against MMP-34240-00001.	Inspection Summary - Meet the regulatory requirements Agreed to address inconsistencies and non-compliances in internal procedures. Action Item 2015-07-6855 Closed
NK21-11717 / NK29-12106 NK21-11126 NK21-12162 / NK29-12578 NK21-12047 / NK29-12427 NK21-12152 / NK29-12563	BRPD-A-2013-010 - Emergency Mitigating Equipment and Operating Procedures, Minimum Staff Complement Validation Action Items 080702 and 1407-4703: Corporate Emergency Exercise Evaluation Report	Emergency Mitigation Equipment, Operating Procedures and Minimum Staff Complements	Provided information of exercises with respect to recovery from a station blackout. Closure of action items requested
NK21-12232 NK21-12309 NK29-12443 NK29-12519 NK29-12592	Action Item 2015-07-6785 BRPC-A-2015-002 - Equipment Reliability – Systems Review DPT-PE-00008 DPT-PE-00009 DPT-PE-00010	Documentation consistency and improvements Operational challenges consistently identified in System Health Improvement Plans	Documentation improvements suggested and acknowledged and improvement plans provided to CNSC e.g., System Health Checklist Action Item closed

NK21/ NK29 CORR-00531	Bruce A and/or B Compliance Inspection Report	Issues	Summary Comments
NK21-12495 / NK29-12911 NK21-12616 / NK29-13044	Action Item 2015-07-7231 – BRPD-AB-2015-008 – Implementation of the Reliability Program BP-PROG-11.01	Documented training Identification of systems important to safety (SIS) Unavailability models for SIS Monitoring of equipment failures and unavailability time Updating procedures Ranking of SIS RD/GD-210 compliance PM deferral process BP-PROC-00456	Review of Annual Reliability Reports conducted. Milestones to update the reports were established with completion dates in time for the next annual update provided to the CNSC in 2017. External hazards are to be included in 2018. Bruce Power requested closure of Action Item 2015-07-7231. No findings with respect to Reactor Safety Control
NK29-12414 NK29-12489	BRPD-B-2015-001 Bruce B Outage Action Item 2015-14-6226	One action item and 2 recommendations Implement a corrective action plan to correct milestone non-compliances. Ensure timelines are practical.	Data from outage improvements to be provided by June 2017 (REGM raised)
NK29-12682	BRP-2016-002 Environmental Qualification (EQ)	RD/GD-210 compliance EQ Health Reports DPT-PE-00008 DPT-PE-00009 DPT-PE-00019	Planned Inspection in 2016
NK21-12194 NK29-12615	Control Room Shift Supervisor Simulator-based Certification Examinations	Compliance with Examination Guide EG-2 [24]	Planned inspection in 2016.
NK29-12657	BRPD-B-2015-003 2015 Planned Station and Vacuum Building Outage	Outage Heat Sink Review Radiation Protection Regulatory Commitments Worker Dose Radiological Hazard Control Maintenance Backlogs Housekeeping and Fire Loading	No enforcement actions or deficiencies identified.
NK29-12768	BRPD-B-2015-005 2015 Unit 6 Planned Outage	Regulatory Undertakings Corrective Maintenance Outage Backlog Outage Heat Sinks Reactor Shutdown Guarantees Overpoisoned Guaranteed Shutdown State Radiation Protection Review Housekeeping and Fire Loading	No enforcement actions or deficiencies identified.

CNSC Type II Compliance Inspection Report, BRPD-AB-2014-004, Action Notice AN2 highlighted instances of non-compliance with procedures requiring annual or bi-annual FASAs to be conducted. These issues were addressed immediately by SCRs 28428688 and 28428961. Additionally SCR 28448865 resulted in an action plan to ensure the issues were rectified prior to the 2015 Self Evaluation Annual Planning per SA-PI-2014-04 and the

delinquent PROGs identified and changed to ensure the appropriate oversight embedded in their procedures. These actions were completed.

Reactive Inspections point out the CNSC felt the need to conduct an unplanned more detailed inspection due to an observation during routine inspections. An increase in frequency of these inspections is an indication of poor performance but this has not been the case, as a review shows the number of inspections has fluctuated from 2 in 2009 to 3 in 2014 with peaks of 4 in 2011 and 2013. In 2010 and 2012 there were none.

7.3.2. Regulatory Quarterly Field Inspections

In addition to the Type I and II CNSC Inspections, thirteen Quarterly Field Inspection Reports were completed by CNSC staff from the last quarter of 2011 through 2014[13] covering the field surveillance inspections conducted to cover the CNSC Safety Control Areas which are closely aligned to the IAEA SSG-25 Safety Factors. An addition five Quarterly Field Inspection Reports were completed from the end of 2014 through 2015. These are shown in Table 9.

The CNSC staff Compliance and Verification activities did not find evidence of unsafe operation that would result in undue risk to health and safety of persons, the environment, or that would compromise respect of Canada's international obligations. Major issues result in an Action Item being opened so the issue resolution can be tracked by the Regulator. Minor issues are usually corrected immediately by Station staff or acceptable responses for the issues were provided. Major issues were reviewed to see if they impacted Safety Performance but no gaps were identified as the CNSC would have requested quick remedial action.

Table 9: Quarterly Field Inspections Reports Completed by CNSC Staff Between 2011 and 2015

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-06987 / NK29-08135	BRPD-2009-AB Field and Control room Inspections Identifies inspections performed for restart and Bruce B for 2009	27	Information Purposes No actions placed	None
NK21-09267 / NK29-09894	BRPD-2011-AB-019	16	Seismic restraining; Radiation protection, Maintenance backlogs Information Purposes No actions placed	None

[13] Note the CNSC quarters start with Q1 being April to June, as their fiscal year starts in April.

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-09826 / NK29-10396 NK21-09947 / NK29-10386 NK21-10226 / NK29-10631 NK21-11808 / NK29-12198 NK21-12556 / NK29-12982	BRPD-AB-2012-008 Action Item 1207-3510	11	5 areas with minor findings; 15 positive findings; Maintenance backlogs Work Request Tagging Operator Walk-downs; 3 action notices and 1 recommendation Need to show a downward trend in Control Room Deficiency type operator challenges. Removed many, but redefined what was included in Control Room Deficiencies due to an incorrect flagging of work orders. Corrective actions have been put in place to resolve this issue. Bruce Power confident the backlog reduction efforts are effective but committed to another update in 2016.	None
NK21-10080 / NK29-10496	BRPD-AB-2012-014	16	16 positive findings; 7 areas with minor findings; key area: Maintenance backlogs; Information Purposes No actions placed	None
NK21-10247 / NK29-10656	BRPD-AB-2012-017	16	13 positive findings; Issues found in 9 areas; fire blanket use for combustible material; scaffolding, work requests for Control Room Panels Information Purposes	2 recommendations (page 43)
NK21-10539 / NK29-10945	BRPD-AB-2013-005	16	18 positive findings; 5 areas minor issues; Key - Elective Maintenance Work Request high backlogs; 3 action notices and 2 recommendations on elective maintenance Information Purposes	None
NK21-10731 / NK29-11118 NK21-10930 / NK29-11309	BRPD-AB-2013-010 – Action Item 1307-4270 Emergency Mitigating Equipment and Operating Procedures, Minimum Staff Complement Validation	11	16 positive findings; 6 areas of minor issues; 3 areas needing improvement; Operator Surveillance, (Elective) Deficient Maintenance Work Requests; Scaffold inspections	1 Action Notice and 1 recommendation (page 44) Closed

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-11018 / NK29-11414	BRPD-AB-2013-015	16	18 positive findings; 4 areas of minor issues; 3 areas needing improvement; Operator Surveillance, (Elective) Deficient Maintenance Work Requests; Whole body counters; 1 action notice and recommendation No formal actions	None
NK21-11194/ NK29-11598	BRPD-AB-2014-001	16	21 positive findings; 2 areas of minor issues; 2 areas needing improvement; Operator Surveillance, (Elective) Deficient Maintenance Work Requests; Whole body counters; No formal actions -1 recommendation - Improve tagging	None
NK21-11354 / NK29-11755	BRPD-AB-2014-003	13	17 positive/ compliant findings; 6 areas of minor issues; 2 areas needing improvement: Operator Surveillance, (Elective) Deficient Maintenance Work Requests No formal actions	None
NK21-11381 / NK29-11784	BRPD-AB-2014-005		1 small area for improvement; 1 recommendation on Fukushima implementation with respect to Unit 4 Safety Relief Valve instrument air hoses for consistency with the other Bruce A units. No formal actions; 1 recommendation - Concurrence on procurement of equipment and modifications to date as consistent with progress updates	None
NK21-11551 / NK29-11932 NK21-11607 / NK29-11987	BRPD-AB-2014-008 Action Item 2014-07-5336	11	17 compliant findings; 5 areas of minor issues; 4 areas needing improvement: Deficient Maintenance Work Requests, Housekeeping, combustible material management and scaffolding inspection; 1 action notice (page 43), otherwise meeting regulatory requirements. Reviewing the process for inspecting scaffolds	None

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-11698 / NK29-12088	BRPD-AB-2014-011	17	18 compliant findings; 5 areas of minor issues; 4 areas needing improvement: Deficient Maintenance Work Requests, and scaffolding inspection; No formal actions Meeting regulatory requirements.	None
NK21-11896 / NK29-12283 NK21-11946 / NK29-12327 NK21-12092 / NK29-12499	BRPD-AB-2014-020 Action Item 2015-07-5155 Report for Q3 2014-15 – October 1 to December 31, 2014 • Operating Performance • Maintenance • Fitness for Service • Radiation Protection • Radiological Hazard Control • Environmental Protection • Waste Minimization	17 compliant findings	9 areas where minor non-compliances with internal procedures. One area with respect to combustible material management received an action notice. Otherwise meeting regulatory requirements. A recommendation was raised on processes for removal of compressed gas cylinders to better align with industry best practices. Previously during the compliance audits had flagged a maintenance high backlog of deficient work. Looking for a corrective action plan to ensure sustained compliance rather than a one-time walkdown to ensure only approved combustibles are stored in the Extended Storage Work Area.	One formal action placed
NK21-12153 / NK29-12565	BRPD-AB-2015-003 Report for Q4 2014-15 – January 1 to March 31, 2015 • Operating Performance • Maintenance • Fitness for Service • Radiation Protection • Radiological Hazard Control • Worker Dose Control • Effluent and Emission Control • Waste Minimization	25 compliant findings	5 areas where minor non-compliances with internal procedures. With respect to combustible material management a repeat finding arose as combustibles are being stored without fire blankets. CNSC Investigation revealed this was a minor non-compliance. No formal actions placed Meeting regulatory requirements.	None

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-12285 / NK29-12715 NK21-12353 / NK29-12779	BRPD-AB-2015-006 Action Item 2015-07-5489 Report for Q1 2015-16 – April 1 to June 30, 2015 • Operating Performance • Maintenance • Fitness for Service • Radiation Protection • Worker Dose Control • Radiological Hazard Control • Environmental Protection • Waste Minimization	21 compliant findings	8 areas where minor non-compliances with internal procedures. Two action notices raised and Bruce Power has: Documented the non-compliance with BP-PROC-00907 Protected Equipment Program. Staff regularly monitors Single Point Vulnerabilities and ensures the remaining equipment is fit for service and not inadvertently impacted. Protected Pathways are set up around in-service pieces of the redundant equipment. A reviewed of this process and a shift crew briefing to all crews with regards to expectations has been initiated. This briefing followed up with Observation and Coaching Reports to ensure compliance. Documented the non-compliance with BP-PROC-00060 Station Condition Record Process. A review concluded the responsibility to submit Station Condition Records for all adverse conditions observed including by CNSC staff (and other outside regulatory agencies) is clear in the procedure. The expectation was reinforced to affected staff via a Manager's Message to ensure compliance in the future. Otherwise meeting regulatory requirements.	2 Action Notices addressed ARs 28520810 and 28520800
NK21-12492 / NK29-12910	BRPD-AB-2015-011 Report for Q2 2015-16 – July 1 to September 30, 2015 • Operating Performance • Maintenance • Fitness for Service • Radiological Hazard Control • Worker Dose Control • Effluent and Emission Control • Waste Minimization	18 compliant findings	11 areas where minor non-compliances with internal procedures No formal actions placed Meeting regulatory requirements.	None

NK21 / NK29-CORR-00531	Bruce A And B Quarterly Field Inspection Report	# of field inspections Bruce A & B	Minor Issues	Major Issues / comments
NK21-12619 / NK29-13047	BRPD-AB-2015-013 Report for Q3 2015-16 – October 1 to December 31, 2015 • Operating Performance • Maintenance • Fitness for Service • Radiation Protection • Radiological Hazard Control • Environmental Protection • Waste Minimization	21 compliant findings	9 areas where minor non-compliances with internal procedures and the intent of the regulatory requirements being met. No formal actions placed Meeting regulatory requirements	None

7.4. Performance Indicators

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

Performance indicators relevant to the safety performance of the Station include Chemistry, Health and Safety, Plant Status, Audits and Assessments, Corrective Action, Human Performance, Reactivity Management, Operator Experience, Radiation, Staff Qualification, Security, Maintenance and Reliability, and Emergency Preparedness.

In addition, Bruce Power submits quarterly reports of Performance Indicators to the CNSC, in compliance with CNSC REGDOC-3.1.1. These quarterly reports include data on industrial accidents, chemistry, change control, emergency preparedness, non-compliances, preventative maintenance, radiation, SSTs, unplanned transients, unplanned capability loss factor and power history.

The following FASAs are relevant to Performance Indicators related to safety performance of the Station and address Section 1.2 Review Task 2:

- SA-RA-2013-02, Assess Timeliness of S-99 Preliminary Reporting.
- SA-AUD-2013-02, Effectiveness of Industry Oversight Metrics.
- SA-AUD-2014-02, Stakeholder Review of Assessment Process.

These FASAs showed Bruce Power had many strengths in ensuring compliance with REGDOC-3.1.1 requirements and few opportunities for improvement. Improvements were made to the Event Reporting process for preliminary REGDOC-3.1.1 reports. The performance indicator metrics review showed Bruce Power was effectively communicating the metrics within and outside the NORA department but should consider adding two more metrics. By 2014 the FASAs did not identify any adverse conditions.

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, Regulatory

Oversight Report for Canadian Nuclear Power Plants: 2014, issued in September 2015 [195], summarizes the 2014 ratings for Canada's NPPs in each of the 14 CNSC SCAs, and presents an integrated plant rating. Overall, the review for 2014 showed that Bruce B's performance was fully satisfactory, improved from the 2013 rating of satisfactory.

7.5. Operational Readiness Reviews

Prior to each Outage the Department Manager responsible for the outage reviews contingency plans, and lessons learned from previous outages to ensure Safety Performance is maintained. High Impact Teams are established and trained to address potential vulnerabilities. Outage Improvement Initiatives such as scope control, 72-hour look-a-heads, accountability reviews, daily metric reviews, vault access and re-enforcement of WANO leadership behaviours have been established. Both Reactor Safety and Radiation Safety are key pillars in all reviews. The focus of the outage reviews is to ensure risks are identified, then prevented and/or mitigated. Each outage has metrics on items such as: unplanned reactor configuration changes, overall dose, personnel contamination, lost time incidents and environmental spillage. Targets are established and monitored throughout the outages and stretch targets are set to focus on continuous improvement. Radiation Protection throughout the outage and dose control ALARA are key items of consideration.

From a Safety Performance perspective outages are key times both from the perspective that some safety systems may be taken out of service so there are fewer barriers available following postulated initiating events, and they provide the opportunity to improve the condition of the systems important to safe performance.

Key FASAs relevant to outage operational readiness include:

- SA-OGO-2013-01, Maintenance & Test Equipment (M&TE).
- SA-OGO-2014-01, Self-Assessment – B1451 PO-6 Meeting.

SA-OGO-2013-01 highlighted numerous shortcomings in the M&TE resulting in weaknesses of the calibration of this equipment. Workgroups and management responsible for this area are now receiving reports on overdue M&TE performance to focus resources on improving the performance. The Tool Specialists and Single Points of Contact understand the process for removing these assets.

SA-OGO-2014-01 was a self-assessment to ensure outage readiness. This assessment recommended the addition of an improved Aggregate Plant Health Outage related indicator which was then used in subsequent outages. Outage Readiness Reviews, e.g., SA-OGO-2013-04, B1471 PO-2 Readiness Review and SA-OGO-2013-01, A1241 Pilot Assessment, are conducted by the Manager responsible for the outage. Safety and Human Performance discussions lead the department presentations during these reviews. The reviews are conducted prior to the outages to ensure staff has the resources and knowledge to conduct the outages effectively.

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 Safety Performance Safety Factor covers a broad range of safety-related areas. The specific objective of the review of this Safety Factor is to determine whether the plant's safety performance indicators and records of operating experience, including how the Station evaluates and overcomes root causes of plant events that arise and whether there is a need for safety improvements. This specific objective has been met by the completion of the review tasks specific to safety performance.

There were few strengths or opportunities for improvement above those identified in the other Safety Factors or based on a review of the Station audits, self-assessments, the Regulatory inspections, the internal NORA review against the WANO 2013 Performance Objectives and Criteria and the external NIEP evaluation.

A strength involves the commitments to improvements that are systematically being undertaken, based on the strong direction and guidance from NORA, both in their audit and assessment reviews and their push to comply with more recent Regulatory Documents, Guidance Documents and Standards. The organization was re-organized to improve their focus on both Audits and Assessments and has committed to the CNSC to introduce a risk-informed process to their audits and assessments process to ensure risk significant areas are reviewed more frequently.

NORA and Performance Improvement documents that summarize information for easier review by management include:

- Quarterly NORA Oversight Reviews covering audits and performance based assessments per Nuclear Oversight Management, BP-PROG-15.01 [180]; and
- Quarterly Focus Area Self Assessment Status & Summary Reports from Performance Improvement per BP-PROG-01.06, Operating Experience Program [107].

Furthermore, the audit organization has a well-developed Auditor Training program which used a Systematic Approach to Training based training design. Job Task Analysis is documented for knowledge and skill elements. The training program is documented and aligned to develop proficient auditors upon completion of qualifications. Auditors are professional and meet expectations of managers for performance as qualified auditors.

Bruce Power's organization shares Safety Performance OPEX, Compliance Reporting and Corrective Action processes as commonly-maintained programs with Bruce B, thus observations and lessons learned at Bruce B can be used at Bruce A. Additionally, there is an opportunity to share knowledge from Bruce B by transferring mangers to Bruce A and vice-versa. Strengths at each station and means to prevent, mitigate and accommodate less desirable situations are shared to increase the corporate knowledge and experience.

Bruce Power's leading role in the modification of the 37-element fuel design (37M) ensured the requirements were understood and fully incorporated, thus ensuring integration of the design and manufacturing aspects from multiple vendors who supported the project. This strength was important in ensuring the safety improvement was completed on schedule, implemented to Operation's satisfaction and as committed to the CNSC.

Table 10 summarizes the key issues arising from the Integrated Safety Review of Safety Factor 8.

Table 10: Key Issues

Issue Number	Gap Description	Source(s)
SF8-1	BP-PROC-00498 was to be revised, obsoleted or integrated in Equipment Reliability program so as to continually better prioritize activities.	Sections 5.14.2 and 7.3.1
SF8-2	The Safety Report Improvement Project needs to capture changes in Margin Management and adverse trend in the erosion of margin in LBLOCA. The Safety Analysis Improvement Program needs to show the additional margins in LBLOCA analysis by completing the work planned under the Composite Analysis Approach for LBLOCA.	Section 5.3
SF8-3	The integrated time frame from conceptual design to station implementation for Nuclear Safety improvements that restore safety margins (e.g., heat transport high pressure trip on Units 3 and 4) should be reviewed to find opportunities to more efficiently implement the safety improvement.	Section 5.7
SF8-4	The Safety Report Analysis of Record for single and dual Heat Transport pump events needs to be updated, with consideration of improvements, such as the modified 37-element fuel bundle.	Section 5.6
SF8-5	The documentation coverage for postulated initiating events not explicitly addressed in the Safety Report or Probabilistic Safety Assessments (PSAs) needs to be improved. Neither the Safety Report deterministic safety analysis nor the PSAs explicitly include Crane Hazard analysis. Complete Hazard Analysis of Record and integrate it with the Deterministic Analysis and PSAs Analysis of	Section 5.7

Issue Number	Gap Description	Source(s)
	Records.	
SF8-6	Produce design documentation that explains the relationship and impact of the Fukushima type changes on the design basis, safety analyses and assessments, as they have been included in the licensing basis. This is necessary to ensure that when the Design Basis Assumptions change the changes to the Design Basis and Configuration Management implications are documented and understood. As appropriate, ensure Design Guides, Design Requirement and Design Manuals are updated appropriately, including capturing of Design Extension conditions if appropriate.	Section 5.13
SF8-7	Not all Bruce Power Programs readily map to the Safety Factor Reports. BP-PROC-01024 [4] should consider mapping each program to the respective Safety Factor Reports in Section 4.6 of the procedure to ensure completeness of items impacting the four pillars of safety. BP-PROC-00936 [104] should interface with BP-PROC-01024 [4] as the PSR is an input to the procedure.	Section 4.7
SF8-8	Updated versions of INPO documents are not always considered when governance documents are revised, nor was a governing procedure found to periodically review INPO, WANO and/or IAEA suggestions for improvement to confirm how they might improve Bruce Power governance documents.	Section 7.2
SF8-9	BP-PROC-00169 is not affiliated with a Program. Define the Program which BP-PROC-00169 implements.	Section 4.1, Table 6, footnote 6
SF8-10	The following PROGs, PROCs have not been revised within the required 3 year timeframe per BP-PROC-00166: General Procedure and Process Requirements and a review of the PassPort action	Section 7.2

Issue Number	Gap Description	Source(s)
	requests does not always provide evidence that the standard 3-year review has been completed and recommended no changes or whether the review has been deferred to a later date: BP-PROG-01.01-R005, Business Planning Program, February 5, 2010 [103] BP-PROG-11.02-R006, On-Line Work Management Program, October 2012 [159] BP-PROC-00169-R002, Safety Related System List, September 2007 [182] BP-PROC-00498-R006, Condition Assessment of Generating Units in Support of Life Extension, February 3, 2011 [144] BP-PROC-00735-R002, Long Range Cycle Planning Process, August 28, 2012 [162] BP-PROC-00795-R000, Human Performance Tools for Knowledge Workers, March 30, 2011 [102] BP-PROC-00839-R000, Reporting to CNSC/IAEA – Safeguards, June 21, 2012 [129] DPT-NSAS-00003-R004, Guidelines for Evaluating and Prioritizing Safety Report Issues, September 2011 [134] DPT-PE-00005-R000, Performance Requirements for Contamination Exhaust Control Filters, February 23, 2005 [148] SEC-EQD-00035-R002, Environmental Qualification Sustainability Monitoring, November 15, 2012 [131]	
SF8-11	ARs 28456029, 28456034, 28456045, on BP-PROC-00666, raised during AU-2014-00024 are not identified in PassPort against the document as either DCRs or ARs yet the audit ARs identity shortcomings against the document with respect to errors, omissions, misalignment and conflicting processes. Suggest all ARs against a document be linked to the document so users of the procedure are aware of the shortcomings.	PassPort and Section 7.2

Issue Number	Gap Description	Source(s)
SF8-12	Review of safety analysis to ensure it has been comprehensively been captured in the safe operating envelope via the Operational Safety Requirements documents.	Section 5.3

Based on this review, it is concluded that Bruce B complies with the requirements of the recent codes and standards for Safety Performance.

The overall conclusion is Bruce Power's programs meet the requirements of the Safety Factor related to Safety Performance, including when considering the gaps and improvements noted in Table 10.

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

No codes or standards relevant to Safety Factor 8 were subjected to high-level assessment. This Appendix is retained only for consistency with the Appendix numbering scheme in all other Safety Factor Reports.

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

No codes or standards were assessed in Safety Factor 8. WANO GL 2004-01, Guidelines for Radiological Protection at Nuclear Power Stations was subjected to a clause-by-clause assessment in Safety Factor 15.