FORM-14159 R000*

Periodic Safety Review - Final Document Review Traveler

Bruce Power

Bruce Power Document #:	Revision:	Information Classification	Usage Classification
NK29-SFR-09701-00009	R000	Internal Use Only	Information

Bruce Power Document Title:
Safety Factor 9 – OPEX and R&D

Bruce Power Contract/Purchase Order:	Bruce Power Project #:
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Supplier's Name:	Supplier Document #:	Revision:
CANDESCO	K-421231-00209	R00

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Safety Factor 9 – OPEX and R&D

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

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Bruce Power Document #	NK29-SFR-09701-00009	**Rev #** R000	**Information Classification:** Internal Use Only		**Usage Classification:** Information
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Division of Kinectrics Inc.

NK29-SFR-09701-00009

Title: Safety Factor 9 - OPEX and R&D

File: K-421231-00209-R00

A Report Submitted to Bruce Power

September 20, 2016

Issue R00D0	**Reason for Issue:** For harmonization				
	Author: D. Rennick	Verifier:	Reviewer:	Approver:	Date: April 23, 2016
Issue R00D1	**Reason for Issue:** For internal review				
	Author: D. Rennick	Verifier:	Reviewer: L. Watt G. Archinoff	Approver:	Date: April 26, 2016
Issue R00D2	**Reason for Issue:** For Bruce Power review				
	Author: D. Rennick	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: June 1, 2016
Issue R00D3	**Reason for Issue:** Addresses Bruce Power review comments and internal verification comments.				
	Author: D. Rennick	Verifier: G. Buckley	Reviewer: L. Watt G. Archinoff	Approver:	Date: August 24, 2016

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

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Acronyms and Abbreviations

AAR	After Action Report
ACE	Apparent Cause Evaluation
AFI	Area For Improvement
ANDE	Advanced Non-Destructive Examination
AOPA	OPEX Applicability Review
AOPX	OPEX Basic Action
AR	Action Request
ASLF	Acres-Sargent & Lundy-Fox
ASRT	Annulus Spacer Removal Tool
BARSA	Bruce A Restart Safety Analysis
BDBA	Beyond Design Basis Accident
BDBE	Beyond Design Basis Event
BP	Bruce Power
BRIMS	Bruce Reactor Inspection and Maintenance System
BRPD	Bruce Regulatory Program Division (CNSC)
CAMEO	Corrective Action Management Effectiveness Oversight
CANDU	CANada Deuterium Uranium
CAP	Corrective Action Program
CAPCO	Corrective Action Program Coordinator
CARB	Corrective Action Review Board
CE	Construction Experience
CFAM	Corporate Functional Area Manager
CHF	Critical Heat Flux
CIGAR	Channel Inspection and Gauging Apparatus for Reactors
CNS	Convention on Nuclear Safety
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
CSTA	Calandria-Shield Tank Assembly

CT	Calandria Tube
CTR	Calandria Tube Replacement
CWEST	Circumferential Wet Scrape Tool
DCN	Design Change Notice
DCR	Document Change Request
DM	Delivery Machine
EACE	Equipment Apparent Cause Evaluation
ECI	Emergency Coolant Injection
EDMS	Electronic Data Management System (PassPort Subsystem)
EFADS	Emergency Filtered Air Discharge System
EME	Emergency Mitigating Equipment
EOF	Emergency Operations Facility
EPRI	Electric Power Research Institute
ER	Effectiveness Review
ERCI	Equipment Root Cause Investigation
ESW	Emergency Service Water
F&P	Fischer and Porter
FAIs	Fukushima Action Items
FASA	Focus Area Self Assessment
FCLCMP	Fuel Channel Life Cycle Management Plan
FLMP	Fluid Leak Management Program
FME	Foreign Material Exclusion
FOAK	First of a Kind
GET	General Employee Training
HFESR	Human Factors Engineering Summary Report
HMI	Human Machine Interface
HU	Human Performance Program
IAEA	International Atomic Energy Agency
IIP	Integrated Implementation Plan
INPO	Institute of Nuclear Power Operations
INSAG	International Nuclear Safety Advisory Group
ISR	Integrated Safety Review

JHSC	Joint Health and Safety Committee
JIT	Just in Time
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plan
LISS	Liquid Injection Shutdown System
LOPE	OPEX Evaluation (Line accountable)
LTEP	Long Term Energy Plan (Ontario)
MCR	Major Component Replacement
MEL	Master Equipment List
MODAR	Modal Detection and Repositioning
MoE	Ministry of the Environment (Ontario)
MoL	Ministry of Labour (Ontario)
MOPT	External OPEX Report Template (MRM accountable)
MRM	Management Review Meeting
MSM	Management System Manual
NDE	Non-Destructive Examination
NEI	Nuclear Energy Institute
NIEP	Nuclear Industry Evaluation Program
NORA	Nuclear Oversight and Regulatory Affairs
NPP	Nuclear Power Plant
NQML	Nuclear Quality Management Leadership
NRC	National Research Council
NSA	Nuclear Safety Assessment
NSASD	Nuclear Safety Analysis and Support Department
NSCA	Nuclear Safety and Control Act
NSCMP	Nuclear Safety Culture Monitoring Panel
OE	Operating Experience
OEF	Operating Experience Feedback
OER	Operating Experience Report/Review
OFI	Opportunity for Improvement
OPEX	Operating Experience
OSART	Operational Safety Review Team (IAEA)

PBQAP	Pressure Boundary Quality Assurance Program
PDS	Problem Development Sheet
PI	Performance Improvement, Plant Integration (by context, both are organizational groups)
PJB	Pre-Job Brief
PMC	Project Management and Construction
PORC	Plant Operations Review Committee
PROL	Power Reactor Operating Licence
PSR	Periodic Safety Review
R&D	Research & Development
RCI	Root Cause Investigation
RM	Responsible Manager
SAMG	Severe Accident Management Guidelines
SAT	Shift Assistant Technical
SBR	Safety Basis Report
SCA	Secondary Control Area
SCR	Station Condition Record
SER	Significant Event Report
SFCR	Single Fuel Channel Replacement
SFR	Safety Factor Report
SLAR	Spacer Location and Repositioning
SMART	Specific, Measureable, Achievable, Realistic, Timely
SME	Subject Matter Expert
SOER	Significant Operating Experience Report (WANO/INPO)
SSC	Structure, System, and Component
SUI	Start-up Instrumentation
SUU	Start-up Unit
TBA	Technical Basis Assessment
TCR	Training Change Request
UDM	Universal Delivery Machine
US NRC	United States Nuclear Regulatory Commission
VMB	Visual Management Board

WANO	World Association of Nuclear Operators
WCNGS	Wolf Creek Nuclear Generating Station
WER	WANO Event Report
WS+	West Shift Plus
WSM	Weekly Screening Meeting

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 there is adequate feedback of safety experience from nuclear power plants (both internal and external) or other pertinent operating experience from relevant non-nuclear facilities and of the findings of research.

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. Verify that arrangements are in place for the feedback of experience relevant to safety from other nuclear power plants and from relevant non-nuclear facilities;
2. Review the effectiveness of such programmes for the timely feedback of operating experience and for their output;
3. Review the processes for assessing and, if necessary, implementing research findings and findings from operating experience relevant to safety.

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 Factors that are reviewed in the current PSR. Appendix F of [18] provides a full chronology of Bruce Power safety reviews up to 2013.

The Bruce B PSR Safety Factor review process comprises the following steps:

1. **Interpret and confirm review tasks:** As a first step in the Safety Factor review, the Safety Factor Report author(s) confirm the review tasks identified in the PSR Basis Document [5] and repeated in Section 1.2 to ensure a common understanding of the intent and scope of each task. In some cases, this may lead to elaboration of the review tasks to ensure that the focus is precise and specific. Any changes to the review tasks are identified in Section 5 of the Safety Factor Report (SFR) and a rationale provided.
2. **Confirm the codes and standards to be considered for assessment:** The Safety Factor Report author(s) validates the list of codes and standards presented in the PSR Basis Document against the defined review tasks to ensure that the assessment of each standard will yield sufficient information to complete the review tasks. Additional codes and standards are added if deemed necessary. If no standard can be found that covers the review task, the assessor may have to identify criteria on which the assessment of the review task will be based. The final list of codes and standards considered for this Safety Factor is provided in Section 3.
3. **Determine the type and scope of assessment to be performed:** This step involves the assessor confirming that the assessment type identified in Appendix C of the Bruce B PSR Basis Document [5] for each of the codes, standards and guidance documents selected for this factor is appropriate based on the guidance provided. The PSR Basis Document provides an initial assignment for the assessment type, selecting one of the following review types:
   - Programmatic Clause-by-Clause Assessments;
   - Plant Clause-by-Clause Assessments;
   - High-Level Programmatic Assessments;
   - High-Level Plant Assessments;
   - Code-to-Code Assessments; or
   - Confirm Validity of Previous Assessment.

   The final assessment types are identified in Section 3, along with the rationale for any changes relative to the assignment types listed in the PSR Basis Document.
4. **Perform gap assessment against codes and standards:** This step comprises the actual assessment of the Bruce Power programs and the Bruce B plant against the identified codes and standards. In general, this involves determining from available design or programmatic documentation whether the plant or program meet the provisions of the specific clause of the standard or of some other criterion, such as a summary of related clauses. Each individual deviation from the provisions of codes and standards is referred to as a Safety Factor “micro-gap”. The assessments, performed in Appendix A and Appendix B, include the assessor’s arguments conveying reasons why the clause is considered to be met or not met, while citing appropriate references that support this contention.

5. **Assess alignment with the provisions of the review tasks:** The results of the assessment against codes and standards are interpreted in the context of the review tasks of the Safety Factor. To this end, each assessment, whether clause-by-clause, high-level or code-to-code, is assigned to one or more of the review tasks (Section 5). Assessment against the provision of the review task involves formulating a summary assessment of the degree to which the plant or program meets the objective and provisions of the particular review task. This assessment may involve consolidation and interpretation of the various compliance assessments to arrive at a single compliance indicator for the objective of the review task as a whole. The results of this step are documented in Section 5 of each SFR.
6. **Perform program assessments:** The most pertinent self-assessments, audits and regulatory evaluations are assessed, and performance indicators relevant to the Safety Factor identified. The former illustrates that Bruce Power has a comprehensive process of reviewing compliance with Bruce Power processes, identifying gaps, committing to corrective actions, and following up to confirm completion and effectiveness of these actions. The latter demonstrates that there is a metric by which Bruce Power assesses the effectiveness of the programs relevant to the Safety Factor in Section 7. Taken as a whole, these demonstrate that the processes associated with this Safety Factor are implemented effectively (individual findings notwithstanding). Thus, program effectiveness, if not demonstrated explicitly in the review task assessments in Step 5, can be inferred if Step 5 shows that Bruce Power processes meet the Safety Factor requirements and if this step shows there are ongoing processes to ensure compliance with Bruce Power processes.
7. **Identification of findings:** This step involves the consolidation of the findings of the assessment against codes and standards and the results of executing the review tasks into a number of definitive statements regarding positive and negative findings of the assessment of the Safety Factor. Positive findings or strengths are only identified if there is clear evidence that the Bruce B plant or programs exceed compliance with the provision of codes and standards or review task objectives. Each individual negative finding or deviation is designated as a Safety Factor micro-gap for tracking purposes. Identical or similar micro-gaps are consolidated into comprehensive statements that describe the deviation known as Safety Factor macro-gaps, which are listed in Section 8 of the Safety Factor Reports, as applicable.

3. Applicable Codes and Standards

This section lists the applicable regulatory requirements, codes and standards considered in the review of this Safety Factor. Table C-1 of the Bruce B PSR Basis Document [5] identifies the codes, standards and guides that are relevant to this PSR. Modern revisions of some codes and standards listed in Table C-1 of the PSR Basis Document [5] have been identified in the licence renewal application and supplementary submissions for the current PROL [19] [20] [21]. Codes, standards and guides issued after the freeze date of December 31, 2015 were not considered in the review [5].

3.1. Acts and Regulations

The *Nuclear Safety and Control Act* (NSCA) [22] establishes the Canadian Nuclear Safety Commission and its authority to regulate nuclear activities in Canada. Bruce Power has a process to ensure compliance with the NSCA [22] and its Regulations. Therefore, the NSCA and Regulations were not considered further in this review.

As described in various International Atomic Energy Agency (IAEA) documents, all signatories to the international Convention on Nuclear Safety are required to have an Operating Experience (OPEX) program[1]. Canada is a signatory and the enforcement of this requirement falls to the CNSC. The CNSC ensures that the requirement is passed to nuclear utilities indirectly through including Canadian Standards Association (CSA) N286 in the licences. In Bruce Power, the program for OPEX and Research & Development (R&D) is BP-PROG-01.06, Operating Experience Program [24].

3.2. Power Reactor Operating Licence

The list of codes and standards related to Operating Experience, Research and Development 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.

[1] A portion of International Nuclear Safety Advisory Group INSAG-23 (IAEA 2008) [23], Section 1.1, states:

"4. By signing the international Convention on Nuclear Safety (CNS), each Contracting Party commits to taking the appropriate steps to ensure that:

> *"... incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body; [and that] programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies".*
>
> *All Contracting Parties have indicated in the review meetings of the CNS that they have such programmes in place. These programmes have been valuable. Nonetheless, events do recur and this gives INSAG reason to believe that the mechanisms for operating experience feedback are not as effective as they could be. INSAG concludes that significant safety benefits could be achieved by enhancing national and international OEF [Operating Experience Feedback] programmes.*

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

Document Number	Document Title	Modern Version Used for PSR Comparison	Type of Review
CNSC REGDOC-2.3.3	Periodic Safety Reviews	[3]	NA
CNSC REGDOC-3.1.1 (2014)	Reporting Requirements for Operating Nuclear Power Plants	[25]	NA
CNSC RD/GD-99.3 (2012) [26]	Public Information and Disclosure	[26]	NA
CSA N286-05 [27]	Management System Requirements for Nuclear Power Plants	CSA N286-12 [28]	NA
Assessment type: **NA**: Not Assessed; **CBC**: Clause-by-Clause; **PCBC**: Partial Clause-by-Clause; **CTC**: Code-to-Code; **HL**: High Level; **2SF**: Assessment performed in another SFR; **CV**: Confirm Validity of Previous Assessments			

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

CNSC REGDOC-3.1.1: Table C-1 of the PSR Basis Document [5] does not call for review of CNSC REGDOC-3.1.1. Compliance with this regulatory document is explicitly required under PROL Licence Condition 3.3, and therefore an assessment is not required.

CNSC RD/GD-99.3: Table C-1 of the PSR Basis Document [5] states that RD/GD-99.3 Public Information and Disclosure which establishes regulatory requirements for public information and disclosure for licensees is included in the current licence and accordingly no further assessment of RD/GD-99.3 requirements is performed for this PSR.

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” [29].

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 [30]. 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 [31]. 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 [32]. Per [32], the major milestones of the transition plan to N286-12 are as follows:

- 22 January 2016: Discuss all the regulatory actions and the transition plan at the Corporate Functional Area Manager (CFAM) meeting
- 31 December 2016: Revision of CFAM Program Document(s) [with LCH notification requirements to the CNSC] to comply with CSA N286-12 requirements completed.
- 31 March 2017: Revision of CFAM Program Document(s) [that do not have LCH notification requirements to the CNSC] to comply with CSA N286-12 requirements completed
- 31 December 2017: Confirmation that that all impacted documents in the program suite comply with the requirements of CSA N286-12
- 15 September 2018: Verification via a 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.

3.3. Regulatory Documents

Per Table C-1 of the PSR Basis Document [5], there are no other Regulatory Documents identified in the Bruce Power PROL [1] and LCH [2] for inclusion in this Safety Factor review.

3.4. CSA Standards

Per Table C-1 of the PSR Basis Document [5], there are no other CSA standards identified in the Bruce Power PROL [1] and LCH [2] for inclusion in this Safety Factor review.

3.5. International Standards

The international standard listed in Table 2 is relevant to this Safety Factor and was considered for this review.

Table 2: International Standards

Document Number	Document Title	Reference	Type of Review
IAEA SSG-25 (2013)	Periodic Safety Review for Nuclear Power Plants	[33]	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 [33] addresses the periodic safety review of nuclear power plants. Per the PSR Basis Document [5], this PSR is being conducted in accordance with REGDOC-2.3.3. As stated in REGDOC-2.3.3 [3], this regulatory document is consistent with IAEA SSG-25. The combination of IAEA SSG-25 and REGDOC-2.3.3, define the review tasks that should be considered for the Safety Factor Reports. However, no assessment is performed specifically on IAEA SSG-25.

3.6. Other Applicable Codes and Standards

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

4. Overview of Applicable Bruce B Station Programs and Processes

Table 3 lists the key Bruce Power documents related to implementation of the elements related to the use and feedback of OPEX and R&D[2].

Table 3: Key Implementing Documents

Level 0	Level 1	Level 2	Level 3
BP-MSM-1: Management System Manual [34]	BP-PROG-01.06: Operating Experience Program [24]	BP-PROC-00062: Processing External and Internal Operating Experience [35]	
		BP-PROC-00137: Focus Area Self Assessment [36]	
		BP-PROC-00147: Benchmarking and Conference Activities [37]	
		BP-PROC-00892: Nuclear Safety Culture Monitoring [38]	
	BP-PROG-01.07: Corrective Action [39]	BP-PROC-00019: Action Tracking [40]	
		BP-PROC-00059: Event Response and Reporting [41]	

[2] Table 3 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-PROC-00060: Station Condition Record Process [42]	
		BP-PROC-00252: Control of Nonconforming Items [43]	
		BP-PROC-00412: Trending, Analyzing, and Reporting of SCRs [44]	
		BP-PROC-00506: Effectiveness Reviews [45]	
		BP-PROC-00518: Root Cause Investigation [46]	
		BP-PROC-00519: Apparent Cause Evaluation (ACE) [47]	
		BP-PROC-00644: Common Cause Analysis [48]	
		BP-PROC-00965 : Visual Management Board [49]	
	BP-PROG-06.03: CNSC Interface Management [50]	BP-PROC-00165: Reporting to Regulatory Agencies [51]	
	BP-PROG-10.01: Plant Design Basis Management [52]	BP-PROC-00363: Nuclear Safety Assessment [53]	

Level 0	Level 1	Level 2	Level 3
	BP-PROG-10.02: Engineering Change Control [54]	BP-PROC-00539: Design Change Package [55]	
BP-MSM-1 Sheet 2: MSM Approved Reference Chart Authorities and Responsibilities - Sheet 0002 [56]			

4.1. Operating Experience

This section describes the processes where there is an opportunity (and requirement) to collect internal and external OPEX both nuclear and non-nuclear for use in every aspect of Bruce B operation. Section 5 of this report, and particularly Section 5.4.2, describes the application of OPEX to solving everyday problems and enhancing safety and production efficiency.

Bruce Power's program for OPEX is described in its implementing documents BP-PROG-01.06 [24] and BP-PROC-00062 [35], which are based on CSA Standards, World Association of Nuclear Operators (WANO), Institute of Nuclear Power Operations (INPO), and IAEA recommendations. The program covers both internal and external operating experience. The OPEX program and Corrective Action Program BP-PROG-01.07 [39] are closely inter-connected and complementary.

For reference, BP-PROG-01.06 refers to the following domestic and international (IAEA, INPO and WANO) documents as inputs.

- Canada Deuterium Uranium (CANDU) Owners Group (COG) Definitive Guidebook for the OPEX Contact Officer
- NEI 09-07, Fostering a Healthy Nuclear Safety Culture
- IAEA GS-G-3.5, Management System for Nuclear Installations
- CSA N286-12, Management System Requirements for Nuclear Facilities
- IAEA Safety Guide NS-G-2.11, A System for the Feedback of Experience from Events in Nuclear Installations;
- INPO 10-006, Operating Experience (OE) and Construction Experience (CE) Program Description;
- INPO 05-005, INPO Guidelines for Performance Improvement at Nuclear Power Stations;

- WANO GL 2003-01, Guidelines for Operating Experience at Nuclear Power Plants
- WANO WPG02, OPEX program guideline; and
- WANO OPEX Program - reference manual.
- OSHAS 18000, Occupational Health and Safety Management Systems Specification (see Section 4.5)

Two principal corporate values in BP-MSM-1, Bruce Power Management System Manual [34] espouse the fundamental principles of OPEX, namely

> *"5.4 Benchmarking and Operating Experience*
>
> *We seek out leading practice and determine how to apply it at Bruce Power to enable continuous improvement.*
>
> *The "Operating Experience" process provides for evaluating and disseminating in house and industry operating experience information. This information is sought by and supplied to appropriate personnel for consideration and initiation of actions to prevent adverse conditions to improve performance with respect to plant safety, reliability, economy and profitability.*
>
> *5.5 Assessments*
>
> *In addition to Event Review Boards and the Nuclear Safety Review Board[3] which provide oversight, we use a combination of assessments and audits to confirm that work activities meet the stipulations of the Management System, evaluate the Management System and confirm the integrity of plant conditions. Assessments include:*
>
> - *Self Assessments.*
> - *Internal and External Audits and Surveillance Activities.*
> - *Annual State of the Functional Area Assessment.*
> - *Performance Assessments and Accountability Reviews.*
> - *Technical Assessments."*

Furthermore, BP-MSM-1 [34] provides the management directive to support these values that unequivocally commits Bruce Power to collecting, assessing, tracking and disseminating internal and external OPEX:

> *"Operating Experience*
>
> *Bruce Power shall use Operating Experience from within Bruce Power and worldwide to identify, evaluate, and apply lessons learned in order to prevent adverse conditions or to improve performance with respect to plant safety, reliability and cost.*
>
> *Bruce Power shall communicate internal experience from the Bruce Site to others in the nuclear industry in order to improve plant safety, reliability, and commercial performance of the nuclear industry around the world."* (page 38)

[3] Comment: Section 7.3.4 of the MSM [34] specifies the mandate of the NSRB as follows:

> *"The NSRB has the responsibility for considering and advising the Boards the extent to which Bruce Power affairs are being 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."*

While OPEX refers to all aspects of the nuclear plant enterprise, the MSM [34] uses maintenance as one aspect where OPEX is particularly beneficial:

> *"Plant Maintenance Management*
>
> *Bruce Power shall focus on predictive and preventive maintenance to support enhanced equipment reliability and improved safety operational performance.*
>
> *Maintenance strategies shall be continually refined on a basis of improved technologies, Operating Experience (OPEX) and feedback from activities associated with plant reliability integration. Work selection, prioritization and response shall be guided by risk informed decision making."* (page 39)

Implementing documents are considered in this review to show the means by which OPEX is woven into the fabric of Bruce Power's business.

This Safety Factor also includes the collection, production, and use of Research and Development (R&D). Fundamentally, R&D is OPEX also, so could be considered to be generically part of OPEX. This Report uses this interpretation except when dealing with programs that are explicitly identified as Research or Research and Development, such as in Section 4.4, which also deals briefly with the governance aspects of R&D.

The generation and processing of OPEX relies significantly on the Corrective Action Program. Section 4.2 discusses the connection to the Station Condition Record (SCR)/Corrective Action Program (CAP) process.

4.1.1. BP-PROC-00062, Processing External and Internal Operating Experience

BP-PROC-00062, Processing External and Internal Operating Experience [35], is the workhorse implementing procedure. This procedure identifies the processes used to accomplish the two Program goals, one for external and one for internal: a) To use external operating experience information to identify, evaluate and apply lessons learned to improve plant safety, reliability and commercial performance through improvements to processes, procedures, training and system/equipment design, and b) Communicate internal experience from the Bruce Site to others in the Nuclear Industry in order to improve nuclear plant safety, reliability and commercial performance around the world.

The procedure requires respondents to avoid dismissing information from other reactor types or situations, and to answer the challenge of whether a parallel event could occur at Bruce. This is a precursor for Nuclear Safety Culture, which is a central principle of OPEX – continuous awareness of the need for learning to apply to daily activities contributes to a successful OPEX program and hence to an enhanced Safety Culture.

BP-PROC-00062 [35] then provides detailed instructions on how to extract and process incoming and outgoing OPEX. The processing of internal or external events is administered using the Station Condition Record (SCR) process and the Corrective Action Program. OPEX processes interface with the SCR/CAP processes as required. Submission of SCRs (BP-PROC-00060 [42]), Action Tracking (BP-PROC-00019 [40]), and Root Cause Investigations (RCI) (BP-PROC-00518 [46]) are associated processes where the impact of either positive or negative OPEX (lessons learned) would be recorded. These are further discussed in Section 4.2.

Section 3.1.4 of BP-PROC-00062 [35] also refers to a weekly communications meeting conducted with/by the Bruce Power OPEX unit where OPEX is screened and actions assigned. The COG Weekly Screening Meeting (WSM) is a teleconference meeting administered by COG. "Participants share lessons learned in the subject areas of reactor safety, radiation safety, industrial safety, environmental safety, and plant reliability that may provide benefits for the others. Participants include Bruce Power, on-shore and off-shore CANDU owners/operators, WANO, and AECL" (Section 3.1.4 of BP-PROC-00062).

Section 4.2.4 of BP-PROC-00062 [35] describes the process for daily review of OPEX at the Management Leadership Meetings. The Senior Advisor OPEX prepares a brief for presentation to the MLM, and for their use in daily briefings to staff, such as at the Visual Management Board (see Section 4.2.10). The material for the brief can be selected from a number of sources including current OPEX to "On this Day" historical OPEX (discussed in Section 5.4.2.14).

Section 4.4.1 of BP-PROC-00062 [35] deals with external sources of OPEX from sources that might not otherwise be considered. It has a requirement for the Senior Advisor, OPEX, to:

"REVIEW the following sources for OPEX which may be applicable to the CANDU industry on a monthly basis and post it into the next COG WSM agenda:

- *United States Department of Energy (DOE).*
- *United States Chemical Safety Board.*
- *ENFORM (Canadian oil and gas industry).*
- *Ontario Ministry of Labour Court Bulletins.*
- *Ontario Ministry of Environment Court Bulletins.*

For non standard external OPEX related to Counterfeit, Fraudulent and Suspect Items (CFSI), on a monthly basis the Senior Advisor, OPEX will[4]:

- *REVIEW the following sources for OPEX which may be contain information about CFSI items and post them into the next COG WSM agenda:*
- *U.S. Department of Energy (DOE), Counterfeit Items web page.*
- *Ontario Electrical Safety Authority, Recalls and Alerts.*
- *EPRI Counterfeit Items Database.*
- *U.S. NRC Part 21 Notifications.*

MAINTAIN on the OPEX web pages, appropriate links to these web sites and add or remove them as more potential sources of CFSI OPEX become known."

[4] In the 2016 R017 of BP-PROC-00062, the word "will" has been changed to "should", providing more discretion for the Senior Advisor.

Section 4.2.3 of BP-PROC-00062 [35], Pre-Job Briefings[5] and OPEX Just-in-Time (JIT) Briefings, describes an important element of the OPEX process. It states that “it is a management expectation that relevant OPEX be reviewed in Pre-Job Briefings. Supervisors have a responsibility to ensure the OPEX they discuss is relevant to the work to be performed. …” It allows Supervisors and Managers to emphasize key lessons learned that are applicable to the activity. Relating an actual previous event to a current work activity provides an opportunity to discuss the following:

- How that event can happen in the same circumstance.
- Actions to prevent a similar event.
- Barriers to prevent a similar event.
- Contingencies to take if a similar event occurs.
- How these lessons will improve or maintain a strong Nuclear Safety Culture today.

In this context, the pre-job briefing forms [57][58][59] include direct references to OPEX to be checked off. The OPEX program offers JIT OPEX briefings (actually B-OPEX-00nnn file name) on a wide range of topics to assist supervisors and managers to assist with this process, presently about 176 topics in all. Also, the COG JIT series supplements the Bruce Power JIT series for some work topics, and is available to managers from the COG web site.

Table 4: Supplementary COG JIT OPEX Reports

Document #	Title
COG-IE-JIT-SM-15	Service Maintenance Just In Time Pre-Job Brief Handbook 2015 (R10)
COG-IE-JIT-OP-15	Operator Just In Time Pre-Job Brief Handbook 2015 (R10)
COG-IE-JIT-MM-15	Mechanical Maintenance Just In Time Pre-Job Brief Handbook 2014 (R9)
COG-IE-JIT-CM-15	Control Maintenance Just In Time Pre-Job Brief Handbook 2015 (R10)

[5] Detailed instructions for preparing Pre-Job Briefings appear in Human Performance procedure BP-PROC-00617, Appendix B [60]. There are also context-specific PJB instructions in many other procedures such as BP-PROC-00474 [61], GRP-OPS-00038 [62], and BP-PROC-00561 [63].

Revision 16 of BP-PROC-00062 (the previous SFR 9 for Bruce A [17] used R014[6]) provides linkage to BP-PROC-00059 [41], and so incorporates the “Rapid Learning”, Reporting. Rapid Learning provides an opportunity for the Responsible Manager (RM) to communicate immediate event details, interim actions taken and Lessons Learned to site leadership from all Significance Level 1 and 2 events (as defined in BP-PROC-00060, Station Condition Record Process). A peer who recognizes an opportunity to apply similar actions from the Rapid Learning report for their station, department or section shall do so by initiating an SCR, as required.

The Senior Advisor(s) – OPEX will review Rapid Learning notifications from the stations. If the event meets or is likely to meet Significance Level 1 or 2 criteria (as per BP PROC 00060 [42]), the station Senior Advisor – OPEX will create an OPEX Applicability Review (AOPA) type assignment via the source SCR for the peer station to review. The AOPA assignment is to be assigned to the peer station’s Functional Area Manager to complete an OPEX applicability review on the Lessons Learned identified in the Rapid Learning report, the source SCR and any of the SCR attachments.

4.1.2. BP-PROC-00137, Focus Area Self Assessment

BP-PROC-00137 [36], Focus Area Self Assessment, provides guidance in identifying and documenting lessons learned from internal sources to continuously improve performance by identifying weaknesses, 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. OPEX is an important aspect of evaluating the effectiveness of the work being assessed and the FASA findings become part of OPEX for the station reviewed through the SCR process.

[6] An electronic comparison of R014 and R016 reveals extensive editorial cleanup. It also includes an update for better tracking of OPEX items. Section 4.3.1 of Revision 16 has a directive for staff to complete FORM-13356 [64] that generates an automatic Action Request for the line organization to complete an External OPEX Report Template (MOPT). The MOPT assignment is scheduled for completion within 30 days of the event date and automatically added to any SCR which is assigned an Apparent Cause Evaluation or Root Cause Investigation by the screening software interface during Corrective Action Program Coordinator (CAPCO) screening of new SCRs.

4.1.3. BP-PROC-00147, Benchmarking and Conference Activities

BP-PROC-00147 [37], Benchmarking and Conference Activities, provides requirements for identifying and documenting lessons learned from external sources to continuously improve performance by making improvements to Processes/Procedures, Training, or System/Equipment Design.

It specifies (in Section 1.0) the requirements and describes the process for gathering intelligence through the following means:

- Benchmarking of external (non-Bruce Power) facilities, which can be accomplished in various ways such as site visits, telephone interviews, or internet research;
- Attendance of Conferences, Workshops or Industry Working Groups (hereafter referred to as Conferences. Note this inclusive definition stimulates gathering OPEX from multiple sources called “Conferences” and broadens the scope of BP-PROC-00147 [37] beyond its title.).

The procedure provides guidelines both for collecting information from external sources and also hosting benchmarking missions at Bruce Power. There are explicit instructions for follow-up (for example and of primary importance, SCRs which will direct the observations through the OPEX screening).

Benchmarking and conference activities foster the use of diverse information sources to identify and understand performance gaps and implement corrective actions to improve performance.

4.1.4. BP-PROC-00892, Nuclear Safety Culture Monitoring

BP-PROC-00892 [38], 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 [65] and based on the approach described in NEI 09-07, Revision 1, Fostering a Strong Nuclear Safety Culture (November 2010). 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 company professionals to make nuclear safety the overriding priority.

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 [65], reveal cultural issues that require to be addressed. As mentioned above, the presence of a strong Nuclear Safety Culture is essential to ensuring consistent capturing and use of OPEX.

This procedure requires the Nuclear Safety Culture Monitoring Panel to meet three times a year and to produce a report with metrics defined in Section 4.3.2.5 of the procedure. Section 7.2.2.4 below expands on the genesis of this procedure and provides additional perspective on its continuing perceived importance among staff at Bruce Power.

Nuclear Safety Culture is important to OPEX because a sustained focus on collecting and referring to OPEX in daily work routines requires awareness from all levels of staff, and is a requirement from the OPEX program document, BP-PROG-01.06 [24].

4.1.5. BP-PROC-00363, Nuclear Safety Assessment

BP-PROC-00363, Nuclear Safety Assessment [53], describes the collection and use of OPEX in Nuclear Safety Assessment. In its description of 4.1.2 Operational Support it states “The process to identify, evaluate and apply lessons learned from operational issues, both from within Bruce Power and from the industry, is defined in BP-PROC-00062, Processing External and Internal Operating Experience. Evaluation and application of lessons learned from operational issues may require NSA [Nuclear Safety Assessment]”. And in 4.1.4 Results from Research and Development or Analysis, it accepts the responsibility that “Issues may arise due to findings from Research and Development activities being performed on behalf of Bruce Power and the industry. Issues may also arise due to findings from ongoing industry analysis programs, both within and outside Bruce Power. Furthermore, issues can also emerge from proactive reviews of operating and design configurations where established operating limits and conditions may need to be more precisely defined. These issues are assessed and documented in Station Condition Records per BP-PROC-00062, Processing External and Internal Operating Experience. In this context, OPEX would be generated or addressed as part of the SCR process (see Section 4.2).

4.1.6. BP-PROC-00539, Design Change Package

BP-PROC-00539, Design Change Package [55], governs the management of design packages. It takes its authority from BP-PROG-10.02, Engineering Change Control [54]. Design Change Packages are an essential piece of the documented design, and in particular, BP-PROC-00539 assigns responsibilities for collecting and recording Lessons Learned at the end of any modification before the project can be closed out formally. The procedure refers to BP-PROC-00060 [42] for the recording of Lessons Learned in an SCR.

4.2. Corrective Action

Corrective Action processes are embedded with requirements to collect and/or disseminate OPEX.

Bruce Power processes related to Corrective Action are governed by the Corrective Action Program BP-PROG-01.07 [39] and related implementing procedures BP-PROC-00019 [40], BP-PROC-00060 [42], BP-PROC-00252 [43], and BP-PROC-00412 [44]. The Corrective Action Program is based on CSA Standards, including references and several other industry guides identified in Section 5.0 of BP-PROG-01.07 [39]. A Corrective Action Review Board (CARB), composed of senior management, performs a review of all significant events at Bruce Power.

BP-PROG-01.07 [39], 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. 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. BP-PROC-00060 is the implementing procedure (see Section 4.2.3) which ensures that OPEX records are included in the SCR database.

4.2.1. BP-PROC-00019, Action Tracking

BP-PROC-00019 [40], 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. The process owners, as defined by the AR types, specify requirements for their processes such as requests for due date extensions and oversight for completion of those assignments. AR types are the responsibility of the process owners.

4.2.2. BP-PROC-00059, Event Response and Reporting

BP-PROC-00059 [41], Event Response and Reporting, has a process specifically supporting OPEX. It defines the process for preliminary response and reporting to internal contacts and external agencies, to ensure compliance with both Bruce Power and Regulatory requirements for reporting OPEX. This procedure describes the process of Incident Response and Reporting which consists of the following major steps:

- Immediate response;
- Rapid Learning;
- Internal and external notifications; and
- Initiation of an investigation to determine the cause of the incident (Section 4.0).

Revision 21 (September 2014) of this PROC restructured the Fact Finding process into the Rapid Learning process. Appendix H of BP-PROC-00059 provides detailed instructions on the process for ensuring information about events is captured and distributed quickly to appropriate staff including sister stations to prevent information loss and potential recurrences before the standard OPEX process is completed. A micro-gap associated with this substitution is that the second step of the process diagram in Appendix G of BP-PROC-00059 R022 still refers to “Call out Event Fact Finding Team” instead of the “Rapid Learning Team”. This discrepancy has been addressed in R023 of the PROC so no gap ensues.

External regulatory agency reporting is discussed further under BP-PROG-06.03, CNSC Interface Management, in Section 4.3 of this Safety Factor Report under Compliance Reporting. It is one means of communicating OPEX to external co-operating utilities and institutions.

Section 4.3 of BP-PROC-00062 [35] provides governance for reporting to other external organizations such as COG, INPO, WANO, and IAEA. Appendix C of BP-PROC-00062 is a flow chart of guidelines for screening data to report externally to Bruce Power.

4.2.3. BP-PROC-00060, Station Condition Record Process

BP-PROC-00060 [42], Station Condition Record 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. The procedure refers to BP-PROC-00062 [35] for the primary requirements on OPEX, but does provide criteria for categorizing SCRs, including a dedicated category (Significance Level 3) with seven classification tags (labels) specifically for OPEX.

In the classification of OPEX, a consistent reporting and evaluation process for identified adverse conditions, including but not limited to non-conformances, undesirable impacts on nuclear safety, business loss, and corporate reputation is accomplished by ensuring the following as listed in Section 1 of the procedure:

- 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 nonconformances (typically a documentation deficiency) which could but have not yet resulted in a nonconforming item (typically a deficiency in a Structure, System, and Component (SSC)), BP-PROC-00060 applies rather than BP-PROC-00252, Control of Nonconforming Items [43]. 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. The means taken to control the nonconformance should be described in the SCR.

The SCR database in PassPort has a “Reportable to” field that has an option for an “OPEX” flag which is selectable in PassPort/e-Suite. The Senior OPEX Advisor sets this flag when an SCR has the potential to be reported externally to WANO or COG and should be evaluated as such (no guarantee that it will meet the criteria of reporting). It appears that the use of this field started in February 2012. It has 1827 occurrences to December 30, 2015, 1082 for Bruce A, 673 for Bruce B, and 72 for Centre of Site. Of the 1827 items with the OPEX flag set, 168 were also reportable to the CNSC overall.

4.2.4. BP-PROC-00252, Control of Nonconforming Items

BP-PROC-00252[7] [43], Control of Nonconforming Items, describes the process used to identify, document, segregate, evaluate and disposition nonconforming items. 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.

4.2.5. BP-PROC-00412, Trending, Analyzing, and Reporting of SCRs

BP-PROC-00412 [44], Trending, Analyzing, 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. This procedure has specific instructions to screen the SCR data for OPEX trends[8]. As per BP-PROC-00060 Section 4.6, there are several outcomes of an SCR depending on the significance and the level of risk associated with the identified adverse condition. If it is a low level/low risk issue the SCR will be trended to help identify larger issues that may need to be fixed later on. A trend analysis and subsequent common cause analysis may be assigned by MRM or otherwise conducted to investigate the common cause of all the low level/low risk issues.

4.2.6. BP-PROC-00506, Effectiveness Reviews

BP-PROC-00506 [45], Effectiveness Reviews defines the process for performing effectiveness reviews of corrective actions and Corrective Action Management Effectiveness Oversight

[7] See second last paragraph in preceding subsection regarding the relationship of BP-PROC-00252 with BP-PROC-00060.

[8] For example, this procedure has a screening label for “Issues caused by failure to identify, correct identified causes, or identify or properly implement Operating Experience. It includes failure by personnel to be cognizant of generic industry issues and of advances in technology” (Appendix D). This addresses aspects of the review tasks for this Safety Factor – e.g., established process, universal deployment, or effectiveness.

(CAMEO). The effectiveness review process is used to determine whether or not a corrective action was effective. This is important for many Safety Factors, but particularly so for OPEX, because OPEX counts heavily on the SCR process for its own effectiveness.

The depth of the review may entail the collection of information and assist in conducting a Root Cause Investigation, Apparent Cause Evaluation or Common Cause Analysis.

4.2.7. BP-PROC-00518, Root Cause Investigation

BP-PROC-00518 [46], Root Cause Investigation, 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). Central elements of the investigation are a) the collection of OPEX, b) the assessment of why internal OPEX did not prevent the recurrence of the event, and c) the filing of an SCR if the existing internal OPEX was not effective at preventing the event. The procedure offers the OPEX Advisors an OPEX web page as resources. A specific responsibility to evaluate the health of the RCI and OPEX programs is assigned to all CARB members. The procedure has a flow chart for the RCI team to deal with an OPEX-preventable event targeted at Performance Improvement.

4.2.8. BP-PROC-00519, Apparent Cause Evaluation

BP-PROC-00519 [47], 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 procedure has specific instructions on gathering and using OPEX to determine the nature of the event and immediate causes, or otherwise evaluating the event. It refers to the Bruce Power OPEX web page for instructions (the web page indicates widespread deployment of OPEX principles). It has instructions to initiate an SCR when an opportunity to use existing OPEX (internal or external) was not effective in preventing the event under evaluation.

The ACE/EACE processes may not prevent recurrence but the availability and use of pertinent OPEX could reduce the probability of recurrence.

4.2.9. BP-PROC-00644, Common Cause Analysis

BP-PROC-00644 [48], 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 detailed instructions for performing Common Cause Analysis. 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 (Section 1 of procedure). A Common Cause Analysis is completed by an individual or team of individuals within the timeframe specified by the Management Review Meeting (MRM), normally 35 days from MRM assigning the analysis.

4.2.10. BP-PROC-00965, Visual Management Board

The Visual Management Board (VMB) procedure, BP-PROC-00965 [49], was added to the hierarchy of BP-PROG-01.07 [39] in November 2015. The VMB is a primary means of communication between management and staff on a sustained basis. Quoting from Section 4.0 of the procedure[9]:

"The VMB is used and maintained by all Managers, Supervisors, Team Leaders and team members at Bruce Power. It is the key tool for everybody to understand their role in the plant. As a work group, it is the place to discuss:

- *How you are doing,*
- *What you plan to do,*
- ***Lessons you can learn** and,*
- *Opportunities to improve.*

The content displayed on a Visual Management Board can be broken into 3 categories:

1. Bruce Power (VMB Content)

- *Current Plant Status Condition.*
- *Safety and/or Human Performance messages.*
- ***Relevant Operational Experience** information among other communications.*

…"

Further, in Section 4.3, Sustaining and Supporting VMBs, there is a protocol for interaction with a VMB lead. In particular,

"The VMB Lead will:

- *LEAD regular reviews and discussions on the following examples:*
  - *a) Current Plant Status Condition(s).*
  - *b) Safety and/or Human Performance (HU) messages.*
  - *c) **Relevant Operational Experience information (OPEX)** among other communications.*
  - *d) …"*

This procedure is pertinent to OPEX because it demonstrates the commitment of Bruce Power management processes to using OPEX in everyday functioning of the enterprise.

4.3. Compliance Reporting

Bruce Power's operating licence requires it to report specific detail regarding design, operation, and analysis findings to the CNSC. Compliance reporting requirements are described in CNSC REGDOC-3.1.1. In the context of OPEX, Item 14 of Table A.1, Hazards, of REGDOC-3.1.1:

*"The licensee shall report on any of the following situations or events arising from **operating experience, research, new or revised safety analysis**, that reveals a hazard to the health and*

[9] Bold emphasis added to delineate OPEX related topics.

safety of persons, security or the environment that may be (or is determined to be) different in nature, greater in probability or magnitude than was previously represented to the CNSC.

a. *Any of the following:"* (list of 10 items)

…

b. *discovery of a problem or potential problem from* ***operating experience, research, new or revised safety analysis****, that represents a hazard or potential hazard to the health and safety of persons, security or the environment, or that may be different, greater in probability or magnitude than previously represented to the CNSC in the licensing basis including:"* (list of 7 items)

OPEX findings different in nature or probability from those previously reported are one aspect that the standards require to be reported, with defined timelines for reporting. In the past few years, the topics of these reports are reported publically on the internet[10], either in the utilities' web sites or the CNSC's.

Internal Bruce Power processes that support these reporting requirements are in references BP-PROC-00165 [51] and BP-PROC-00059 [41].

BP-PROG-06.03 [50], 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 Canadian Nuclear Safety Commission. BP-PROG-06.03 [50] was updated[11] to confirm the need for compliance against CNSC REGDOC-3.1.1 which is a source of OPEX ([50] Section 4.5 item 3, reporting).

BP-PROC-00165 [51], Reporting to CNSC – Power Reactor Operating Licences describes 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 and as appropriate content for reports to the CNSC per REGDOC-3.1.1 [25].

4.4. Research

While the term OPEX appears to focus on "Operating" Experience, results learned from new research or methodologies can also lead to items to be shared with the nuclear community and lessons learned, and the enhancement of nuclear safety or improvement of margins. In fact, the term OPEX is used with this much broader meaning, and includes Research.

The governance for Research and Development activities in Bruce Power begins with the roles and responsibilities listed in BP-MSM-1 Sheet 2 [56]. Quotes from the document in the following table demonstrate the extensive scope of R&D to be undertaken at Bruce Power:

---

[10] Per Section 4.1 of BP-PROG-09.02 [66], Stakeholder Interaction: "Publicly posting on brucepower.com, on a quarterly basis, a listing of CNSC regulatory event reports."

[11] At Revision 4 at time of change, currently at Revision 6.

Table 5: R&D Responsibilities per BP-MSM-1 Sheet 2

Primary Responsibility Organization Element	Description of R&D Responsibility
Engineering, Fitness for Service Assessment, Section Manager	Provide technical oversight and direction of research and development programs in the above areas[12], including the use of research results. Provide liaison with external organizations, including participation in **CANDU Owners Group, Research and Development Technical Committee, Industry Working Groups and Canadian Standard Association** committees.
Engineering, Risk and Severe Accident Analysis, Section Manager	Advise the Department Manager in the application and development of analysis codes and methodology, taking into account industry research and development findings. Provide **technical oversight and direction of research and development i**n the area of severe accident phenomena and the use of research results. Provide liaison with external organizations, including participation in CANDU Owners Group and Industry Working Groups on probabilistic risk analysis, severe accident analysis and applications. Coordinate the development, validation and maintenance of models and computer codes required for severe accident analysis and containment integrity beyond design basis, including the establishment of the reference data sets.
Nuclear Safety Analysis and Support Department	Liaise with external organizations in coordinating common nuclear safety programs, including participation in CANDU Owners Group, utility regulatory review and CSA committees.
Law & Emergency Management, Programs & Support, Department Manager	Be responsible for Emergency Protective Services (EPS) Division Programs in the following areas: Projects (Capital Projects, Small Projects/CEWR, RAC/IMC/ITAC, Life Cycle Planning, Define User Requirements, Needs Analysis & Prioritization, Project Impact & Resource Requirements, **Research & Development**).
Nuclear Oversight & Regulatory Affairs, Integration, Department Manager	Providing supervision and overview in the area of scientific expertise. Responsibility for **research and project management**, including developing and managing budgets, schedules and quality of products. Providing **scientific analysis and strategy** to various stakeholders. Making recommendations on strategy, policies, compliance and

[12] fuel channels, feeders steam generators/preheaters, calandria, fuel design, fuel performance, fuel manufacturing (current and future)

Primary Responsibility Organization Element	Description of R&D Responsibility
	communications. Representing Bruce Power externally to stakeholders and government/regulatory authorities, **at international scientific conferences,** providing clear evidence and persuasive arguments in support of the Company's direction. Providing internal scientific advice in area of expertise to all key managers up to and including the Chief Executive Officer. Disseminating **scientific manuscripts in peer reviewed journals and provide written briefings of relevant applications and decisions**. Tracking and communicating trends, and provide analysis of regulatory and market policies relevant to the business plan and goals.

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.

The emphasis of the tasks for Safety Factor 9 is on external experience. However, the Bruce station is in a unique position in that there are two stations with fundamentally the same design, but quite different in equipment, design requirements, and therefore nuances in operation. In this context, Bruce A is an external plant to Bruce B, operated "by the same operating organization".

As a member of the global nuclear community, Bruce Power seeks and shares operating experience and actively participates in numerous bodies that create or recommend best industry practices or standards. This includes attending relevant conferences and workshops and participating in benchmarking missions to identify strengths, as well as performance and process gaps between Bruce Power and its industry peers. These activities are directed by the Performance Improvement department and governed by BP-PROC-00147 (see Section 4.1.3), which describes the process for gathering business intelligence through benchmarking and conferences. BP-PROG-01.06 [24] and BP-PROC-00062 [35] further define how to identify and capture lessons learned from internal and external operating experience.

Bruce Power also provides representatives for numerous local and international committees that shape industry practices or standards, such as the CSA Group, Electric Power Research Institute, CANDU Owners Group and WANO/INPO. One specific example of international participation activities in the nuclear community from which Bruce Power garners OPEX is noted in the 2015 Oversight FASA [67]. It states in Section 7.0 that: "Bruce Power is well represented in the North American nuclear community through active participation in the Nuclear Quality Management Leadership (NQML) Steering Committee and NIEP [Nuclear Industry Evaluation Program] Subcommittee. This participation ensures Bruce Power is kept current of recent industry developments and best practice. This participation also ensures that NIEP peer reviews are conducted every three years at Bruce Power and BP staff have the opportunity to participate in these reviews at other NPPs".

The sections that follow provide examples of this deployment of resources to OPEX-driven activities, both internally and externally to Bruce Power.

5.1. Verify that Arrangements Are in Place for Feedback of Experience Relevant to Safety

Review task 1 is verified by inspection of the processes identified in Section 4. The sequence is as follows. The licence provides the mandatory requirement to have a Management System Manual (MSM) and that MSM has a principal value to subscribe to an Operating Experience program, as quoted in the introduction to Section 3.1/footnote 1 of this document. As noted there, the enabling program is described by BP-PROC-01.06 [24]. The main implementing procedure is BP-PROC-00062 [35], which describes the collection, organization, and dissemination of the OPEX. It is used extensively in concert with the SCR and Action Tracking processes, for which BP-PROC-00060 [42] is the head node. Related activities are investigations, reporting, and monitoring safety culture, which are described in detailed procedures identified in Section 4.

As noted in Section 5.1 of [17], Appendix A of BP-PROG-01.06 R014 [24] still needed to be updated, as it referred to the long superseded Bruce Power POLICY series. A Document Change Request (DCR) had been submitted to incorporate this change. This editorial change has been implemented in the 2016 version (which is past the PSR cutoff date).

In summary, Bruce Power has governance for implementation, monitoring and management of an extensive Operating Experience and Research and Development program as described throughout Section 4. This verifies that arrangements are in place for feedback of experience related to nuclear safety, and so meets the requirements of the first review task.

5.2. Review of Program Effectiveness for Timely Feedback of OPEX

Review task 2 is addressed by consideration of Section 7, which describes regular and persistent effectiveness reviews. These effectiveness reviews, BP-PROC-00506 [45], are focused on continuous improvement of the process. Both procedures and audits have requirements on timeliness. In addition, BP-PROC-00059 [41] has recently introduced a "Rapid Learning" process (see Section 4.1.1 above) that substantially improves the timeliness for distribution of pertinent OPEX – event evaluators are required to expeditiously publish such OPEX inside Bruce Power (affected groups and sister station).

Section 7 of this report demonstrates that there is a strong OPEX program at Bruce Power, which is used extensively. In the reviews in Section 7, there is a recurring theme that actions raised in audits and assessments are sometimes closed before completion. However, a review by Bruce Power in response to this observation showed this to be limited and addressed by an ongoing managed process that has received increased emphasis recently. Section 7 of this report provides additional examples of Effectiveness Reviews over those provided in the

Bruce A ISR [17], reflecting the increased emphasis. This is a standard part of the Bruce Power process and actions get reopened due to non-effectiveness. Actions are not closed without completing the work. The incidents cited in the audits reviewed in Section 7 followed the process as expected if the effectiveness review found that the original actions were ineffective.

In summary, Bruce Power has governance (BP-PROC-00506 [45]) for performance, monitoring and management of Effectiveness Reviews as described in Section 4 and demonstrated in Section 7, and so meets the requirements of the second review task.

5.3. Review of Processes for Assessing and Implementing Research and OPEX Findings

Review task 3 is addressed by citing examples of Research and Development projects (Section 5.3.1), staff culture and qualification (Section 5.4.1) and providing examples of application of OPEX in plant programs (Section 5.4.2), in both design and operation.

5.3.1. Research

Bruce Power is heavily invested in Research and Development to support ongoing operations. This occurs in many different areas and disciplines. For example, Bruce Power summarized its extensive involvement in, and commitment to, Research and Development activities in a response [68] to the CNSC Inspection on Condition Assessments [69] on page A-2:

> *"Research and Development is already a key area in Bruce Power's OPEX processes. Bruce Power participates in and conducts industry workshops, conferences, newsgroups, forums, training sessions, lessons-learned meetings, and R&D sessions, and maintains information exchange with the industry and international community, regulators, vendors, contractors, designers, research organizations, and employees.*
>
> *OPEX is required to be accessed during the life cycle management process and the many sources of OPEX to be reviewed when preparing the Technical Basis Assessments (TBAs) and Life Cycle Management Plans…This includes accessing Research and Development reports from sources such as EPRI, INPO, and COG". …*

As mentioned above, Bruce Power participates in a significant array of research and development activities with other organizations. Co-operative interactions related to research with CANDU Owners Group (COG), Electric Power Research Institute (EPRI), WANO, IAEA, American Society of Mechanical Engineers, INPO, CSA, NRC (National Research Council), Canadian Nuclear Society and others are well known inside Bruce Power and throughout the industry. Moreover, Bruce Power performs research in conjunction with the Ontario Ministry of the Environment and Climate Change, and attends workshops to acquire OPEX (e.g., Radiological Effluents and Environmental Workshop). This topic is discussed further in Section 7.2.2.3, below.

Section 5.3.1 of the Bruce A ISR [17] identified that "no definitive governance was found for the objectives and mandate, other than tangential references in BP-MSM-1 Sheet 2 and BP-PROG-09.02" and assigned a gap SF9-1 in the equivalent of Table 9 of that report. In the meantime, BP-PROG-01.06 has been updated in January 2016 to provide this governance, albeit past the cut-off date for this report. On this basis and the evidence in Section 7.2.2.3, the conclusion is that the gap no longer exists.

5.3.1.1. Participation in CANDU Owners Group

Bruce Power provides a report to the CNSC annually on COG R&D activities (e.g., [70], [71], [72], [73], [74]) and also participates in an annual industry forum to discuss the results with the CNSC.

Each year there is a thorough report and the general topics are fairly stable year to year. Table 6 provides the COG major R&D Programs for 2015/2016 (please refer to [17] for the equivalent 2014/2015 table). Each of the programs is divided into working groups to which Bruce Power contributes resources. In addition to direct benefits from active participation in some of the research, all of this work helps satisfy the Benchmarking and Conference Activities Procedure requirements.

Table 6: COG Major R&D Programs, 2015/2016

Number	Title	Areas[13]	#WP[14]
COG 15-9105	Fuel Channels R&D Program, 2015/2016 Operational Plan	7	56
COG 15-9205	Safety and Licensing R&D Program 2015/2016 Operational Plan	13	70
COG 15-9305	Health, Safety & Environment R&D Program, 2015/2016 Operational Plan	10	34
COG 15-9405	Chemistry, Materials and Components R&D Program, 2015/2016 Operational Plan	8	77
COG 15-9505	Industry Standard Toolset Program, 2015/2016 Operational Plan	20[15]	64

Bruce Power continually participates in R&D via COG, but for Bruce-specific initiatives, it can and does proceed with research on its own or in concert with other parties. The Critical Heat Flux (CHF) testing for Bruce Power's 37M fuel project is an example of R&D in the nuclear technology area (in association with Stern Laboratories). Another example is the production

[13] Project Areas or Disciplines.

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

[15] 18 codes divided into 4 major disciplines: a) Containment and Severe Accident, b) Thermal hydraulics, c) Physics, and d) Fuel and Fuel Channels.

and introduction of new fuel carriers (at AECL Sheridan Park and Stern Laboratories) - an example of development work to minimize fuel defects in Bruce B. In another collaborative venture, OPG and Bruce Power jointly developed the Annulus Spacer Retrieval Tool (ASRT). OPEX from OPG's first deployment in 2013 was instrumental in the planning and successful capture of 4 tight fitting garter springs during the Unit 8 J18 Single Fuel Channel Replacement in 2016 outage [75]. Still another example is the continuing environmental research into the impact on whitefish in the vicinity of the station that has been undertaken in cooperation with the Saugeen Ojibway nation [76]. Whitefish environmental studies started during the Bruce A Units 3 & 4 Restart and continued with active reporting to the CNSC until the end of the Units 1 and 2 Return to Service.

The Calandria-Shield Tank Assembly (CSTA) is an example of a major in-house research project. This project looked for innovative ways to shorten the outage time for replacement of the calandria as a plug-in module, rather than in-place refurbishment.

In addition to the annual report on COG R&D Activities, there is an annual status report on significant safety issues. References [77] through [81] represent the last five years` reports. These safety issues involve both experimental and/or analytical research; some programs of mutual interest are cofunded by the CNSC.

5.3.1.2. Participation in Canadian Standards Association

Bruce Power participates actively in the Canadian Standards Association in the codification of existing practices and in the advancement of standards. In addition to the fundamental purpose, it provides an opportunity for developing awareness of new technologies from other committee participants. It represents a considerable commitment, but it is consistent with operating a major enterprise, as well as undertaking design, procurement, installation and commissioning.

A snapshot in early 2016 shows that Bruce Power had direct representatives on 69 of the 74 CSA nuclear committees or subcommittees surveyed. There was a sum of 110 person-committee representatives; up to 5 participants in one committee, with an average of 1.6 persons per committee for the 69 committees where Bruce Power was represented. Some individuals contributed to multiple committees; for example one individual participated in as many as 8 forums. There were 66 unique individuals exposed to the CSA Standards committees. As part of its continuous improvement efforts, a position has been created within Nuclear Oversight and Regulatory Affairs to provide more formal oversight to the company's CSA Group activities. Appendix D lists the committees and the number of Bruce Power representatives on each as of early 2016.

As well, Bruce Power gains additional exposure to/from the CSA committees through subcontractors working on Bruce Power tasks and retirees, contributing (usually voluntarily) to CSA Standards. This occurs because the CSA has a policy that the optimum committee makeup should include at least one consultant from the specialty area on each technical committee and subcommittee. Given that many of these would be working for either Bruce Power or OPG, there would be a significant sample of committee/subcommittee members working for Bruce Power on a quasi-continuous basis, carrying with them the interests of these two utilities in both directions.

The emphasis in governance for CSA activities is in-bound, that is, the focus is on compliance with CSA Standards. A significant objective of the CSA Standards is to codify best operating and business practices. It would appear that an opportunity exists to define the explicit use of OPEX in setting standards and to include it in the mandate of Bruce Power participants in CSA committees. No such OPEX-specific governance has been located. This is identified as gap SF9-1 in Section 8, Table 9.

5.3.1.3. Cooperation with OPG on Refurbishment Technology and Lessons Learned

Both Bruce Power and Ontario Power Generation Inc. presently have massive and ongoing refurbishment programs for the Bruce and Darlington reactor sites, and have a working agreement to share knowledge regarding nuclear safety. In November 2015, Bruce Power and OPG formally concluded an arrangement [82] to share OPEX from their refurbishment programs. A few quotes from the publically available document demonstrate the OPEX aspect, ostensibly external OPEX but between stations with many common design aspects:

"II The 2013 LTEP … outlines the importance of collaboration between the Province's two nuclear operators in order to *'find ways of finding ratepayer savings through leveraging economies of scale in the areas of refurbishment and operations, This could include arrangements with suppliers, procurement of materials, shared training,* ***lessons learned****, labour arrangements and* ***asset management strategies***'.

…

VI. Bruce Power and OPG have a long-standing relationship as operators of CANDU reactors **sharing best practices and information through a range of industry forums** including the CANDU Owners Group (COG) and the World Association of Nuclear Operators (WANO).

…

VIII. Bruce Power and OPG have developed a **range of lessons learned and strengths** through their respective operation of CANDU reactors and are committed to building a long-term relationship to enhance the co-operation between the two organizations.

…

XI. As nuclear operators, Bruce Power and OPG are committed to the value of 'Safety First' and achieve this high standard through **active collaboration**, transparency and continuous improvement."

The agreement establishes formal management structures to implement these fundamental concepts. This will improve the efficiency of both utilities through application of lessons learned from operating experience.

Going forward, BP-PROC-14410 [83] deals with OPEX for upcoming Project Management and Construction (PMC) projects. In particular, it notes (in Section 4.3) the following resources (and their locations) should be used:

"The following resources are available:

- *Project Management and Construction (PMC) Lesson Learned Database located on the PMC Intranet (Reference BP-HBK-14410-001 [84], Lessons Learned Database Handbook).*

- *Operating Experience (OPEX). Internal and External OPEX searches are located on the Performance Improvement Intranet. (Reference BP-PROC-00062, Processing Internal and External Operating Experience).*
- *TMP 14410.06, Lessons Learned Register."*

Note the use of BP-PROC-00062, in keeping with the fact that PMC is now a fully integrated division of Bruce Power with the associated management plans with adjustments for special aspects such as the use of Bruce A Restart OPEX. BP-PROC-14410 procedure [83] preceded the agreement regarding Darlington refurbishment OPEX, but the nature of the OPG OPEX could be accommodated within the BP-PROC-00062 definition of External OPEX so no immediate revision of the PMC procedure is required unless and until there is some special requirement.

5.3.1.4. Research Summary

This description summarizes the extent of R&D activities that Bruce Power undertakes. It is consistent with operating a major facility. The review task has an emphasis on having processes in place to undertake and co-ordinate research, and assimilate it into standards and procedures at Bruce Power. Therefore, Bruce Power meets the requirements of the third review task.

5.4. Examples of Effectiveness

The previous three subsections cover the review tasks directly. This subsection supplements the previous three, citing major examples of the application/deployment of OPEX at Bruce Power.

5.4.1. Fundamental Behaviours and Training

Bruce Power has a set of fundamental behaviours [63] and [85] to [95] that apply to most technical jobs. A review of these procedures shows that OPEX is mentioned in most of them, and often in the context of Nuclear Safety Culture. For engineering [88], there are specific job tasks for Section Managers to use OPEX as part of their "Communications and Advice" role, and for Workers in their "Critical Thinking" role. Engineering [88] and Chemistry [89] specifically mention "Must-know OPEX", although without direct reference to the specific INPO document set[16], but the Bruce Power OPEX intranet site does reference the INPO "Must-know OPEX" set [96] to [99] directly and this series of documents is part of the training curriculum at Bruce Power.

[16] The phrase is so unique that the Engineering and Chemistry references are unlikely to have any other genesis.

In the case of Operations, the procedure GRP-OPS-00038 [62] sets the fundamental expectations and standards for operators, similar to fundamental behaviours. It does have requirements throughout for the use of OPEX.[17]

Relevant material from the INPO Must-Know OPEX documents could be systematically incorporated in Bruce Power's Fundamentals documents.

Training is required to promote Nuclear Safety Culture and continuous awareness, which is discussed in Section 5.4.1.1.

5.4.1.1. Continuous Awareness and Indoctrination

Bruce Power has advanced the deployment of OPEX awareness significantly over the past few years. In addition to specialized training for staff directly involved in OPEX and SCR processing, all staff have an introduction to OPEX as part of their General Employee Training (GET) and have continuing training according to their job function. This is documented in the training department TDQ-00010 R004, General Employee Training, Training and Qualifications Description, September 2014 [100]. Specifically it states that:

> *"6.2 Continuing General Employee Training*
>
> *…*
>
> *On an annual basis, the GET CRC shall recommend topics for inclusion in GET Continuing Training that focus on maintaining and enhancing employee knowledge and capabilities. In particular, it shall include discussions about the following topics when applicable:*
>
> - *Degraded human performance.*
> - *Plant modifications or equipment changes that impact employees' daily activities.*
> - ***In house and industry operating experience** or regulatory changes.*
> - *Special plant operations or maintenance activities of importance to general employee audiences … "*

In the context of certified operators, Section 6.1.2.1 of TQD-00014 [101] states:

> *"6.1.2.1 Classroom Knowledge Curriculum Content*
>
> *… The classroom knowledge curriculum consists of fixed content and flexible content PELs arranged in a pre-defined and repeating 5-year cycle.*
>
> *The fixed content portion of the curriculum for generating unit operations consists of 12 blocks of classroom knowledge training for ANOs and CRSS/SMs. … The fixed content classroom knowledge curriculum includes:*
>
> 1. *Refresher lectures on science fundamentals and equipment principles.*
> 2. *Refresher lectures on station-specific knowledge.*
> 3. ***A review of related OPEX**.*

[17] Section 4.2 of GRP-OPS-00038 R010 (March 2016, after the cutoff date), has added explicit wording on governance for OPEX. "*Operations Management and Supervisors understand Operations "must know" significant Operating Experience (OPEX), and the importance of using significant Operating Experience and job related Operating Experience to prevent events*."

4. *A review of the WANO Select List by certified staff twice in the 5-year continuing training program. It is scheduled in Blocks 5 and 10 for generating unit staff, and in Blocks 3 and 8 for Unit 0 staff.*

Note: CRSSs and SMs will be scheduled to attend one or two days of Unit 0 classroom continuing training per year; however, they are responsible for all Unit 0 training objectives designated for continuing training.

…"

BP-PROC-00561 [63] (Appendix D) has two examples of the use of OPEX in deciding whether to follow the procedures based on response to actions or to stop and check. Detailed system knowledge based on OPEX helps avoid repeating errors or inefficiencies.

This general staff to certified operator training regimen shows Bruce Power's commitment to ensuring and sustaining employee awareness and use of OPEX.

5.4.2. Major Design and Design Change Initiatives

As repeated throughout this report, the objective of the Bruce Power Operating Experience Program is to define and implement the processes used to identify and capture lessons learned from sources within Bruce Power, and external to Bruce Power, in order to continuously improve performance by making improvements to Processes/Procedures, Training, or System/Equipment Design. This fosters a healthy nuclear safety culture in all aspects including reactor safety, radiation safety, industrial safety and environmental safety management. This is particularly important when a complex design initiative is being undertaken. This section enumerates some of those design initiatives and summarizes the use of OPEX at Bruce Power in the assessment of these major projects. This demonstrates the effective use of OPEX at Bruce Power.

The reports reviewed in Sections 5.4.2.1 to 5.4.2.14 provide examples of the success of the OPEX process, in that the focus of each is on the useable information gained through application of the process. The first 5 OPEX subsections are directly applicable to Bruce B and the remainder are examples of sister station OPEX shared on site that contain operating experience also with applicability to Bruce B.

5.4.2.1. Fukushima Impacts

The nuclear event at Fukushima, Japan is one of the most ubiquitous pieces of OPEX in recent times, inside or outside the global nuclear industry. Observation of actual consequences galvanized the nuclear industry to act to be capable of responding successfully to a beyond design basis event in the future. About 5 years have passed and it has consumed (deservedly) a huge amount of attention and could for decades. The industry was able to respond because it already had a foundation of knowledge and tools based on previous events, through analysis and observation and recording of the plant responses to transients and upsets, and through ongoing R&D (e.g., hydrogen behaviour in containment).

Following the Fukushima event there were hundreds of event sequences and operator and plant behaviours (OPEX) published by prestigious organizations like WANO, IAEA, INPO, EPRI and

United States Nuclear Regulatory Commission (US NRC), in addition to the CNSC and COG reports. Bruce Power also provided employees and the press with regular updates and interpretations during the evolution of the event. Reference [102] describes some of the contributions from WANO during the event and immediately following the event, and lists some of their OPEX reports. Significant Operating Experience Report SOER 2013-2, Post-Fukushima Daiichi Nuclear Accident Lessons Learned [103] is an example. This SOER, based on INPO 11-005 Addendum, Lessons Learned from the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station, provides recommendations that WANO members' operating nuclear facilities should follow and the associated schedule for WANO members[18].

The CNSC marshaled a full Canadian response to the incident in concert with the Canadian nuclear industry. Immediately following the event, the CNSC conducted a reactive inspection at Bruce Power [104][105] based on lessons learned, and published the Fukushima Action Plan which spawned 36 Fukushima Action Items (FAIs) [106]. As reported in Section 7 of Safety Factor Report 2, Bruce Power has responded to the FAIs with design, emergency mitigating equipment (EME), and operating procedure revisions to be able to cater to this type of event for a CANDU plant. Bruce Power continues to report annually on progress [107][108][109][110]. The status table attached to the latest CNSC inspection report [111] indicates all FAIs related to Bruce A and B are closed. As shown in Attachment 1 to the letter, there were 6 open CNSC actions tracking completion of the “previously closed” FAIs.

The CNSC recently closed [112] the actions arising from their May 2015 inspection [113] related to the FAIs. In the inspection, CNSC staff concluded that Bruce Power met the regulatory requirements, however, some inconsistencies and non-compliances with licensee procedures were observed and are documented in Section 4 (of [113]). CNSC staff did not find evidence of unsafe operation that would result in undue risk to the health and safety of persons, or the environment, or risks that would compromise respect for Canada's international obligations. The inspection raised 1 action notice and 8 recommendations for improvements.

The Fukushima accident and the sequence of events following it validated the long held strategy for severe accident management at CANDU plants, namely that a symptomatic response[19] to Beyond Design Basis Accidents (BDBAs) was essential to cater to any unforeseen accident progression.

This piece of OPEX demonstrates both the production of OPEX and its immediate use to make changes to provide the ability to respond to BDBAs in a reactor of a different type.

5.4.2.2. Calandria Tube – LISS Gap Inspection Tooling

NK29-REP-31911-00001, OPEX Report: CT-LISS Gap Inspection Tooling OPEX [114] is a Bruce B report that explicitly also includes Bruce A “external” OPEX. The Just-in-Time briefing summarizes 1 event based on a COG report, 8 events from Units 6, 7, and 8, and 4 events from Units 3 and 4.

[18] All commercial nuclear station operators world-wide are members of WANO.

[19] The CANDU Emergency Operating Procedures have used symptomatic response to serious process upsets since at least the late 1980s.

As part of the research mandate of COG, a life assessment of in-service calandria tubes (CTs) was carried out. It was noted that the sag rate of calandria tubes with respect to the Liquid Injection Shutdown System (LISS) and Horizontal Flux Detector tubes will eventually result in contact. The postulated lead channels were noted to be in rows 'F and 'S' at Bruce B (with the highest power channels in these rows being the most likely candidates for leading contact).

It was concluded that calandria tube sag measurement and CT-LISS clearance measurements were required as inputs to determine both the number of potential Calandria Tube Replacement (CTR)/ Single Fuel Channel Replacement (SFCR) targets as well as the potential to reduce the number of channel replacements.

The CT-LISS tooling was originally developed to perform inspections of CT to LISS nozzle gaps within three CTs from the view port. However, many of the smallest expected gaps are located further than 3 CTs from the view port. To be able to obtain measurements at these worst case gaps, a new inspection tool was required that could be installed through both an Adjuster Absorber guide tube and a Shut-Off Rod guide tube, such that the inspection tool could be positioned closer to the critical targets

NK29-REP-31911-00001 [114] addresses the Engineering Change Control requirement for an OPEX review.

There were many Lessons Learned in this OPEX review, such as lessons involving additional care in specifying the equipment materials, the setup and alignment procedures, stronger attention to foreign material exclusion (FME), and better communication between the supplier and Bruce Power.

5.4.2.3. Replacement of Even Side Class 1 250 VDC Battery Banks

NK29-REP-55100-00007, OPEX Report - Replacement of Even Side Class 1 250 Vdc Battery Banks [115] summarizes the findings of the OPEX review performed to support the Design Change Notice (DCN) to replace the Class I batteries at Bruce B. Specifically, there was a search for the experience of nuclear operators as it applies to such a replacement.

The search was for experience with the existing batteries 55100-BY1, 55100-BY2, NuSCI number 55100, and battery manufacturers such as GNB, Enersys, Exide, C&D, and YUASA.

The databases searched included Bruce Power's internal SCR database (Bruce A and B), as well as COG, WANO and INPO OPEX databases. Also, the Nuclear US NRC source was searched for experience with these types of batteries in other nuclear stations around the world.

The Bruce Power SCR database, as well as COG, WANO and INPO, identified multiple findings of low voltage cells, small cracks on upper corners of the jar (casing) where the jar meets the cover. During a seismic event, it is unknown how the cracks would affect electrolyte leakage and may contribute to battery failure. Other failures would be deformed battery cells, battery bank degradation, vital battery loss of capacity, etc.

Assessment of the search revealed that C&D and GNB manufacturers recorded a lower number of failures (11, 14 respectively) compared to Enersys (Section 2.0).

The US NRC OPEX collection also indicated battery failures reports/bulletins for failures such as solvent-induced case cracking, degraded cell, corrosion within the battery, and cracking of the battery jar.

The WANO database provided no additional information other than that already shared through COG. The null finding provides a measure of validation and is in itself OPEX.

Overall, this report achieved the objective of providing OPEX to determine what the failure modes might be and what manufacturers' reliability rates are.

5.4.2.4. HF OPEX Summary Report for Bruce Reactor Inspection and Maintenance System (BRIMS)

The Bruce Reactor Inspection and Maintenance System (BRIMS[20]) uses a combination of currently existing tools, modified existing tools and new tooling. The report, B-REP-30530-00001, Human Factors OPEX Summary Report for BRIMS [116], records the results and assessment of searches of the following OPEX databases:

- SCR,
- COG, and
- WANO

regarding existing tooling including, but not limited to:

- Channel Inspection and Gauging Apparatus for Reactors (CIGAR);
- Spacer Location and Repositioning (SLAR);
- mini-SLAR, Replica;
- Non-Destructive Examination (NDE); and
- Universal Delivery Machine (UDM), which is the current delivery method prior to the BRIMS project at Bruce B.

Additionally, a review of any relevant investigation reports or incident reports from investigations into previous errors or problems with the use of any of the tools was conducted in the SCR/COG searches.

The OPEX sections from the Circumferential Wet Scrape Tool (CWEST) Human Factors Engineering Summary Report (HFESR) in B-REP-06700-00004 [117] were also reviewed.

[20] BRIMS is a system of tooling and processes developed by Bruce Power with the objective of delivering the full suite of fuel channel inspection and maintenance activities including the Fuel Channel Inspection tool (a merger of CIGAR and Advanced Non-Destructive Examination [ANDE]), SLAR, Replica, Circumferential Wet Scrape Tool (CWEST) and Modal Detection and Repositioning (MODAR) to be used at Bruce A and B in an efficient and fully integrated manner, using a common delivery platform.

As the BRIMS design is similar in features to the mini-SLAR system, outage activities from the Bruce A outage A1241 for the current mini-SLAR system were observed to capture relevant OPEX from current system users.

Additionally, interviews were conducted with similar system users, field operations and maintenance personnel who have experience utilizing the current tooling for fuel channel inspection and maintenance.

“There were 2258 SCRs, 260 COG events and 100 WANO events which yielded 150 items that were applicable to the BRIMS project” (Section 7.1 [116]). The report contains a detailed table of the OPEX search and dispositions.

Overall trends found in the OPEX reviews included: maintenance, installation, configuration issues, vault layout, physical equipment issues, physical interferences, alignment issues onto channel, loss of power, loss of control system, storage area issues, maintenance area issues, outage logistics, procedures, training, communications, documentation, tool and Delivery Machine (DM) communications, software, radiation protection, factory acceptance testing, medically treated incidents, physical layout, transportation, movement, cabling, troubleshooting, workspace issues, human machine interface (HMI) controls and indication. All of the OPEX findings were presented to the project team for recommendations and dispositions proceeding into the detailed design phase of the BRIMS project.

This OPEX review shows the depth of OPEX information and diversity of observations that can be achieved for new or refined uses of tools. BRIMS has been deployed at Bruce A, with Bruce B deployment imminent.

5.4.2.5. OPEX Guidance for Design and Deployment of 37M Fuel

Errors made during the introduction of a new fuel type can impact interfacing systems such as fuel handling, reactor physics issues, and can result in thermal hydraulic issues, and fuel channel interactions.

During the development and deployment of 37M fuel, the fuel designers considered about 50 parameters. There was an OPEX report for each parameter, leading to a successful design, fabrication, testing and launch campaign, with no incidents.

5.4.2.6. West Shift Plus

Bruce A and B fuel channel life and degradation mechanisms are managed in accordance with the Fuel Channel Life Cycle Management Plan (B-PLAN-31100-00001 R03 [R005][21]) [118]. Of all the degradation mechanisms that affect Fuel Channel life, elongation is the most limiting in Unit 3. It is a code requirement to avoid channel elongation causing the fuel channel to go off-bearing.

[21] Revision numbers in square braces indicate the current revision number. R003 was the revision used for the OPEX assessment.

A review in the form of a calculation note [119] was issued to document the review of operational experience in support of West Shift Plus (WS+), a major program intended to offset the lifetime elongation of the fuel channel. The aim of the review was to identify and implement lessons learned from similar events at Bruce A and Bruce B and other CANDU plants worldwide.

The COG Screened Events database and Bruce Power SCR database were reviewed from January 1990 to December 2010 for events from previous West Shift programs. The Bruce Power SCR database contains events from Bruce A Units 1 to 4 and Bruce B Units 5 to 8. The COG Screened Events database contains events from all CANDU reactors and world view events from various sources (i.e., CNSC, IAEA, INPO, US NRC, WANO, and vendors).

This report provided 18 OPEX inputs that would affect the West Shift for both Bruce A and Bruce B on a range of topics from Pressure Tube (PT)/Calandria Tube (CT), welding, feeder clearances, records keeping, and doses to workers which were used in the development and implementation of WS+.

5.4.2.7. Feeder Conceptual Engineering

NK21-REP-33126-00071, OPEX Review Report for Bruce A Unit 4 MCR Feeder Conceptual Engineering [120] describes preparations to replace the Feeders and other components in Unit 4 under an MCR program. The replacement feeders needed to be designed to comply with modern codes and standards, incorporate design improvements made to the feeder piping and supports as CANDU technology has evolved, and to address Operating Experience. As part of this Conceptual Engineering phase, an OPEX summary was required to identify and review known design-related issues for feeder piping and feeder supports in CANDU reactors.

The objectives of this report were to:

- Search OPEX databases from CANDU organizations (COG, WANO, Bruce Nuclear Generating Station, Point Lepreau Generating Station, Darlington Nuclear Generating Station, Pickering Nuclear Generating Station, Karachi Nuclear Power Plant (KANUPP), etc.) and summarize relevant findings.
- Document and understand the failure and degradation mechanisms of feeder piping in CANDU reactors.
- Compile a list of lessons learned and design-related mitigating actions for feeders, so these can be considered in the conceptual, preliminary and detailed engineering phases of MCR program at Bruce Unit 4.

The COG screened events database and Refurbishment OPEX Management database containing events from all CANDU reactors and worldwide organizations were searched using a list of keywords for issues applicable to the MCR Feeder Piping/Support design.

The following sources of OPEX were examined in this report:

- Bruce Feeder Life Cycle Management Plan (LCMP)
- Bruce SCR Database Review

- COG OPEX Database Review
- Subject Matter Expert Input.

Topics covered in the findings of this report are applicable to both Bruce A and B and include input for items such as piping materials, bend radii, cracking, clearances and fretting, chafing shields, hangers and supports issues, and seismic spacers and dampers, to name a few.

5.4.2.8. Annulus Gas Modification

The report NK21-REP-34980-00010, Modification to Annulus Gas System - OPEX Review Report [121] documents the results of a search of a) the Bruce SCR database, b) OPEX database, and c) INPO OPEX database for annulus gas lessons learned.

The report identified 5 items in the Bruce SCR database (from SCRs in 1998 to 2003), 2 in the OPEX database (one from Darlington in 2002), and 1 from the INPO database (from 1986).

Unfortunately, this review from 2009 was too early to capture the events of circa 2011-2012 where there were multiple issues with annulus gas systems at Bruce A & B. No updated report was found (based on a title search) and apparently no specific OPEX was available to indicate the impact of clearances on gas streams passing through the end fittings such as occurred during Bruce A Unit 1 refurbishment. The Bruce A experience will be factored into any design changes made for Bruce B end fittings and fuel channels. One relevant lesson learned from this, among others, is that a governing principle for Bruce B MCR overall is that no first-of-a-kind (FOAK[22]) components will be used (assuming the practicality that unless as a last resort, there is no alternative, e.g., if OPEX shows there is no currently acceptable component).

5.4.2.9. Refurbishment Lessons Learned

At the end of the Units 3 and 4 Return to Service (~2003), Bruce Power assembled the various lessons learned from members of the Restart Team. The senior Bruce Power Vice President previously in charge of Units 3 and 4 Restart subsequently summarized this information for industry participants in a keynote address to the 2004 Canadian Nuclear Society Conference (outgoing OPEX) [122].

The Units 3 and 4 project collected OPEX information from Bruce Power participants and also contractors working on major support projects such as BARSA (Bruce A Restart Safety Analysis). These reports have been archived in Bruce Power's legacy documentation system (e.g., [123]) for use by future projects. The lessons learned included both technical and organizational information (such as the interaction among Bruce Power and contractors and consortia of contractors).

During the Units 1 and 2 Return to Service (Refurbishment), Bruce Power added to this database [124] through lessons learned on the refurbishment, plus augmented it by polling

[22] See also INPO Event Report 14-20.

previous participants in the Units 3 and 4 Restart. This database was used during the Units 1 and 2 Refurbishment and is available for future refurbishments.

As noted in Section 5.3.1.3, this information and additional OPEX from OPG/Darlington is/will be available for the MCR in Bruce B.

5.4.2.10. Fischer and Porter Controller Replacements

Two OPEX reports deal with replacement of ageing/obsolete Fischer and Porter (F&P) controllers - a) NK21-REP-60458-00002, OPEX Report for Bruce A Fischer and Porter Controller Replacement [125], and b) NK21-REP-60458-00009, Operating Experience Report for Bruce A Fischer and Porter Controller Replacement (Long Term Solution) [126].

The first report [125], generated a summary of an OPEX review to investigate the experience operators have in replacing obsolete analog controllers. The Fischer and Porter controllers were deemed obsolete (spare parts) starting in the early 2000s. The chosen replacement was then found to be unsuitable/unreliable.

The databases searched included Bruce Power's internal SCR database (Bruce A and Bruce B), as well as COG, WANO, JIT and INPO OPEX databases, plus Worley Parsons internal OPEX. The COG search covered databases from the following plants and organizations: Bruce Power, Cernavoda Romania, Darlington, Embalse Argentina, Gentilly, Pickering, Pt Lepreau, Qinshan, Wolsong, OPG, OPGN, Cameco, EPRI, Kinectrics and US DOE. At the same time the authors investigated possible replacement controllers from manufacturers such as Honeywell, Emerson Process Management, Siemens Energy and Automation, Rockwell Automation, Ivensys Foxboro, Yokogawa, Rosemount, Smar and Endress & Hauser. The search for replacements involved both nuclear and non-nuclear application providers.

The second report [126], released two years later, had basically the same objective, to find a replacement for the F&P controller that was obsolete and failing regularly with limited spare parts. Again, there was a focus on defining a replacement for the F&P devices and the Asea Brown Boveri (ABB) devices which were emerging as unsatisfactory. The OPEX searches were conducted with essentially the same databases as for the previous report, except INPO was not accessed.

Of the 77 records identified searching the Bruce Power SCR database to attempt to itemize issues not to be repeated, few useable items were found. Many of the items were related to logistical reports, such as incorrect model installed, scope changes, etc., not associated with the equipment performance itself. Of the three useable results, one was incorrect adjustment of a range limiting potentiometer, and the other two had insufficient information to reach a conclusion.

For the 250 hits for ABB controllers, there were items that revealed generic issues such as displays that were radioactive and also containing Mercury (hazard), propensity to spuriously switch to manual mode and absent alarms from some functions, failure caused by Digital Control Computer transfer of control, display failures, failures caused by power cycling, and internal battery failures. The search confirmed the troublesome history of the devices.

A search of the COG database also showed pertinent examples where the controller failure/mal-output led to other unwelcome items such as Shutdown System trips. Similarly, searching for the ABB controllers yielded useful information on hardware items such as shorting caused by the backplate and a stuck pushbutton leading to an unintended boiler level change.

These two reports demonstrate the use of previously collected OPEX to avoid repeating selection of components with poor performance characteristics. They also illustrate the need for objective review before accepting the results as applicable.

5.4.2.11. Bruce Units 1 and 2 Startup Instrumentation

Bruce A Units 1&2 restart required a new in-core Start-up Instrumentation (SUI) system because the existing in-core SUI system uses BF3 detectors which cannot be used in refurbished Units 1 and 2 reactors for initial fuel loading because of high gamma radiation (γ > 1000 R/h) in the calandria which would have caused BF3 detectors to fail and lose their sensitivity for low neutron flux monitoring. The proposed design adopted Fission Chambers/Counters as in-core detectors which can detect very low neutron thermal flux. The SUI system consisted of Start-up Unit (SUU) and Start-up Instrumentation. SUU is a mechanical guide tube assembly inserted through the viewport. An Operating Experience Review (OER) was performed to identify any issues relating to the current design to ensure they were addressed in the modification. As adopting the fission counters/chambers as in-core detectors in a refurbished core was being done for the first time, the suitability of such modification to SUI was provided in a separate report for Bruce Power. The purpose of the OPEX report [127] was to document operating experience with regard to the original and current designs.

The COG Screened Events database and the Bruce Power SCR database were reviewed in September 2008. The Bruce Power SCR database contains events from Bruce A units 1 to 4 and Bruce B units 5 to 8. The COG Screened Events database contains events from all CANDU reactors and worldwide events from various sources (i.e., IAEA, WANO, and Vendors).

There were 140 search records for NuSCI 63716 and 13 records were determined to be relevant; there were 0 search records for NuSCI 31739, 0 records for fission counter; there were 3 search records for VIEWING PORT, 19 records for fission chamber, 191 records for Start-Up Instrumentation, 1731 records for SUI, 32 records for BF3, 24 records for in-core detector, and none of them was related to the proposed modification. (Section 3 of [127]).

Based on the OPEX records received, the report described the confirmation of issues with BF3 detectors in high gamma fields, and provided information on some other characteristics of the fission chambers that enabled a new set of design requirements to be produced.

The redesigned SUI was used successfully for both Units 1 and 2 startups; the experience will be available for MCR at either Bruce B or Bruce A.

5.4.2.12. Bruce Units 1 and 2 Secondary Control Area

As part of the plant design requirements upgrade, Bruce Power was required to design and install a Secondary Control Area (SCA) as part of the Unit 1 & 2 return to service project. This SCA has the ability to control, shut down, cool down and monitor the reactor performance in the event that the main control room becomes uninhabitable. Another SCA, in room R3-116, was provided as part of the Unit 3 & 4 restart project to perform a similar function. The Units 3 & 4 SCA project was larger in scope as Containment, Emergency Coolant Injection (ECI) supply, Emergency Filtered Air Discharge System (EFADS) and other common systems were included.

Per the Engineering Change Control process for modifications to systems at Bruce Power, an Operating Experience Review (OPEX) was to be conducted during the preparation of the Modification Outline. The Modification Outline was prepared and two Design Change Packages for Units 2 and 1 (DCP3268 and DCP3269 respectively) were identified for the project. The OPEX review was conducted [128] and the results were documented in the Modification Outline.

Subsequent to the issuing of the Design Change Notices (DCNs) for the project, a Design Review was held for the SCA project. The review was documented in report R-REP-63760-10Jul2009: Secondary Control Area Final Design Review Report Bruce A Units 1 & 2 Restart Project. An action was placed on Acres-Sargent & Lundy-Fox (ASLF) to prepare an OPEX report to expand on the SCRs which are currently listed in the Modification Outline, clearly describing how they have been implemented in the design.

This report documents 28 OPEX issues (SCRs and ARs) that affect the SCA and makes recommendations for outstanding issues. This experience for instrumentation and control issues and logistics is available to designers for Bruce A and B MCR.

5.4.2.13. Bruce Units 3 and 4 Containment Vault Crane

This OPEX report, NK21-REP-76111-00001, OPEX Report Bruce A Unit - 3 & 4 Containment Vault Crane [129], is unique because it has also been assigned a TBA (Technical Basis Assessment) category in PassPort.

The condition of the Unit 3 and Unit 4 vault cranes has been deteriorating for a number of years due to the age and obsolescence of components. These cranes perform a critical role during outages and any failure can result in a significant delay to outage schedule and critical path. For this reason any failure of these cranes is unacceptable, and their condition must be improved in order to improve reliability.

In preparation for the upgrade of the vault cranes in Units 3 and 4, a search for OPEX associated with the operation and the upgrade of the cranes in the other units was conducted. The information was reviewed and evaluated.

This report addresses OPEX pertaining to plant reliability and commercial performance, while the design of the crane itself is pertinent to plant and personnel safety.

There were six ARs on five topics generated that were pertinent to the reliability issue of the cranes. There was a detailed analysis and Lesson Learned from each of the five. Quality Issues with important components (e.g., push buttons) assisted with avoiding a costly delay. An important lesson learned related to engagement of all the stakeholders and communications between technical staff and others, such as Supply.

The distinctive element of this “TBA” OPEX Report compared to others reviewed in this Safety Factor Report was that detailed lessons learned were itemized for each observation.

5.4.2.14. Pre-Job Briefs and OPEX Database/Resource Material

Procedures call for every job to have a pre-job brief (PJB). For example, Operations has a specific database that can be used to issue pre-job briefs efficiently and effectively.

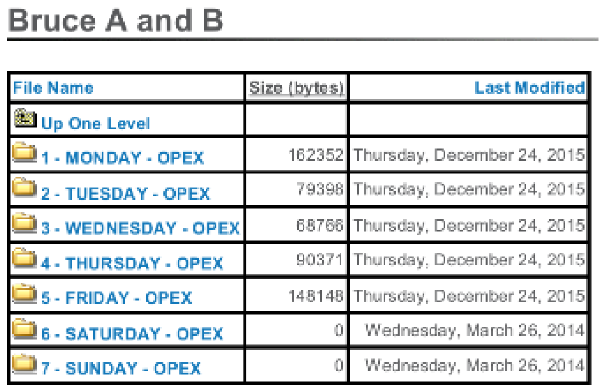
A notable aspect of PJBs is that supervisors have access to a database of OPEX events on quite a wide range of topics from which to draw for the PJB – there are presently ~176 reports in the B-OPEX series. However, a quick review shows that 84% of the reports have not been updated for more than 5 years, and the median age of the documents is about September 2009. The earliest PassPort date is July 2006. It appears that not much of the collected OPEX is making it to these particular briefing notes.

There appears to be no mandatory review time, or alternately, no requirement to see if the massive number of OPEX observations would fit in any of the existing B-OPEX-00xxx files. Section 4.2.3 of BP-PROC-00062 [35] leaves the responsibility open/voluntary so the OPEX used for the PJB is not the most recent. There are many other possible sources, e.g., see Section 4.1.1 above, and while this would appear to be a gap in the process, it is considered an acceptable deviation. Also, the use of the term JIT OPEX is easily confused with JIT OPEX available from many other sources (this is a continuity/legacy situation so no gap is assigned to this aspect).

On the positive side, as an adjunct to the JIT OPEX for pre-job briefings referred to in Section 4.1.1, the Bruce Power OPEX website also offers an interesting feature called "On This Day" and these are used every day in the Morning Leadership Meetings and distributed to the Visual Management Boards (see also discussion in Section 4.1.1). The intranet interface, Figure 1 below, enables managers and staff to select from events in the history of Bruce from a day of the week. For example, a partial extraction from an event descripton on Saturday, December 26, 2008 follows:

> *"In 2008 Unit 3 had the turbine trip as a result of generator ground back-up trip relay A64B. Generator ground primary trip did not occur. A reactor stepback occurred as a result. No work was occurring at the time and there were no advance warnings of generator trouble. The back up electrical protection relay utilizes ….".*

Other events on the same day were from 1986, 1989, and 1991. These pieces of information add interesting historical stimuli to OPEX.



Bruce A and B

File Name	Size (bytes)	Last Modified
Up One Level		
1 - MONDAY - OPEX	162352	Thursday, December 24, 2015
2 - TUESDAY - OPEX	79398	Thursday, December 24, 2015
3 - WEDNESDAY - OPEX	68766	Thursday, December 24, 2015
4 - THURSDAY - OPEX	90371	Thursday, December 24, 2015
5 - FRIDAY - OPEX	148148	Thursday, December 24, 2015
6 - SATURDAY - OPEX	0	Wednesday, March 26, 2014
7 - SUNDAY - OPEX	0	Wednesday, March 26, 2014

Figure 1: Bruce Power Intranet Interface for “On This Day” OPEX

5.4.3. Compliance Reporting

As noted in Section 4.3, Bruce Power is bound by its licence [1] to notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 [25]. One of the provisions of CNSC REGDOC-3.1.1 (and the precursor regulation S-99 [130]) was that the licensee is required to report on items it finds that may be different in nature or greater in probability or magnitude than previously stated. OPEX screening is one source of such reports. One sequence that occurred within the last four years demonstrates the effectiveness of the OPEX process at Bruce Power. In NK29-CORR-00531-10452 [131], the CNSC wrote to Bruce Power enquiring whether the OPEX program had responded to a Darlington S-99 report where the COG OPEX database had been populated with an event that had concluded that there could be gaps in the shift complement in terms of handling a Beyond Design Basis Event (BDBE). In its response [132], Bruce Power clarified that the database entry was preliminary and that while Bruce Power had been aware of the event through the regular COG OPEX weekly meeting(s), no detailed information was available so it was premature to engage in speculation. The event had been marked for follow-up by Bruce Power and in the response committed to providing an After Action Report (AAR) on the findings of minimum shift complement arising from the Huron Challenge Severe Accident Management Exercise. Bruce Power provided that AAR in [133], where it also provided a detailed licensing basis for minimum shift complement.

5.5. Summary

The foregoing examples are a small sample of the effective use of OPEX at Bruce Power. They demonstrate the deployment and use of OPEX in meeting all three review tasks described in Section 5.

Bruce Power meets the requirements of review tasks applicable to OPEX and R&D. As demonstrated in Section 7, following, these processes are under constant review and refinement at Bruce Power, further enhancing their usefulness to the entire enterprise.

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 points identify specific aspects of this Safety Factor that are addressed in, or where more detail is provided in, another Safety Factor Report.

- "Safety Factor 2: Actual Condition of SSCs" in Section 5.10, addresses the use of available internal and external OPEX information including COG, WANO and the SCR databases to evaluate the operating history of SSCs.
- "Safety Factor 4: Ageing" in Section 4.2, assesses the continuing equipment reliability improvement including the technical basis assessment which considers internal and external ageing degradation.
- "Safety Factor 5: Deterministic Safety Analysis" in Section 5.2, reviews the current state of deterministic safety analysis including the use of relevant OPEX in the Safety Report and Safety Report Improvement plan.
- "Safety Factor 6: Probabilistic Safety Analysis" in Section 5.3, reviews the sufficiency of scope and applications for the probabilistic safety analysis which includes regular updates to the model to incorporate accumulated significant changes stemming from various sources including operating experience.

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 (BP-PROC-00137 [36] described in Section 4.1.2);
- 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.

The FASAs and Audits reviewed in the Bruce A Integrated Safety Review [17] share common programmatic elements with Bruce B and as such they have been substantially retained in this report. The additions for Bruce B emphasize Effectiveness Reviews because some of the previous audits revealed issues in that area. This focus has been adopted to show that Bruce Power is aware of some implementation issues (many minor) and is taking managed steps to correct them.

7.1.1. SA-HP-2011-01, Screening and Evaluating External OPEX

The objective of FASA SA-HP-2011-01 [134] was to evaluate the process used to screen external OPEX for applicability at Bruce Power and, create corrective actions to learn from that external experience, as per Section 4.4 of BP-PROC-00062 [35]. It provided insight into where the OPEX screening and evaluation process is working well and where it is not. The outcome was that areas were identified where OPEX screening could be improved, especially in the context of adherence to the need to assimilate and distribute OPEX. Three main issues were identified: 1) Unknown expectations exist for Centre of Site Organizations participation in the OPEX program, 2) Not all people are properly engaged in fulfilling their roles in the external OPEX screening process, and 3) Awareness levels of process for new-to-role; Corrective Action

Program Coordinators (CAPCOs), Subject Matter Experts (SMEs), and managers, needs improving. These presented improvement opportunities.

SCR 28272559 documents the actions arising from this review. All three of the sub-assignments are complete (January 2012).

While the FASA does not assess the respondents' knowledge of the following sources of external OPEX, the auditors confirm that the sources are part of the OPEX evaluation process:

- Nuclear: COG, WANO, INPO, US NRC, IAEA, and EPRI.
- Non-nuclear: Ministry of Labour (MoL), Ministry of the Environment (MoE), Canadian Oil and Gas Industry, U.S. Department of Energy, U.S. Chemical Safety Board, British Oil and Gas industry.

The positive aspect of this observation is that these are commonly endorsed external sources for the Bruce Power OPEX.

The FASA keyed on the same procedures as on the Bruce Power OPEX website's list of governing documents, namely:

- CSA N286-05
- BP-PROG-01.06
- BP-PROC-00062
- IAEA NS-G-2.11
- WANO PO&C
- WANO GL-2003-01

7.1.2. SA-NSAS-2010-03, Use of OPEX in Fuel Channels Life Cycle Management and Life Extension of Fuel Channels

The objective of FASA SA-NSAS-2010-03 [135] was to determine whether fuel channel OPEX is being reviewed and used in a timely manner in Life Cycle Management Plans and fuel channel life extension. This was a Nuclear Safety Analysis and Support Department (NSASD) FASA, because NSASD provides support for fuel channel life cycle management.

The timely identification of fuel channel issues is critical to ensuring operation to end of life. A FASA reviewing the current processes for identification and use of fuel channel OPEX and interaction with the industry is beneficial in ensuring that all issues are being identified in a timely manner, and appropriate mitigation strategies are being developed.

The FASA was based on review of the existing Fuel and Fuel Channel management process for identification, communication and disposition of fuel channel issues. The Fuel Channel Life Cycle Management Plan (FCLCMP) and major fuel channel life extension work were also reviewed to determine whether OPEX had been identified in the fuel channel life cycle management process and used in a timely manner.

The FASA concluded that, in terms of the use of OPEX, the existing processes for Fuel Channel Life Cycle Management and Life Extension of Fuel Channels were found to be robust and reliable. A wide range of industry OPEX was identified and shared in a timely and consistent manner in a number of different forums. The FASA observed that it would be beneficial to share these good practices and lessons learned within NSASD to improve the effectiveness of OPEX use in other technical areas/groups within NSASD. Therefore, one action for opportunity for improvement was to roll out to NSASD staff good practices and lessons learned in use of OPEX for Fuel Channel Life Cycle Management to assist colleagues in understanding the benefits of OPEX.

There were no negative findings. The single sub-assignment to SCR 28218671 related to this FASA is complete.

The FASA described 6 good characteristics (strengths) of the NSASD Fuel Channel group, largely based on communications, such as participation in industry meetings (CSA and COG), subscription to Newsletters, and Informal Meetings with Industry Partners.

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

The objective of this self-assessment [136] was to assess the adequacy of improvements made in response to the 2010 Bruce A WANO Peer Review OE.4-1 area for improvement (AFI); namely with the evaluation of SOER and Significant Event Report (SER) related items.

The specific scope of the assessment was "… for Bruce A to assess its previous 2 years performance with the 'BP-PROC-00062 - Processing External and Internal OPEX - R013' standard for evaluating significant external OPEX (SOERs and SERs)."

A performance review of each component of the significant external operating experience (SOER and SER) evaluation process was conducted, gathering observations and feedback from leaders, supervisors, and workers involved in each of the various phases of the SOER evaluation process. The results of the assessment noted positive characteristics in all 7 review areas. It also revealed several opportunities to improve performance and efficiency with the SOER evaluation process.

One of the SOERs reviewed was INPO SOER 10-2, Engaged, Thinking Organizations [137]. The impetus for this SOER was the LWR-based observation of multiple misses to take advantage of OPEX. There was a call for immediate response and through COG there was a CANDU fleet combined response (SCR28342408). One outcome is the SOER 10-2 training [138] given widely throughout Bruce Power. It is one of the underpinnings for Nuclear Safety Culture and the fundamental behaviours expected in OPEX (see titles [96] to [99]).

There were no adverse findings requiring an SCR. Actions have been captured under AR #28426354 to track completion of the opportunities for improvement in a managed process. All 6 sub-assignments were complete by March 2015.

BP-PROC-00062 was reissued 10NOV2014 in accordance with the recommendations.

7.1.4. SA-PI-2013-02, OPEX - Utilization of Significant Internal OPEX

The objective of FASA SA-PI-2013-02 [139] was to determine:

- Which products were provided from internal significant events, to assist corporate and station management oversight of Lessons Learned, and

- Which trending or aggregate reviews of significant investigations takes place in order for Bruce Power to identify trends of root causes, organizations, and corrective actions identified in root cause evaluations over time.

The report has a detailed assessment of which items are causing resets of performance indicators (e.g., reactor trips) for both Bruce A and Bruce B. The top five contributors were seen to be comparable for the two stations.

The FASA concluded that individual events evaluated by Root Cause Investigations (RCIs) already have Lessons Learned Briefings published for them. Since the creation of this FASA purpose statement, SCR-28382306 was raised on a lack of a process for communicating Lessons Learned from lower level events involving HU clock resets, Effectiveness Review (ER) clock resets, or ERBs so they now have Internal Lessons Learned Briefings published for them as well[23]. Therefore, management is aware of and can use the results of these individual events. The potential for improvement was classified as “None”.

The report adds that Bruce A and B also produce quarterly Performance Assessment reports that look at overall trends of all SCRs at each station to identify the most often identified issues. However, these reports do not currently review trends and results from the most significant events (RCIs) by themselves, in order to examine the causes that are causing the company the most significant problems evaluated by the Corrective Action Program. The report concludes that this information needs to be made available in order to inform Management of the amount and trends of issues identified by RCIs, and/or validate other inputs to business decision making processes which occur at the Vice President and Executive Vice President level, or possibly higher. Adverse conditions are in regards to:

- No Root Cause Investigation trending, and
- RCIs are not distinguished from other SCR data (so trending is not available).

The identified SCR # 28405724 was raised to have the Senior Advisor, OPEX, begin to trend RCIs and meet with the Performance Improvement Peer Team to establish the parameters for reporting (performance metric, report format, reporting frequency). The important sub-assignment for this action was completed. After meeting with the Performance Improvement (PI) team, two sub-assignments on distribution of the RCI trending report were cancelled (justification form is attached to the EDMS of the AR 28405724).

7.1.5. SA-PI-2012-02, OPEX Training Materials

The explicit scope of FASA SA-PI-2012-02 [140] was “Training and tools available to assist with OPEX external screening and evaluation process including interviews of selected Performance Improvement Coordinators and OPEX Subject Matter Experts.”

A process review and interviews with personnel involved in external OPEX screening were completed to determine the knowledge level and quality of training tools available. An interview

[23] This item has been clarified by small changes to Section 4.2.6 in R017 of the BP-PROC-00062 (after the freeze date for this report of December 31, 2015).

of an OPEX Advisor peer at Darlington Nuclear Station and review of the Darlington external OPEX screening process was completed to benchmark Bruce Power's process with that of a peer.

The review and interviews revealed that the process is straightforward and simple; therefore specific training would not provide an improvement in OPEX screening results.

Three opportunities for improvement were identified:

- Consider increasing the amount of time allowed to screen and evaluate external OPEX to increase the number of responses and quality of the evaluation;
- Pilot the exclusive use of AOPA[24] assign requests to evaluate external OPEX by one screening organization (Engineering); and
- Link Performance Improvement Coordinators to introductory level CANDU technical training to enable them to assist with the screening process.

There were no adverse conditions identified within the scope of this FASA, i.e., there were no issues associated with training for screening of external OPEX. All three of the sub-assignments to SCR 28325626 associated with this FASA are complete.

7.1.6. SA-EPS-2014-06 Assess Employee Awareness and Safety Culture re Extreme Events

The objective of this FASA [141], completed in March 2014, was to assess Bruce Power employees' knowledge and awareness of extreme external events that can affect the site and the rigorous preparations that must be made to respond to such events.

An assessment of Bruce Power employee awareness and safety culture of extreme events was conducted. With 100 % participation from the randomly selected group, the survey showed a significant number of employees were familiar with the Fukushima Daiichi event and the subsequent actions being taken by Bruce Power as a result of that event. In terms of improving Bruce Power staff perception of readiness for such an event, the survey responses and comments reinforce the need for more frequent quality communication. Participants expressed a need for Line Management to provide an overall comprehensive picture of the progress of the post-Fukushima actions at Bruce Power.

The responses were compiled statistically for anonymity. The highlights of the survey results were as follows:

Strengths

- High awareness of the Fukushima Daiichi event

[24] AOPA is an SCR screening label for the OPEX classification. It is "OPEX applicability review (non SOER and select list)" per BP-PROC-00060 and BP-PROC-00062.

- Majority of interviewees (87%) received communications on actions taken by Bruce Power as a result of the Fukushima event, mainly via Employee Communication and Global e-mails

Areas for improvement

- Only 64% felt they received adequate information from Bruce Power communications
- 79% of the interviewees felt personally prepared for an extreme event on site, however considering the importance of having everyone feel prepared, respondents felt more could be done to increase this number; One helpful Observation was that we can only control how prepared people feel to an extent.

There was no adverse condition recorded.

Completion of this report was sub-assignment #6 (complete) of an omnibus SCR 28407993 for production of Emergency Protective Services FASAs.

Overall the FASA showed that Bruce Power management had done a credible job of distributing the OPEX, however considering the importance of having everyone feel prepared, already interested (surveyed) employees thought that with the rigorous preparations and structure Bruce Power has in place to adapt to and deal with extreme situations, more should be done to increase the 79% comfort level number.

7.1.7. SA-PI-2015-01 Effectiveness of OPEX Implementation

This FASA [142] evaluates the effectiveness of the significant changes in OPEX process implemented in 2014 by which OPEX applicability reviews were initiated, tracked and documented. BP-PROC-00062 (OPEX) was updated 2014 Q4 to make initiation of an SCR and action assignments for all OPEX items mandatory. This provides an auditable trail of the review of the OPEX item. The process to use SCRs and Action Tracking assignment to track OPEX applicability reviews has been accepted across most workgroups. With this change, the OPEX screening rate has demonstrated an appreciable increase in completion and the action rate[25] has remained steady. Tracking via AR completion notes provides an auditable and clear record of the applicability review.

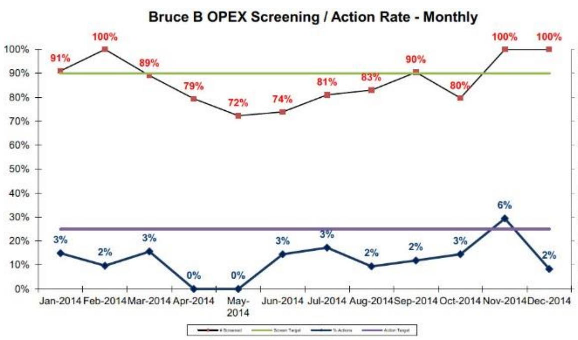
An adverse trend was identified in completion of OPEX Evaluation - Line accountable (LOPE) assignments and assignments when OPEX items are deemed to be applicable. The work groups most affected have been identified and actions have been put in place to address the deficiency.

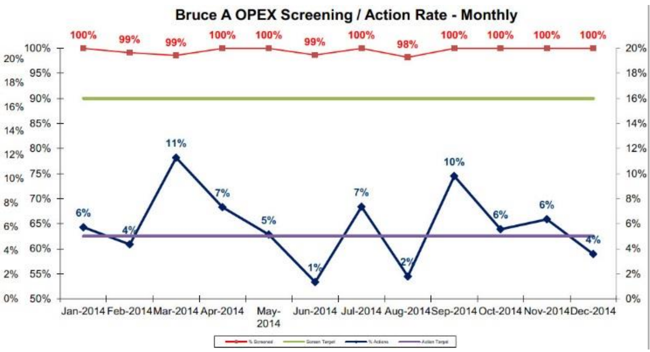
A Rapid Learning pilot was carried out mid-year and the process incorporated into BP-PROC-00059 Event Response and Reporting [41] on 08SEP2014. Rapid Learning is utilized as a new and immediate means of sharing OPEX between sister stations.

Section 4 of the FASA presents trends over the calendar year 2014.

[25] Note that the action rate metric has since been discontinued at Bruce Power because it was not particularly valuable based on benchmarking with other COG utilities.

The Bruce A workgroups demonstrated strong performance in screening OPEX with the Bruce B workgroups slightly behind but demonstrating an increasing trend. In the embedded figures, extracted directly from the FASA [142], the top pair of lines show the monthly screening rate (%) experienced vs the target (90%) over a year window, and the bottom pair (ordinate on the right) shows the percentage action rate and target (5%) over the same period. Bruce A adopted the use of SCRs and Action Tracking for OPEX review early and demonstrated good engagement. The Bruce B implementation of the SCRs and Action Tracking Assignments followed Bruce A and demonstrated engagement from most work groups.





Many Centre of Site organizations demonstrated strong engagement with OPEX applicability reviews, especially Engineering. There were some inconsistent results from the program groups (Industrial Safety, Radiation Protection, Environment, Outage Maintenance Services and Chemistry). This is attributed to the growing pains of implementing the new SCR method and assigning resources to complete the applicability reviews.

A review of the trends for 2015 shows that these issues have been resolved. The following two graphs from the internal March 2016 performance statistics, covering the last 9 months of 2015, confirm this FASA assertion from the early 2015 time period.

Pre-job brief quarterly data for 2014 was also reviewed and demonstrates an increasing trend on the use of OPEX during these briefings. The FASA evaluators noted the trend over the year for “relevant OPEX used” was improving.

The FASA observes that 141 of the 2356 external OPEX items screened were identified as ‘applicable – action required’. Overall, 76% of the 2691 items were screened for applicability and on average across the workgroups, 6% of the items were deemed to be applicable with some action required.

Section 4.4.2 of BP-PROC-00062 [35] provides options for addressing 'applicable – action required' OPEX items. A Training Change Request (TCR) can be initiated where the OPEX is applicable to training material or a DCR can be initiated for items where the OPEX is applicable to controlled documents. For items that will be used for communications an OPEX Basic Action (AOPX) assignment can be used to track the completion of the communication. The procedure also provides that other action types such as LCA, MCA or CCA actions (low, medium, high priority corrective actions respectively, or Line, MRM, and Corporate Corrective Actions) can be used at the evaluator's discretion based upon the risk and significance of the Lesson Learned. Finally, for OPEX items that require a full gap assessment, a LOPE assignment (full OPEX evaluation) is to be created.

As a result of the FASA, DCR 28495119 was raised for BP-PROC-00062 to clarify the assignment types that were appropriate for OPEX-applicable actions. This DCR has been fully implemented in the most recent revision of the procedure.

The overall conclusion of the FASA was that

> *"The process to use SCRs and Action Tracking assignment to track OPEX applicability reviews has been accepted across most workgroups. With the implementation of this process change, the OPEX screening rate has demonstrated an appreciable increase in completion with the action rate holding steady. Tracking via AR completion notes provides an auditable and clear record of the applicability review."*

SCR 28498702 was initiated to provide encouragement and coaching to the few (3) under-performing groups to enable improvements in their OPEX handling performance. All three sub-assignments are complete but the SCR is still open pending further follow-up.

7.1.8. SA-PI-2015-04, BP-PROC-00506 Actions MFIX

The objective of SA-PI-2015-04, BP-PROC-00506 Actions MFIX [143] was to evaluate compliance with BP-PROC-00506, Effectiveness Reviews [45] and validate effectiveness of corrective actions to address AU-2014-00013 [144] audit findings (see Section 7.2.1.1 of this report).

The FASA shows the corrective actions taken to address Effectiveness Review (ER) quality issues identified in internal audit AU-2014-00013 have not been fully effective. Some process gaps exist, resulting in: a) signed copies of revised ERs not always being attached to the SCR, and b) recovery plan actions not always being added to the SCR or re-opened.

The issues raised in the audit report and not already addressed occurred in three categories:

- Pre-Job Briefs (PJBs) not being conducted;
- SCRs not initiated for ER rejections by CARB / MRM; and
- Quality issues with reports, including PassPort not being updated to match ER reports.

PJB Item

Evaluators at Bruce A and B were surveyed regarding PJBs. Most had not had a pre-job brief, but a number of those did not feel that they would have benefited from receiving a pre-job brief and in particular, some who had conducted the original investigation did not think a pre-job brief would have added any value. Inversely, evaluators who had not conducted an ER before felt that a pre-job brief would be helpful so when R008 of BP-PROC-00506 [45] was issued, the wording of Section 4.1 was changed to require that the Responsible Manager “UTILIZE judgment and experience to determine if a pre-job brief is required with the evaluator(s) based on their experience and knowledge about effectiveness review”.

Based on this procedure change, this FASA did not attempt to determine whether a pre-job brief had been conducted for each ER.

SCRs Not Initiated

The FASA investigation revealed that the actions from the station MFIXes (SCR 28467976 (Bruce A) and 28467977 (Bruce B)) were completed by the end of February, 2015. A check of all ER rejections at the stations was made to see if an SCR was initiated for each rejection. For Bruce A there were 5 ER rejections since March 2015, and only 2 of these had SCRs initiated. For Bruce B there were 9 ER rejections since March 2015, and only 1 of these had an SCR initiated.

Quality Issues with Reports

Internal Audit report AU-2014-00013 Effectiveness Reviews [144] listed a number of deficiencies with completed Effectiveness Reviews (ERs). The audit report was reviewed to create a checklist of all the different deficiencies the auditors found. The most recently completed ERs were then reviewed against the checklist.

Note: One ER was not included because it was legally privileged, so the report was not attached in EDMS. Two others were not included because it could not be confirmed from the MRM Comments field that they had been reviewed by MRM or CARB. Because the MRM or CARB review is an important barrier to prevent quality issues in ERs, these reports were not reviewed as part of the analysis for this assessment. A follow-up check was done to see how many ERs did not have MRM comments showing that they had been reviewed by MRM or CARB. It was found that 22 ERs from Bruce A did not have review comments. Some of these may have been reviewed by PI staff prior to MRM or CARB review, and deemed not ready for MRM or CARB. The PI follow-up to re-open the ER assignments and communicate the quality issues to the Responsible Managers may have been deficient, and the assignments not re-opened in a timely manner. It is also possible that some of these ERs were reviewed by MRM or CARB, and that the MRM Comments field was not updated. SCR 28523785 was initiated to document this adverse condition, to determine the extent of condition, and to track corrective actions via an LFIX. (This SCR, although discovered while performing this assessment, is considered outside the scope of the assessment, so the SCR and its corrective actions are not included in the corrective action plan for this assessment.)

In total, 28 ERs were reviewed using the checklist (17 from Bruce B and 11 from Bruce A). Of these, 17 had quality issues. The specific deficiencies found were:

- The ER assignment completion notes do not state whether actions were effective or ineffective (1 ER out of 28)
- Signed report not attached in Electronic Data Management System (EDMS)* (2 out of 28 had the Word version attached)
- Incorrect number of extensions of the ER assignment (5 out of 28)
- Incorrect original due date of the ER assignment (5 out of 28)
- The ER assignment subject on the ER does not match PassPort (8 out of 28)
- Corrective action Assignment Description not correctly entered on form (3 out of 28)
- Corrective action completion notes not copied to ER report correctly (1 out of 28)
- Recovery plan assignment numbers not on ER report (3 out of 9 - only 9 of the 28 ERs required a recovery plan)
- Recovery plan assignments not added to PassPort (3 out of 9)
- Recovery plan assignments do not match PassPort (1 out of 9: error on ER report - PassPort is correct)
- Recovery plan subject does not match the ER subject (4 out of 9)
- ER report not signed by Department Manager (1 out of 28)

  Note: Deficiencies marked with * in the above list have been corrected, based on the importance of the deficiency.

The following deficiencies were noted on the audit report, but were not found among the 28 ERs spot checked for this assessment:

- Oversight checkbox (CARB vs MRM)
  - Type of Investigation checkbox correct (only applies to FORM-13857, Effectiveness Review - Apparent Cause Evaluation/ Common Cause Analysis)
- Root Cause/Apparent Cause/Common Cause listed on form
- Effectiveness criteria included on ER report
- Recovery plan includes new ER assignment
- Recovery plan assignment includes owner (accepted by)
- Quality checklist filled out

Following this review, actions have been assigned to address these process gaps.

Minor quality issues continue to occur with ERs. An action has been assigned to propose simplifying the ER Report forms by reducing the number of pieces of information required on the forms without weakening the ER process.

The issue of pre-job briefs has been addressed by removing the universal requirement from BP-PROC-00506 [45], and leaving it to the discretion of the Responsible Manager to determine if a pre-job brief is required (as described above).

The issue of SCRs being initiated for rejected ERs has not been resolved. An action has been assigned to reinforce this expectation at MRM and CARB and to monitor the results over the next two quarters.

The quality of the ER reports, and fidelity of the information matching Passport has improved, but an adverse condition still remains. Consequential process errors are occurring, such as:

- Unsigned versions of ER reports attached in EDMS (two occurrences at Bruce B);
- Recovery plan actions not re-opened or added in Passport (3 occurrences at Bruce A)

Adverse Condition(s)

Adverse Condition Description #1:

Procedure non-compliances and quality issues with Effectiveness Reviews continue despite corrective actions previously taken to address the findings of audit AU-2014-00013. These include:

- SCRs not initiated for ER rejections at CARB and MRM;
- Unsigned versions of ER reports attached in EDMS (two occurrences at Bruce B);
- Recovery plan actions not re-opened or added in Passport (3 occurrences at Bruce A); and
- Minor quality issues with ER reports.

SCR#28525170 has been initiated with 11 sub-assignments; all 9 sub-assignments with impact on the actual processes have been completed with two completion assurance type actions still open (latest Target Completion Date (TCD) is December 2016, i.e., not yet due).

Summary

As stated in the opening of this subsection, the pursuit of these necessary processes demonstrates Bruce Power's commitment to ensuring that problems are identified, solutions proposed, and results followed up.

7.1.9. SA-PI-2015-09, NORA Assessment Effectiveness – Bruce B

The objective of SA-PI-2015-09, NORA Assessment Effectiveness - Bruce B [145] was to evaluate the effectiveness of the nuclear oversight assessment function at Bruce B. This is an assessment of the auditor by the auditee.

Interviews were conducted with four Department Managers and two Section Managers with pre-established questions. The following conclusions were made from the responses received;

- Nuclear Oversight and Regulatory Affairs (NORA) provides valued support with the identification of adverse conditions.

- NORA provides timely updates and quality products.

One potential area of improvement in the report content highlighted in these interviews is that there was no identification of positive findings within the report on assessed areas. Such identification would provide line management with a more balanced view of the performance assessment. Positive findings would confirm whether previously identified adverse conditions have been mitigated. As part of the more balanced report, recommendations to mitigate adverse conditions would be advantageous. Following discussions with NORA, the Problem Development Sheet (PDS) has been modified to include a section on "Current Perspective" which permits the identification of strengths as well as opportunities for improvement. Otherwise, the overall consensus was that the assessment topics and quality of the report meet their requirements.

Adverse Condition

One adverse condition was identified:

> *" …to increase Management oversight and timely completion on mitigating actions to assessment findings; the recommendation is that a graded approach be taken to the type of evaluation to address findings based on significance."*

No new SCR was raised to address this issue because corrective action had already been taken and is being tracked under SCR28403437-09 with a TCD 25MAR2016. The action states:

> *"Develop and formalize a graded approach for assessment products that allows assessment to monitor and follow-up on important issues they identify (e.g. findings and PDS?) to ensure timely and effective resolution of those issues, and that the issues are receiving adequate management visibility to assure support for resolution."*

Opportunity for Improvement

The FASA presents discussion about whether escalation to senior management of a previous SCR, High Risk Evolutions Elevation SCR 28459153, was perhaps premature, and the associated reasons; some aspects were not suitable for escalation because the AR assignments were not due for 6-9 months. A review of BP-PROC-00706 - Nuclear Oversight Issues Elevation and Escalation [146] identified that there is no procedural requirement to follow the Corrective Action Process for any elevation or escalation. To address this, SCR 28517473 [147] was raised to track the Opportunity for Improvement, TCD 30JUN2016 for the main assignment; administrative closure TCD September 2017. The assignment description follows:

> *"Revise and re-issue BP-PROC-00706 - Nuclear Oversight Issues Elevation and Escalation to include procedural requirement to initiate an SCR when an elevation is submitted Ensure that the elevations are attached to the SCR, as well as the station's responses. All actions to mitigate the elevation are to be captured in the SCR with CARB oversight actions to ensure timely completion."*

The overall conclusion of this FASA was that in review of the NORA assessments and their findings, the corrective actions taken by the affected departments to mitigate future reoccurrence, NORA's assessments are effective.

This FASA demonstrates the healthy communication between auditor and auditee that leads to a more effective and accurate representation to management on the follow-up of actions.

7.1.10. SA-PI-2015-06, Trending

The objective of SA-PI-2015-06, Trending [148] was to compare Bruce Power's current trending process to the "best in class" based on benchmarking, and review INPO Guideline 07-007 Performance Assessment and Trending. Trending is an important element of revealing and assessing OPEX.

Bruce Power's current trending process was compared to the "best in class" based on review of INPO Guideline 07-007 Performance Assessment and Trending, and the programs of ENTERGY (River Bend Station) and Ontario Power Generation (Darlington). A number of gaps have been identified (7 performance gaps, and 10 trending gaps), and prioritized to develop a short list of gaps to be addressed in the corrective action plan for this self assessment. Gaps to be addressed in the short term are:

- “Trending over time”: Develop tools for CAPCOs to use to show trends over time (quarter-to-quarter rather than just a snapshot of one quarter);
- Communications to staff: Departments communicate to staff the results from their trending;
- Formal Department Performance Assessment Meetings: Begin steady transition to INPO 07-007-style Performance Assessment meetings;
- Other Assessment tools for adverse trends, such as Performance Analysis and FASA;
- Use of Statistical Process Control and/or pre-established limits on trend graphs (not to be over-used).

The following gap is to be addressed on a medium priority basis:

- Explore options for automated trend extraction software, such as River Bend database, DevonWay (SanFrancisco Software Company).

This FASA, also basically a self-benchmarking study using external OPEX, explored the various aspects of trending and produced a prioritized list of gaps for follow-up. The resulting SCR 28494159 had 9 assignments, to address the gaps, the last of which is to review this FASA to determine what additional steps are necessary (based on the results of the previous 8 assignments or additional lessons learned in the process). Sub-assignment 8 of the AR completion notes indicates that the FASA report SA-PI-2015-06 gap analysis has been reviewed, and it was determined that no additional actions are warranted at this time.

7.1.11. SA-PI-2015-03, BP-PROC-00059 / Rapid Learning

The objective of SA-PI-2015-03, BP-PROC-00059, Event Response and Reporting [149] was to evaluate a recently implemented process called Rapid Learning. The FASA provides a history of the process that has not been widely explained in layman’s terms so far. In 2012 ownership for the Fact Finding process was transitioned from the Performance Improvement group to the individual line organizations. To align with the 2014 Learning Organization initiative, the Performance Improvement Program group completed a study to review the current state of, and propose changes to, the process. This project resulted in a renewed prompt fact-finding method that was rebranded as Rapid Learning and a pilot began in May 2014. This FASA was performed to assess the current implementation of the Rapid Learning process based on the outcome of the project and pilot.

A review of data related to Rapid Learning initiation, timeliness, report information, and overall value determined two adverse conditions and two opportunities to enhance the process. The associated procedure BP-PROC-00059 prescribes expectations for timeliness and report content; the analysis revealed that reports are not always completed to the expected standard and distributed within the specified timeline. Two actions resulted from this FASA that will increase oversight and enforcement of these standards.

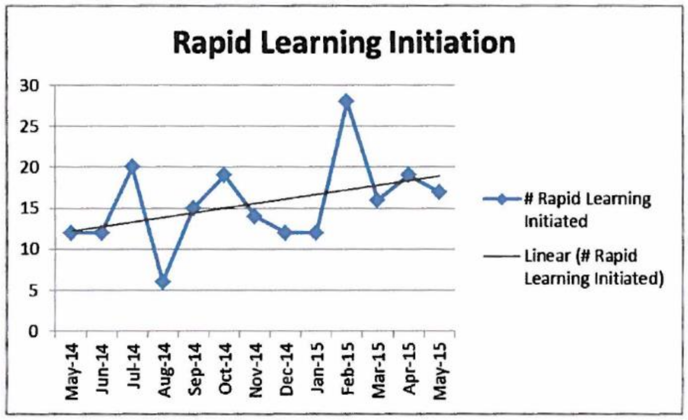
The review process also identified two opportunities that will enhance efficiency for managers reviewing the Rapid Learning reports. Survey results included in [149] (pages 9 & 10) demonstrated that while the amount of content in the report is appropriate it would be more efficient to have an executive summary that provides a high level overview of the event and allow a quick decision as to whether reviewing the full report is necessary. Similarly an opportunity exists to introduce a standard report distribution e-mail subject (including facility, unit, and SCR significance level) that will also enhance managers' decision to review the report in full immediately or if a quick review at a later time is sufficient.

BP-PROC-00059 indicates that the need for Rapid Learning is determined by management, and is typically done for immediately/self-identified significance level 1 and 2 events, station level human performance clock reset events, events considered consequential by Shift Manager, Plant Manager, Vice President, or Executive Vice President. Some level 2 events are exempt from Rapid Learning such as degradation of system or component health to red. Similarly, Rapid Learning may not be necessary for events that prompted another form of 'learning' such as a Post Transient Review or Technical Operability Evaluation. Although Rapid Learning is intended for level 1 and 2 events many groups are going beyond the requirements in BP-PROC-00059 and initiating the process for level 3 events. This presents an opportunity for continued learning with a structured approach.

The surveys showed that the majority of Rapid Learning is completed for significance level 1 and 2 events. Rapid Learning was completed for 7 of 20 level 1 events, 28 of 174 level 2 events, 152 of 9985 level 3 events, and 15 of 21876 level 4 events. Although Rapid Learning was not completed for all significance level 1 and 2 events, the breakdown shows that the process is being used most often for higher level events as desired. The survey results support these numbers with 100% of managers and 79% of staff who have completed Rapid Learning agreeing that the process has been initiated for the right type of events in terms of significance and impact to our safety pillars, production, and reputation.

Occasionally when a new initiative is piloted managers and staff are more likely to use the process more often during the initial few months and then taper off. Initiation rate for Rapid Learning was collected and reviewed to determine if the overall initiation rate is going up or down over time since the pilot began. Graph 7 (from the report[26]) shows the rate of Rapid Learning initiation from May 2014 to May 2015.

[26] The report has many useful graphs, omitted here for brevity.



Graph 7: Rapid Learning Initiation Over Time

Although the graph shows peaks and valleys of initiation over the one year time frame the trendline demonstrates a gradual improvement over time. The sharp spike in February 2015 corresponds with the A1511 outage and an increase in the need to respond to events during the outage. Again the survey results also indicate that across site Rapid Learning is initiated for the right events.

Overall the trend in Rapid Learning initiation shows a sustained use of the process over time; however, to keep the focus for Rapid Learning on the most significant events the initiation rate is expected to remain fairly stable or increase slightly.

BP-PROC-00059 [41] states that within 18 hours of an event the Rapid Learner must provide the completed report to the designated Responsible Manager who will then complete any other notifications and processes. The end goal is distribute the final report to the Rapid Learning e-mail alert list within 18 hours of the event. The analysis shows only 27% of reports were sent to the e-mail distribution list within the 2-18 hour timeline while 48% (virtual median) took greater than 36 hours.

Although the review of distribution timeliness shows that the timeline is not met for almost three quarters of the report the survey results did not indicate this as a significant issue. Based on survey results 89% of the managers agreed that the reports are distributed in a timely manner. Only one anecdotal survey comment indicated that the reports are not always timely, and in contrast another suggested that it may be more effective to send a preliminary report within 24 hours and a formal report within five business days. This comment echoes the outcome of the survey question posed to staff who have completed Rapid Learning regarding whether the 2-18 hour timeline is achievable. Only 47% of respondents agreed that the timeline is achievable, and many of the comments indicated that the biggest challenge for completing the report is getting opportunities to discuss the event with all of the staff involved. This can be especially difficult when the staff involved are on shift crews and are not available for interviews when needed. Survey comments indicate that Rapid Learners strive to deliver an accurate report, and that means they do not want to distribute the report until they discuss the event with all staff involved.

As described previously, two different surveys were sent to a selection of staff who have completed Rapid Learning and to a selection of managers who have initiated Rapid Learning and/or are on the e-mail alert list. The survey results provided insights to other areas of the Rapid Learning process including ease of using the report template and instructions, amount of information in the report, and overall process value.

Survey results showed that 66% of Rapid Learners agreed that the report template and instructions are easy to access while 80% agreed that the template is easy to complete. BP-PROC-00059 clearly indicates where to locate the template and instructions, and it also includes a process flowchart to guide staff through the process. According to 93% of Rapid Learners surveyed the overall Rapid Learning is a valuable tool for investigating and reporting events.

The survey for managers questioned if the amount of information in the report is appropriate or not, and if an executive summary would be more effective and efficient for managers to review. Only 33% of managers surveyed agreed that the report contains too much information while 61% agreed that an executive summary would be useful to glean the most pertinent information and help determine if further review is required. Several survey comments indicated that it would be detrimental to remove any of the information already in the template, so to that end an opportunity for improvement will be pursued to build an executive summary into the beginning of the report template. Other comments indicated that not all reports are filled-out completely and this results in missing information that may be important to many readers. A review of Rapid Learning reports showed that only 55% of reports are filled in their entirety. The majority of reports are missing information in section 6.0 Administrative Actions where the Responsible Manager is to document that all of the proper reporting, notifications, and documentation is complete for the event. Although much of the content of the report is of good quality it is still imperative that the administrative actions are completed to be compliant with the identified processes, and to maintain adherence to BP-PROC-00059. A NORA review also confirmed that Rapid Learning report completeness and quality is an ongoing issue, so this will be addressed with an action to perform quality oversight on the reports for a period of time.

Four SCRs were raised to address gaps discovered during the review. The first (AR 28505253) addresses timeliness, the second (AR 28505257) addresses quality; the third (AR 28505262) proposes implementation of an executive summary; the fourth (AR 28505266) proposes context information additions to the Rapid Learning template to improve information transfer. Assignments are presently scheduled throughout 2016 with all actions scheduled to complete by end of Q2 in 2017.

Overall the Rapid Learning process is perceived as a valuable process for promptly investigating significant events at Bruce Power. A review of data and survey results related to Rapid Learning initiation over time and by significance, report distribution timeliness, quality, report contents, and ease of use identified two adverse conditions and two opportunities for improvement. An action plan has been developed to address the gaps, monitor and assess progress, and enhance the process.

7.2. Internal and External Audits and Reviews

The objective of the audit process as stated in BP-PROG-15.01 [150] 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 [27]).

7.2.1. Internal Audits

7.2.1.1. AU-2014-00013, Effectiveness Reviews

This audit [144] evaluates Effectiveness Reviews performed since 01JUN2013 against BP-PROC-00506, Effectiveness Reviews [45] and its interfacing procedures for completeness and compliance. Additional considerations are a) evaluation of training as a compensatory action as per AR 28278195 Nuclear Oversight missed opportunity (Bruce A WANO AFI, assignment 01), and b) effectiveness review of WANO AFI AR 28229180 Training on worker understanding of new equipment.

The missed “WANO” opportunity arises from the observation that the governance flaw identified by WANO had been undetected in at least three previous audits of the same process.

Documents associated with BP-PROC-00506 R007[27] Effectiveness Reviews were audited for alignment and interfaces to support the defined process for Effectiveness Reviews. In support of evaluating compliance to the procedure, MRM and CARB meetings at both stations were observed and interviews were conducted at Bruce A of a sampling of staff associated with the reviews. Interviews were restricted at Bruce B because of the concurrent WANO evaluation.

The audit team concentrated on the most recent of a list of Effectiveness Reviews conducted since 01JUNE2013 and to consider the effects of SMART (Specific, Measureable, Achievable, Realistic, Timely) training and other enhancements implemented to increase the quality of Corrective Action Plans and their subsequent reviews.

A total of 118 Effectiveness Reviews (ER) were evaluated for compliance to the procedure; these comprised 32 associated with Root Cause Investigations and 86 associated with Apparent Cause Evaluations. Sampled reviews had been or were observed presented at Bruce A, Bruce B and Centre of Site management review meetings.

[27] Currently at R008.

On rigorous assessment, each ER was found to not comply fully with the requirements of BP-PROC-00506 [45] to varying degrees. Most of the instances of non-compliance were deemed administrative in nature, considered minor. Cumulatively, they become significant in that attention to detail, and 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 included:

- Inappropriate signatories for approval
- Absent linking and cross-references to associated SCRs and FORM numbers
- Failure to complete CARB/MRM actions
- Absent follow-through to changes to the AR; e.g., cancellation of assignments did not affect the subsequent assignments.

As noted in the previous paragraph, most non-adherences are administrative. This imparts a tendency to trivialize them individually; however when an active Root Cause Investigation (RCI) has no ER assignment, then the (potential) risk to Bruce Power's business becomes elevated. This is important to this Safety Factor Report in the sense that items lumped in the generic term "business risk" include Nuclear Safety.

CARB and MRM were observed enforcing the SMART action philosophy (Specific, Measureable, Achievable, Realistic, Timely) currently in implementation. Instances were noted at their meetings that the original actions were not SMART-compliant and Evaluators were coached with requests for modification.

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

- Non-adherence to BP-PROC-00506, Effectiveness Reviews [45],
- BP-PROC-00506 is not entirely aligned with its program document (BP-PROG-01.07) and contains unclear and incomplete instructions.
- Training and qualification to conduct Effectiveness Reviews is not defined.

BP-PROC-00506 R008 has been issued; the revision notes indicate significant changes to ensure effective reviews clearly state effective or ineffective. BP-PROG-01.07 [39] has since been updated, in November 2015.

This Audit shows that Bruce Power has recognized a need for improved effectiveness reviews and has acted on the requirement to better align BP-PROC-00506 with its Program document. The alignment issue was addressed in the latest revision, as discussed in the previous paragraph.

See Section 7.1.8 for a follow-up FASA review and associated residual actions. In the associated FASA, there is recognition of the afore-described issues and discussion of a continuing program to monitor and address them.

7.2.1.2. AU-2011-00010, Performance Improvement

The objective of AU-2011-00010 [151] was to “assess the elements of the following programs in the Performance Improvement (PI) Department: BP-PROG-00.07 R009, Human Performance Program, BP-PROG-01.06 R010, Operating Experience Program, and BP-PROG-01.07 R008, Corrective Action for completeness and implementation”. The following description focuses on the latter two. This was initiated as the routine audit required every three years.

The audit team conducted document and database reviews and interviewed the CFAM. CAPs from SCRs, initiated as a result of previous related audits, were reviewed and a search of programmatic SCRs related to the Performance Improvement programs was completed.

The audit concluded in Section 2.0 that

> *“overall the programs within Performance Improvement are well documented and thorough (Strength)”.*
>
> *BP-PROG-01.07 R008 was compared to the Pressure Boundary Quality Assurance Program (PBQAP) Section 15 “Control of Nonconforming Items", and Section 16 “Corrective Action”. There were some differences between the PBQAP and the Corrective Action Program implementing procedures which were listed in Adverse Condition No. 1.*
>
> *There are non-adherences of the program documents to the requirements of BP-PROC-00774 R001 “Program Requirements”. There are also non adherences of implementing procedures to BP-PROC-00166 R019 “General Procedure and Process Requirements”.*

These were listed in Adverse Conditions 2, 3, and 4.

Eighteen SCRs related to OPEX were reviewed.

No significant OPEX related to the Performance Improvement Programs was found in the COG OPEX database.

The adverse conditions were:

1. Pressure Boundary Program requirements for control of nonconforming items, and corrective action, were not always aligned or are missing from the Corrective Action Program and its implementing procedures. Differences between the Pressure Boundary Program and implementing procedures could result in non-compliance to the program. ARs submitted and accepted;
2. Performance Improvement programs BP-PROG-00.07 R009, BP-PROG-01.06 R010, and BP-PROG-01.07 R008 contained non-adherences to BP-PROC-00774 R001, Program Requirements;
3. Performance Improvement implementing procedures for BP-PROG-00.07 R009, BP-PROG-01.06 R010, and BP-PROG-01.07 R008 contained non-adherences to BP-PROC-00166 R019, General Procedure and Process Requirements;
4. Some Performance Improvement program elements were not described in implementing procedures. Lack of instruction for program elements in implementing procedures may result in reduced effectiveness of the program.

ARs were submitted and accepted for all 4 Adverse Conditions.

In addition to the periodic audit, the auditee requested a comparison of BP-PROG-01.07 R008, and WANO GL 2001-07, Principles for Effective Self Assessment and Corrective Action. The corrective action aspects were reviewed, and yielded 9 gaps between the BP Program and the WANO Guidance.

Overall, the audit concluded that the OPEX aspects were sound. It also provided direction in improving the alignment and consistency of the documentation.

7.2.1.3. AU-2013-00018, Fluid Leak Management Program

AU-2013-00018 [152] was performed at the request of the Bruce B Plant Manager as part of an effectiveness review for an SCR follow-up action. The management of fluid leaks at the stations was evaluated against BP-PROC-00673 R001, Fluid Leak Management Program (FLMP) requirements and referenced procedures.

The audit made use of OPEX (Benchmarking Trip to McGuire Plant in 2009, a Unit 7 Leak Incident, and SCR Searches). In addition, the Audit used an EPRI Nuclear Measurement Analysis and Control (NUMAC) guideline on Fluid Sealing Technology.

The audit concluded that BP-PROC-00673 R001 is not fully integrated with interfacing procedures resulting in incomplete or conflicting instructions. It identified opportunities for improvement of the FLMP that would lead to improved performance in detecting, prioritizing, and resolving leaks and spills, as well as improving employee morale and workplace culture. Actions have been defined in the referenced ARs and have been undertaken in a managed process, with oversight provided by Nuclear Oversight and Regulatory Affairs (NORA) to ensure effectiveness. The three referenced SCRs are 28351427 (14 assignments, all complete September 2015), 28351429 (7 assignments (2 cancelled), complete by August 2014), 28351431 (8 assignments (1 cancelled), complete by August 2014).

In addition, this audit demonstrated the use of benchmarking through collection of OPEX from external organizations.

7.2.1.4. AU-2010-00024, Root Cause Investigation Audit

The objective of AU-2010-00024 [153] was to evaluate compliance with BP-PROC-00518 R002[28] Root Cause Investigation of the Bruce Power Corrective Action Program, BP-PROG-01.07 R008, and to determine its effectiveness. The audit assessed the Root Cause Investigations completed, or in progress, from June 2008 to the time of the audit, January 2010. It is pertinent because Root Cause Investigations are part of the input stream for OPEX (via SCRs raised in the process).

[28] Current revision is R007 per [46].

The audit team observed a CARB Meeting and conducted interviews of Performance Improvement Department personnel. They also performed reviews of procedures, Station Condition Records, Action Tracking assignments and Root Cause Investigation records.

The audit concluded that instructions provided in BP-PROC-00518 R002, Root Cause Investigation, were not always clear and there were procedural misalignments with the governing document and other interfacing or reference procedures. As a result, the purpose of BP-PROC-00518 R002 was not always achieved with respect to consistency and comprehensiveness, as a number of non-compliances were observed. The RCI process was not always effective at initiating required RCIs and completing identified RCIs in a timely manner.

In the OPEX area, the audit observed that industry best practice for Root Cause Investigations is 28-30 days. This time line has been adopted by Bruce Power; however, it has not been enforced. Excessive completion times for RCI conduct has been previously identified as an AFI by WANO (i.e., AR#28181670) and questioned by the Nuclear Safety Review Board. This has an impact on the timeliness of the OPEX but the OPEX process *per se* was not an element of the review.

The audit issued the following Adverse Conditions:

- Root Cause Investigations are not completed in a timely manner
- Root Cause Investigations are not always initiated as per requirements established In BP-PROC-00060 R016
- Non-compliances with BP-PROC-00518 R002 - Root Cause Investigations Procedure, Section 4.6.5, Joint Health and Safety Committee (JHSC) Presentation
- BP-PROC-00518 R002 - Root Cause Investigations (RCI) Procedure does not always provide clear Instructions to ensure consistent and comprehensive RCI conduct
- Non-compliances with BP-PROC-00518 R002 - Root Cause Investigations Procedure Section 4.3, Develop Corrective Action Plan
- Root Cause Investigation Process Records are not clearly identified and appropriately managed resulting in noncompliance with CSA N286-05 requirements
- Root Cause Investigation Procedure does not conform to Bruce Power requirements.

All adverse conditions and corresponding referenced 8 SCRs were accepted by the Performance Improvement Department for follow-up in a managed process. All of the >70 sub assignments are either complete or cancelled (9). SCRs 28192951 and 28192952 addressed the timeliness issue. Expectation letters were sent from Bruce B Plant Manager, Bruce A Plant Manager, and Chief Engineer & SVP Engineering to all managers and staff that a target completion date of 35 days is the accountable period. A transition period of 3 years was approved to reach the target. In addition, full time RCI/ACE Subject Matter Experts were hired, trained and are in place, 2 at Bruce B and 3 at Bruce A. Reports on progress are to be provided to senior managers quarterly. As noted, these actions are complete.

7.2.1.5. AU-2010-00007, S-99 Reporting

AU-2010-00007 [154] is about S-99 reporting, and is relevant to OPEX because these reports generate OPEX data points and are also passed on to external agencies (e.g., COG[29]). With the replacement of S-99 by CNSC REGDOC-3.1.1 on January 1, 2015, and the parallel nature of the two regulatory documents, this audit still applies to the reporting function in general.

The surveillance evaluates the compliance of a sample of S-99 reportable events to the S-99 Reporting Standard and Bruce Power's reporting processes. Events contained in privileged root cause reports are included in the sampling. The surveillance is a follow-up to an audit conducted in 2007 and evaluates the effectiveness of corrective actions taken in response to the identified adverse conditions.

Sample S-99 events requiring root cause investigation were analyzed for adherence to reporting guidelines. No issues were noted within the 5 reports reviewed.

A previous audit, AU-2007-00032 generated two adverse condition SCRs which were analyzed for completion and effectiveness of corrective actions.

Adverse Condition #1 related to the fact that the body of BP-PROC-00059 R016[30], Event Response and Reporting had been updated but the Appendix had not, leaving the situation that the body of the procedure called for the Duty Manager to be responsible for immediate reporting whereas the Appendix still said the Shift Manager (or Shift Assistant Technical (SAT)) could submit the immediate report. Preliminary and Detailed S-99 reports were found to be prepared and submitted to the CNSC by personnel other than the required Duty Manager so the previous audit’s action was complete but ineffective.

Adverse Condition #2 is related to the observation that Security’s S-99 records were not included in Nuclear Records and should have been (in a secure folder).

No Opportunities for Improvement were identified. Two SCRs (28232076, 28232079) addressed the Adverse Conditions. All sub-assignments in both SCRs are complete, but only SCR 28232076 is marked complete overall.

7.2.1.6. AU-2009-00026, CAMEO Review SCR B-2006-07441, Service Water OPEX

In 2006, WANO released Significant Event Report (SER) 2006-2 on the subject of degradation of emergency service water (ESW) system piping which caused the August 2004 circumferential rupture of an inspection hatch “neck” on a train of the ESW system at Vandellos-2 NGS. This finding resulted in the generation of Bruce Power SCR B-2006-07441 to address WANO SER 2006-2 Degradation of Essential Service Water Piping, as is required by BP-PROC-00062. This was a follow-up audit [155] to determine the effectiveness of the implementation of this OPEX from an external station.

[29] Clarification, being reportable to the CNSC is not a condition of passing to COG.
[30] Currently at revision R022 per [41].

The subsequent CAP identified 8 corrective actions and, at the time of the audit, 6 of the actions were identified as COMPLETE. The audit looked at the 6 corrective actions marked complete and a "report-card" format was used to simplify the status reporting of the actions reviewed. The audit concluded that 3 of the 6 actions associated with AR #28043406 were not completed as indicated. This resulted in a 50% assignment completion rate and an indeterminate effectiveness rate.

SCR B-2009-05074 Ineffective Corrective Actions Associated with SCR B-2006-07441 OPEX WANO SER 2006-2 was entered into the SCR system. The audit noted that the SCR could be closed out for trending if the incomplete assignments were re-opened. The pertinent aspect of this audit is not whether the OPEX made it to field but whether processes were followed correctly (effectiveness). It is an example of the screening of external OPEX to generate a Bruce Power review, and to generate follow-up actions. That worked, even if the execution required follow-up. In the meantime, the NORA Audit oversight has been put in place to ensure follow-up. As described at the end of Section 5.2, the Oversight audits have resulted in all of the ineffective actions being reopened for completion.

7.2.2. External Audits and Reviews

In addition to the regular internal audits, Bruce Power has had an independent nuclear industry evaluation of their nuclear oversight program [150] and a NORA improvement initiative where NORA continuously reviews the effectiveness of their Oversight against the WANO Performance Objectives and Criteria to learn lessons from WANO 1 Stations around the world.

7.2.2.1. Nuclear Industry Evaluation Program Evaluation

The 2014 Nuclear Industry Evaluation Program (NIEP) evaluation of Bruce Power [156] found the Programs were effective in meeting the Nuclear Oversight Audit and Supply Chain Quality Services requirements. The audit evaluated effectiveness in 8 general categories, two of which were deemed out of scope. Within the 6 remaining categories, all 74 parameters evaluated (5 of 79 were considered not applicable) were satisfactory, although 9 areas that were satisfactory had recommendations, 3 had a deficiency and 1 was 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 the Plant Operations Review Committee (PORC) meetings (the frequency of the PORC meetings was already being addressed at the time of audit and has been verified updated in the latest revision of BP-PROC-00136 that governs the PORC). The delay in 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: “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.

7.2.2.2. NORA Assessment

This subsection demonstrates the scope of the NORA assessments. The first part is a repeat of the Bruce A ISR [17] assessment; the second part provides a few statistics from the collection of quarterly reports [157] to [162], four of which have become available in the interim. In the opening segment of its inaugural report [157], the NORA oversight team made the following observations:

- During Q2 2014 the Bruce A Nuclear Oversight Group worked on two large assessments:
    - The first one was on work process efficiency. This assessment involved the entire BA NORA team and included field observations and interviews across Control, Civil, Mechanical and Fuel Handling Maintenance sections. A problem development sheet was issued and insights are outlined in Section 2.3 [of the assessment].
    - The second assessment was a joint assessment with the Bruce B team on the Equipment Health Initiative. This commenced in June and is expected to be debriefed and finalized in July. Results from this assessment will be reported in the Q3 report.
- In addition to these large assessments that involved the whole team, some smaller assessments were conducted. Mirroring some of the assessments conducted during the Bruce B outage in Q1, NORA examined work in progress reviews and contractor safety. Rapid OPEX from the Bruce B deaerator FME cap event resulted in the BA NORA team providing oversight of the A1431 Outage FME plans. Deviations from best practices and procedures were immediately noted and corrected.

The inaugural report (in Section 2.1) provides insight into the functioning of the NORA team and the culture it engenders:

> *"It is noteworthy that the entire organization from the shop floor workers to upper management have been very open and honest with the BA NORA team. This has contributed positively to the depth of insights gained during the assessments this quarter".*

Four more NORA quarterly reports [159] to [162] have become available since the Bruce A ISR. Table 7 provides some statistics, extracted from each report, which show the level of activity for effectiveness audits in each quarter. The Table focuses on formal reporting to management, Problem Development Sheets (PDSs), usually accompanied by an SCR. In addition there are usually many written observations and assessments per quarter, typically ~40 per station that record the observations; many of these are also accompanied by SCRs. These observations also include records of strengths as well as developing situations or areas for follow up. When a PDS languishes, NORA staff elevate the item to senior management as per BP-PROC-00706, Nuclear Oversight Issues Elevation and Escalation [146]. The value in the table represents the number open during the quarter – opening one and closing one would produce no change in the statistic from quarter to quarter. Values with a 2 divisor are common to Bruce A and Bruce B. Typically they have similar or identical scope and sometimes share the same SCR overall.

Table 7: Output Statistics from the NORA Quarterly Oversight Reports

	Bruce A		Bruce B		Elevations		Notes
AQR	PDSs	PASs	PDSs	PASs	BA	BB	
2014-Q2	1		2		0	1	one pre-WANO report to BB management; one additional joint assessment BA/BB on ERI started Report also has list and status of in-progress PDSs
2014-Q3	8+5/2		3+5/2		0	2	BB Elevation re high risk evolutions; BB Elevation on hand safety still open
2014-Q4	3+2/2+ 1/2		5+2/2+ 1/2		1	1	2 PDSs were common at both stations, one with joint owner, 43 assessments at BA, 44 assessments at BB NORA Section manager per station added One elevation opened, one elevation closed for BB. Elevation at BA was to document need for improvement on timely work management
2015-Q1	4+2/2	5	3+2/2		1	1	Sister Station OPEX among common 2 assessments (timeliness of sister station OPEX PDS/SCR) Elevation was for High Risk Evolutions
2015-Q2	4+1/2	2	4+1/2	2	2	2	Maintenance Corrective Actions/WANO AFIs (BA) FME practices/residual from Q1 (BB) VBO Lessons Learned (BB)
2015-Q3	3+1/2	1	1+1/2	1	0	1	Both BA PDSs closed in quarter (no residual elevation); Q1-2015 FME PDS still open at BB, TCD Q1 2016

Legend

PDS Problem Development Sheet
PAS Performance Area Summary (debriefed with line management)
Elev Elevations per BP-PROC-00706 [146]

This table demonstrates sustained activity for an ongoing monitoring and oversight function by the NORA organization, evaluating strengths and weaknesses and highlighting these to Bruce Power management as necessary to ensure expeditious follow up.

7.2.2.3. Benchmarking and Conferences / Statistics

The process for Benchmarking, as described in Section 4.1.3, produces OPEX. Aside from effectiveness reviews of the Benchmarking process, the SCR database provides numerous examples of OPEX and follow-up actions generated from benchmarking activities. The following sections very briefly itemize some examples.

Palo Verde

There were three benchmarking trips to the 3 unit Palo Verde station in Arizona, 2012, 2014, 2015. Based on titles, the topics covered were Training, FLM Fundamentals (Maintenance), and Outage Management.

Wolf Creek

There was a benchmarking trip to Wolf Creek Nuclear Generating Station (WCNGS/Kansas) in 2015 to review the use of Emergency Management Metrics as part of responding to a WANO AFI on the topic [163]. Wolf Creek has a long history of collecting and using performance metrics, since 1998. Other areas that were reviewed include: WCNGS Metrics performance and management to obtain clarification and INPO interactions; Emergency Response Organization (ERO) Staff Policy and management techniques; planning, conduct and evaluation of drills; visit to WCNGS emergency operations facility (EOF) follow-up on Emergency Preparedness topics in 2015. WCNGS metrics were used in fall 2014 as the start point for development of the Bruce Power metrics based on recommendations from WANO for industry leading metrics and performance management.

INPO Engineering Programs

A conference trip to the INPO Engineering Programs meeting on August 12/13, 2014 yielded multiple OPEX-worthy reports both through Action Requests related to SCR 28453968 [164] and files collected at the conference, attached to the SCR file via the EDMS.

The summary report [165] identified 6 general observations and 9 specific areas for follow up. Two interesting general observations pertinent to Safety Culture/OPEX were:

> *"4. A common approach and methodology for reporting Engineering Programs was presented by industry working group. Working group continues to incorporate feedback. The 4 cornerstones used by Bruce Power is the suggested standard.*[31]
>
> *5. Challenged by Sr Sponsor on role of Eng Program Manager relative to 5 principles of an Effective Technical Conscience and Integrated risk inherent in effective execution of Eng programs."*

The following descriptions and associated completion statements from the SCR [164] demonstrate the actions taken and the distribution of lessons learned to the Bruce Power organization:

> ***Assignment:*** *"Document in the completion notes of this action any gaps identified, any actions already completed to address the gaps and summarize any additional corrective actions if required. If no further corrective actions are initiated, document the rationale. It is recommended to consult the Initiator and/or FLM of the SCR to ensure the problem is If additional assignments are required, add SMART corrective actions (type MCA, LCA or AEA depending on the oversight required) to this SCR via the CAP Screen (setting assignments to NTFY/PRI status). Include the name of the person who agreed to the action. Note that if a recommended assignment is to do a more thorough Investigation (ACE, RCI, Common Cause), email BNPD-SCR Administrators."*
> ***Completion:*** *"Action plan prepared and reviewed by Division manager Station Engineering. Assignments added in Esuite."*

[31] Recognition of Bruce Power's four pillars of safety philosophy by the international utility organization.

Assignment: *“Present INPO’s assessment of Strengths and AFI’s for Engineering Programs (attached to EDMS) to Corporate and Station Component teams of Station Engineering. This includes all CAPE and BA/BB Component Section staff. “*
Completion: *“INPO's assessment of strengths and AFI's for engineering program (attached to EDMS) was presented to all sections of CAPE (SECECP, SECPBP, Mechanical components, reactor tools and major components), BA components [person responsible] and BB components [person responsible]”*

Assignment: *“Forward Engineering Advocacy and Technical Conscience training material being used by some fleets to Technical training section manager for consideration in the development of Continuing Engineering Training lesson plans.”*
Completion: *“Training material (attached in EDMS) from Harris NPP and Calaway NPP was sent to Section Manager – Technical Training and Engineering Continuing Training coordinator.”*

Assignment: *“Complete industry survey on scope and structure of Engineering Programs at Bruce Power arising out of the Aug 2014 meeting.*
Completion: *“Survey completed (attached in EDMS) and forwarded to [person] at INPO.”*

Assignment: *“Conduct awareness sessions on INPO Consolidated Event System (ICES) (presentation is attached in EDMS) to Station engineering staff at Department All Hands meetings.”*
Completion: *“ICES awareness was presented to station engineering Section Managers and Department Managers on 12Dec2014 at the Station Engineering Leadership Meeting. The material presented is included in EDMS. Section Managers were actioned to dissiminate [sic] the material to their staff.”*

Assignment: *“SPHC Project ranking methodology Orig Due Date: 14NOV2014 Secure Plant Health Committee project ranking methodology from industry that more effectively leverages Engineering programs and forward to ER CFAM for consideration in next revision of Form-12881, SPHC Initiative prioritization worksheet.”*
Completion: *“Industry best practice in methodology to balance priority of Engineering Programs related improvements incorporated in Plant Health Committee governance was received and forwarded to CFAM and owner of BP-PROC-00559. DCR 28467066 was submitted for BP-PROC-00559 and DCR 28467061 was input for SPHC Initiative Prioritization Worksheet Form-12881. Industry input has been included in EDMS.”*

Benchmarking and Conference Statistics

The Bruce Power Benchmarking & Conferences intranet web page has a series of files that list the Benchmarking and Conference Attendance titles and participants for each year from March 2007 to December 2016. In straight numbers for the ensemble list[32] the following statistics emerge:

[32] Lists were as of January 04, 2016 for years 2014 and beyond, and December 26, 2015 for before 2014 annual records.

Table 8: Statistics from the Benchmarking and Conference Tracking Lists

Statistic	Observation
Number of entries in the combined list	856
Number completed (report issued[33])	662 or ~75 per year
Number in "planned" category, all in 2016	78
Number of SCR/AR reports for completed, BM and CF	640
Start date for tracking BM and CF in PassPort Action Tracking	25-Feb-11
Number cancelled, deferred, or otherwise incomplete	116[34]

These statistics demonstrate that there is an active management program for the Benchmarking and Conference activity with reports archived for examination and extraction of OPEX.

In summary, based on a very few selected examples among hundreds others available, the Benchmarking and Conference activity provides a wealth of information (OPEX) to Bruce Power in achieving and sustaining excellence in safety and operations. Bruce Power is managing the collection and dissemination of materials, catalogued and available for future use.

7.2.2.4. Nuclear Safety Culture

As described in Section 4.1.4, a strong Nuclear Safety Culture is essential to the overall Bruce Power mission of "Safety First" and to OPEX in the context of maintaining focus on collecting, assessing, and implementing lessons learned from all aspects of operating experience.

This recognition existed in a broader context throughout Bruce Power well before there was a formal procedure for Nuclear Safety Culture Monitoring. As part of the Bruce Power Management System review, a nuclear safety culture self-assessment was performed covering Bruce A, Bruce B and Centre of Site in May-June 2013 [166]. An electronic survey was delivered to all staff in May, conducted by an external contractor (Collis-Reid) for Bruce Power. The number of surveys returned was 2,932 (54% response rate), along with 13,092 written comments. Interviews and focus groups were held with a total of 290 people in the week of 24-28 June. The self-assessment used a framework of characteristics based on the INPO Traits of a Healthy Nuclear Safety Culture. The assessment results clearly showed that the nuclear safety culture is viewed very similarly across the entire organization. The higher and lower rated areas are almost identical and the issues of concern were also very similar.

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[33] 20 of these had no explicit report number, but all of the reports did have a hyperlink.

[34] Without a detailed analysis of why events were cancelled, deferred or incomplete, this is not a particularly relevant statistic other than demonstrating consistency in the summation of numbers. There could be a multitude of reasons for deferment, e.g., business priority, personal, or change of mind on relevance.

Higher Rated Areas

a) People recognize unusual conditions and stop in the face of uncertainty

b) Senior leadership frequently communicates the importance of nuclear safety

c) The roles of regulators are well respected

d) Dialogue and debate are encouraged when evaluating nuclear safety issues

e) Training reinforces safe behaviours and establishes high expectations

f) People are comfortable raising concerns

g) People have a strong sense of ownership over their work.

Lower Rated Areas

a) Coordination issues between work groups are effectively resolved

b) There are normally enough qualified people to do the work safely

c) Managers are approachable and spend enough time in open discussions and at the work sites to know "what really goes on around here"

d) The Corrective Action Program identifies and resolves problems in a timely manner

e) When an error or event happens, management focuses on the cause and does not automatically jump to the conclusion that it was the fault of the people involved

f) Plans and schedules can normally be followed without substantial changes

g) Operating plant is in good condition and is well maintained

h) Procedures are generally up to date, technically correct and easy to use

i) Changes to standards, programs and procedures are well implemented and effectively communicated.

This was a perception-based assessment where the most frequently raised issues were related to nuclear safety culture focus, equipment condition, corrective action program, management presence, and nuclear knowledge and experience, all elements of OPEX.

Clearly, the beginnings were good, but there were some aspects that needed improvement. Assignment #6 of the SCR 28398830 [166] that recorded this survey was the direct genesis of BP-PROC-00892, Nuclear Safety Culture Monitoring [38].

Recent Employee Engagement Survey

While BP-PROC-00892 has been in place and monitoring the nuclear safety culture pulse of the station, Management included the culture topic in the 2015 Employee Engagement Survey [167]. Eighty percent of the Bruce Power community (employees, contractors, and part time staff) responded with nuclear safety culture being one of the top 3 favourable categories. The rating was 88%, a sign of the continuing perception of the importance of nuclear safety culture among Bruce Power staff, and a measure of the success of continuing emphasis at Bruce Power.

7.2.2.5. OSART Review

Bruce B was the subject of an IAEA Operational Safety Review Team (OSART) review from November 30 to December 17, 2015. Bruce Power prepared an extensive Advance Information Package [168] primarily for the Team on the important aspects of the operation of Bruce B, with OPEX forming a good portion of Chapter 9 as well as being featured prominently throughout other sections of the backgrounder report. In many ways, the OSART introductory material and especially Chapter 9 parallels the content of this Safety Factor Report, as elaborated on below.

The purpose of including this account is to show that Bruce Power presented a detailed and comprehensive description of all programs, including OPEX, and that program was reviewed and accepted by a team of internationally recognized experts [169]. As noted, quite a bit of the detail duplicates material already presented in this and previous Integrated Safety Reviews (e.g., [17]), but the OSART version puts more actual “deployment” flavour on the procedural description. OPEX was one of the 6 functional areas where the OSART team included a specific functional area expert (from France) [169], and as described below, undertook detailed assessment of the Bruce Power OPEX program at various times on at least 4 days.

In Section 2, the background document highlights the quarterly meeting of the Bruce B Performance Improvement Oversight Committee comprising eleven senior technical and operations managers to

> *“review the health of the performance improvement programs in the station, which include* ***Corrective Action Program*** *(CAP),* ***Operating Experience Program (OPEX)***[35]*, and Human Performance Program (HU)”.*

Devoting such senior resources shows the commitment of Bruce Power and the recognition of benefits from OPEX.

Again in Section 2, the report describes the Nuclear Safety Culture Monitoring Panel (NSCMP), comprising about 19 senior managers from diverse disciplines that meets three times a year to

> *“review a sample of a variety of types of input, engage in thoughtful discussion about the* ***nuclear safety culture*** *implications arising from the inputs and prepare a summary of insights against the INPO Traits [65] framework to support reflection, informed dialogue and cognitive analysis by Station Senior Leadership Team.”*

This activity supports BP-PROC-00892, Nuclear Safety Culture Monitoring [38] as described in Section 4.1.4 of this Safety Factor Report. Again, this reinforces Bruce Power’s commitment of resources and recognizing the corresponding benefits.

Section 4.8 of the OSART pre-review information bulletin describes another senior level of oversight for a range of topics including the OPEX program. It states that

> *“the Nuclear Safety Review Board (NSRB) has the responsibility for considering and advising the Board of Directors the extent to which Bruce Power affairs are being conducted in a manner that promotes reactor, radiological, industrial and environmental safety and for continuing to*

[35] Bold face type has been added to show the effective use of operating experience trigger words operating in the milieu of OPEX, Safety Culture, Research and Benchmarking.

*emphasize the long term effort required to permanently **improve safety culture**, including **changing management behaviours** and demonstrating leadership.*

The NSRB is responsible for:

1. Advising the Board on:

- *The extent to which plant operations are within power reactor operating licence and safety analysis. Significant reactor, radiological, industrial and environmental safety issues.*
- *The effectiveness of reactor, radiological, industrial and environmental safety policies. The effectiveness of the **management oversight** process given to **significant events, event trends and use of operating experience (OPEX)**.*
- *The **effectiveness** of policies, systems, and monitoring processes in place to manage reactor, radiological, industrial and environmental safety.*
- *…*

2. Monitoring and Reporting to the Board on:

- *Reactor, radiological, industrial and environmental safety performance and **culture**.*
- *The **benchmarking** of policies, systems, and monitoring processes against industry best practices.*
- *Significant events, **event trends and use of OPEX**.*
- *…*

3. Monitoring:

- *Management processes for **identifying and correcting performance** issues.*
- ***Safety culture** from a holistic approach, including **specific safety culture** performance measures and targets.*
- *…*
- *Regular reports from management on reactor, radiological, industrial and environmental safety performance including the **results of investigations into significant events and determining the appropriate root cause**.*
- *…*

Section 4.9 is devoted to Nuclear Safety Culture and Human Performance topics. The following paragraph from that segment paraphrases the objective and commitment of Bruce Power to establishing and maintaining safety culture:

*"Nuclear Safety is a primary focus for the Bruce B leadership team and the underlying principles of the four pillars of nuclear safety are discussed on a daily basis. These are referred to and covered in different programs and procedures[36]. By design, the BPMS contributes to the establishment of a **nuclear safety culture**[37] that assures reactor, environmental, industrial and radiological safety, during normal operations as well as during extreme events. It also provides the necessary guidance for making risk based decisions that satisfy the desired balance between safety, commercial, corporate reputation and other performance requirements."*

[36] Section 4 of this Safety Factor Report.

[37] See quote from MSM for commitment to OPEX in Section 4.1 of this Safety Factor Report.

Section 4.6.1 of the introductory information bulletin emphasises and documents the fundamental behaviours expected of staff at various levels. The table beginning on page 74 itemizes the use of **OPEX, lessons learned, and sharing of experiences** as employee position descriptions progress from individual contributor to executive levels. This is parallel to the progressive use of OPEX described in Section 5.4.1 of this Safety Factor Report and throughout Sheet 2 of BP-MSM-1 [56].

Returning to the 10+ page OPEX-specific Chapter 9, titled Operating Experience, Organization and Management in the OSART package, the chapter addresses 8 main topics as given by the section's Table of Contents, all of which are associated with the 13 member Plant Integration Department at Bruce B (organization chart provided in backgrounder). The introduction begins with a description of 2 foundations of OPEX: 1) **Operating Experience** (learning from, and sharing experiences with other organizations, including benchmarking and Focus Area Self Assessments) and, 2) **Corrective Action Program,** plus the Human Performance program (HU).

The specific topics are:

9.1 Performance Monitoring

9.2 Analysis and Solutions Identification

9.3 Solutions Implementation

9.4 Operating Experience Program

9.5 Sharing of Internal OPEX

9.6 Review of External OPEX

9.7 Overview of Reportable Events 2012-2015

9.8 Human Performance Investigations.

Topics 9.1 and 9.4 through 9.7 are the most pertinent to this Safety Factor Report.

Topic 9.1 focuses on the Corrective Action program`s role in identifying OPEX and demonstrates that OPEX is ingrained in every aspect of the operation. Namely,

> *"Staff are encouraged to identify adverse conditions through the Station Condition Record (SCR) database. Over the last three years, an annual average of 15,000 SCRs were submitted to identify opportunities for improvement."* and *"All SCRs are reviewed at the Management Review Meeting (MRM) that occurs three times a week. This meeting is chaired by Operations and is composed of representatives from all functional areas. …"*

Topic 9.4, Operational Experience Program, is a short description espousing the benefits of OPEX that demonstrates Bruce Power`s commitment to the activity.

Topic 9.5, Sharing of Internal OPEX, describes Bruce Power's sharing of OPEX with external organizations. Bruce Power reports events to both WANO and CANDU Owners Group (COG). The criteria used to identify reportable events are taken from the WANO Operating Experience Reference Manual. All WANO Event Reports (WERs) are also submitted to the COG Operating Experience database. In the period from 2012 to 2014, Bruce Power's reporting to the WANO database produced 138 WERs at WANO. The 2015 rate appeared to be commensurate with previous years'.

Topic 9.5 also notes that:

> *"Internal OPEX is … shared via the* ***Corrective Action Program*** *and the* ***Rapid Learning Process****. For significant events at a station, a Rapid Learning report is generated by the source station and distributed to the sister station. The senior OPEX advisor reviews these reports and will initiate OPEX applicability review actions to the subject matter experts of the sister station to review the event for applicability, similar to an external OPEX item. Where gaps are identified, corrective actions will be initiated to prevent an event at the sister station."*

Topic 9.6, Review of External OPEX, describes the assimilation of **OPEX from external sources**. Namely:

> *"The main source of external OPEX is via the CANDU Owners Group (COG). COG collects events reported by other COG members including Ontario Power Generation (Darlington and Pickering NPP), New Brunswick Power Nuclear (Pt. Lepreau NPP), Canadian Nuclear Laboratories (Chalk River), Cameco, Cernavoda, Embalse and others. COG also gathers items from the Electric Power Research Institute (EPRI), the U.S. Department of Energy (DOE), items submitted to the Institute of Nuclear Power Operations (INPO), the International Atomic Energy Agency (IAEA) and the World Association of Nuclear Operators (WANO). Every week, COG gathers the event reports submitted by COG members and provides a summary in the COG Weekly Screening Meeting (WSM) agenda. Once per week, COG members gather via conference call to review the WSM agenda and discuss the lessons learned shared by the individual events.*
>
> *This agenda is reviewed by the Senior Advisor, OPEX (SA). The advisor identifies the internal work groups that should review each individual OPEX item in the Weekly Screening Meeting agenda. The SA documents these recommendations in a database and forwards the recommendations to the Bruce Power Performance Improvement Coordinators (CAPCOs). The CAPCOs then write SCRs to document action tracking assignments for Subject Matter Experts (SME) from their representative groups to review the OPEX items identified for their work groups. The OPEX items are reviewed by the SME for applicability to Bruce Power.*
>
> *The review of WANO Significant Operating Experience Reports (SOERs) and INPO Event Reports (IERs) are also governed by the OPEX program. The evaluation of WANO SOER and level 1 and 2 INPO IER documents and resultant action plans are reviewed and approved by the station Corrective Action Review Board (CARB). The status of the SOERs and IERs with open action plans is subject to periodic effectiveness reviews. Lower level INPO IERs are treated as external OPEX items as described above.*
>
> *Bruce Power's implementation of the recommendations and corrective action plans stemming from WANO SOERs and INPO IERs is subject to evaluation by WANO during their peer review assessments."*

Topic 9.7, Reportable Events, lists 28 sample SCRs in the period between 2012 and 2015, with a few sentences each for each SCR; some of the pre-2015 example items and all of the example SCRs for 2015 were previously listed on the Bruce Power 2015 S-99 public web page report (titles only).

Section 13 of the OSART package contains an extensive section on severe accident management, and not surprisingly, OPEX plays a significant role in its development. Even less surprising is the fact that Fukushima plays a significant role (see Sections 5.4.2.1 and 7.1.6 of this report, above) along with Lessons Learned from COG-sponsored Severe Accident Management Guidelines (SAMG) development. The following passages from Section 13.13 and 13.14 are pertinent:

> *"The CANDU utilities in Canada conducted self assessments immediately following the event in Japan, and responded to Canadian Nuclear Safety Commission's (CNSC) requests and recommendations to complete assessments on severe accident mitigation capability and make improvements where necessary. Based on these assessments, the Canadian utilities prepared a plan and schedule to address the CNSC Fukushima Action Items (FAIs), and to implement physical changes at the station as well as document changes. The utilities carried out the work independently to prepare and implement design and procedural changes to address the FAIs."*
>
> *…*
>
> *"A systematic and comprehensive review of the Fukushima lessons learned was performed in this project, including: assessments completed by Tokyo Electric Power Company (TEPCO); assessments completed by Electric Power Research Institute (EPRI); EPRI SAMG Technical Basis Report updates; assessment completed by each utility in Canada on the impact of Fukushima related events and phenomena; international feedback and lessons learned issued by international organizations, such as WANO, Western European Nuclear Regulators Association (WENRA), etc.; information issued by Japanese sources; information from Canadian Nuclear Safety Commission (CNSC), U.S. Nuclear Regulatory Commission (NRC), and other national regulators; European national reports on stress tests conducted on European NPPs; Sandia Fukushima Daiichi Accident Study; etc."*
>
> *…*
>
> *"The initial Candu Owners Group (COG) SAMG project was completed in 2006 and it resulted in the first set of generic SAMG documents for CANDU reactors in Canada. In the past several years all Canadian utilities have implemented SAMG programs for their NPPs and produced station specific SAMG documents. A systematic review was performed of operating experience (OPEX) from the preparation and implementation of station specific SAMG, SAMG drills conducted in the past few years, as well a number of other items and experiences collected by different utilities. The identified OPEX items applicable to future updates of the generic and site specific SAMG documentation were collected and assessed. The OPEX feedback provides important information that was used in addressing safety concerns related to CNSC FAI in the COG Joint Project 4426 project. The OPEX was reviewed against the current generic SAMG documentation, and corresponding enhancements were undertaken, either for updating the generic SAMG documentation, for site implementation consideration, or as input to other COG Joint Project 4426 tasks addressing revisions to the generic SAMG documentation."*

In addition to SAMG development, the OSART introductory package describes other cooperative efforts related to topics such as analysis, phenomenological behaviour (e.g., hydrogen, aerosols), damaged core retention, spent fuel bay-specific considerations, and equipment performance (e.g., instrumentation survivability/operability).

The culmination of the OSART review is described in an IAEA report [170]. The findings noted 10 strengths of the facilities, people, and operations at Bruce B in a range of topics covering management communications, training, innovative equipment, EME strategies and Major Component Replacements. There were 5 recommendations covering topics such as alcohol and drug testing, deficiency reporting, HU items on maintenance, facilities for assembly areas, and methodology for scoping SSCs. OPEX was not mentioned explicitly.

In summary, OPEX was a significant and pervasive review item for the OSART members. The Bruce Power introductory package provided the framework, but the review team conducted OPEX-specific focus sessions on December 3, 4, 10, and 11, 2015. There was no adverse finding related to OPEX. The conclusion of this focus on OPEX is that Bruce Power's OPEX program stood the test of an internationally recognized expert mission without an adverse finding.

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 Inspections for Units 1 and 2 refurbishment involved two aspects. There was an inspection in 2009 on the overall Lessons Learned Program and there was a specific review on OPEX related to the Integrated Implementation Plan (IIP) 47 (IIP 47 was solely about OPEX for Bruce Units 1 and 2). The next two subsections address these two topics followed by additional inspections.

7.3.1. CNSC Inspection, Bruce 1 and 2 Lessons Learned

The CNSC initiated an inspection of the governance of the Units 1 and 2 Return to Service Lessons Learned program in September 2009 [171]. In the CNSC staff observations from the inspection [172]:

> *CNSC staff found that Bruce Power is documenting and tracking lessons learned on the current Bruce A Units 1 & 2 refurbishment project and that they are being used for the future Units 3 & 4 refurbishment, meeting regulatory requirements. There are several changes that could be made to enhance the processes, the most important being the update that is needed to PMC.3.4.008 to align it with the Units 3 & 4 program and incorporate certain aspects of industry best practice.*
>
> *In addition, based on the observations made during the inspection, the Bruce Power Restart Operating Experience (OPEX) program meets regulatory requirements. Experience is being*

sought, shared and used on the project, and there is a transfer of knowledge from the Direct Work Contractors to Bruce Power and vice versa. Some minor issues were noted which could future enhance the process.

The findings were along the lines of alignment of plans and requirements, and as noted the PMC procedure required update. The CNSC initiated Action 090741 to track the resolution.

In the response [173], Bruce Power committed to updating procedure PMC 3.4.008 and aligning it with the corresponding program plan element by May 28, 2010, as well as considering the additional suggestions for future incorporation in the Lessons Learned processes.

In its response [174], the CNSC staff acknowledged that the PMC procedure update had been completed and closed the action.

Overall, this was a positive interaction and contributed to enhancing Lessons Learned for the Units 1 and 2 project and for the collection of OPEX for future refurbishment projects. In the interim, Bruce Power has continued to refine the OPEX programs. As presently planned, Bruce B is the next “refurbishment” (major component replacement via asset management) but the OPEX collected on Units 1 and 2 is readily adaptable.

See also Section 5.3.1.3 above regarding the current PMC procedure BP-PROC-14410 [83] and the potential integration of Darlington refurbishment OPEX going forward.

7.3.2. CNSC Inspection, Bruce Units 1 and 2 IIP 47 (OPEX)

This CNSC Inspection of the Units 1 and 2 Return to Service OPEX IIP focused on training. The item was raised as IIP 47 from the corresponding Integrated Safety Review. Implicit in the CNSC’s acceptance of the IIP 47 (OPEX) was the acceptance of the remainder of the Units 1 and 2 OPEX program (in circa 2004). IIP 47 was discussed in three correspondence letters as follows:

1. NK21-CORR-00531-08638, Action Item 110719: Bruce A Units 1 and 2 Return to Service: IIP[38] Completion Inspection - OPEX Program BRPD-2011-R-010 [175].

   This is the opening transmittal letter stating a compliance inspection had been completed in response to Units 1 and 2 IIP 47. The objective of IIP 47 was “…To ensure that internal and external operations experience is communicated to, and acted upon by, Bruce Power staff.” This closely parallels the second review task in Section 5 of this Safety Factor Report. The CNSC inspectors noted that:

   > *“Although it was noted that the improvement to the OPEX program has been implemented, Bruce Power's training qualification document, TQD-00043 [176], does not contain the correct information or reflect actual practice.”*

   The CNSC agreed with the central assertion that internal and external OPEX was being communicated to and acted upon by Bruce Power staff.

[38] Bruce Units 1 and 2 Return to Service, IIP 47.

The nature of the non-compliance was that the TQD-00043 was not aligned with BP-PROC-00062 and did not reflect practice such that one qualification requirement should be removed.

2. NK21-CORR-00531-08673, Action Item 110719: Bruce A Units 1 and 2 Return to Service: IIP Completion Inspection - OPEX Program BRPD-2011-R-010 [177]

   Bruce Power's response transmitting the updated document citing a review of BP-PROC-00062 indicated that some additional requirements should be removed.

3. NK21-CORR-00531-08746, Action Item 110719: Bruce A Units 1 and 2 Return to Service: IIP Completion Inspection - OPEX Program BRPD-2011-R-010 [178]

   The final letter was a simple statement from the CNSC accepting the updated TDQ-00043 as meeting the objective and closing the action.

In summary, in this inspection the Bruce Power OPEX program was found to be acceptable with the correction of a mismatch of a training requirement from the actual situation, which has been completed.

7.3.3. CNSC Inspection, Assessments (Self and Independent)

In 2014, the CNSC staff conducted an inspection of Bruce Power's Assessment processes. The resulting BRPD-AB-2014-004 report accompanied a letter, Action Item 2014-07-5109: CNSC Type II Compliance Inspection Report BRPD-AB-2014-004 Assessments (Self and Independent) [179] which provided overall positive comments but opened several action notices and recommendations. The following quotes from the introduction of the assessment present an executive summary of the findings.

> *"The assessment inspection measured the compliance with specific clauses of N286-05 and Bruce Power processes for self-assessment as defined by BP-PROG-01.06* ***'Operating Experience Program'*** *and independent assessments defined by BP-PROG-15.01 'Nuclear Oversight Management', and related implementing and interfacing documents. Documentation Review, examining licensee databases for assessments and discussions with Bruce Power staff were the methods used during inspection.*
>
> *CNSC staff had positive observations about the process. In general, Bruce Power personnel followed the procedures for self-assessments and audits as identified in their programs.*
>
> *CNSC staff identified a number of weaknesses associated with the implementation of the audit and self-assessment processes. For some issues identified during inspection, Bruce Power raised SCRs, which in their opinion will correct the issues. CNSC staff concluded that the self-assessment process does not always continually assess and improve the effectiveness with which work activities meet the requirements. CNSC staff concluded that despite the efforts to audit all programs in a three-year period, the performance audits covered only a limited number of the implementing procedures of the programs even though a risk-based audit methodology was not fully developed. The consequence of the mentioned weaknesses is that management would not have complete input information for their effectiveness management system reviews.*
>
> *The results of the CNSC Type II inspection led to four action notices and four recommendations being raised."*

The first action notice, and most relevant to this Safety Factor Report, related to the observation that the implementation of the requirement for a FASA once every three years in a functional area did not seem to provide adequate coverage because there usually were many procedures implementing process and there was not a means of placing priority on the most important processes to ensure effectiveness. Action Notice #1 stated:

> *"In order for Bruce Power to become compliant with BP-PROC-00295 "Planning & Scheduling audits" section 4. 1, CNSC staff requests Bruce Power to develop and implement a corrective action plan for a risk-based audit-methodology to correct the identified observations regarding the frequency, depth, and width of audits credited for the programs."*

Bruce Power's first reply [180] provided responses to the Action Notices and recommendations and separately with 8 internal SCRs to support the request for closure of the action item. The CNSC staff response [181] accepted the Bruce Power position on two Action Notices and part of a third but kept the action item open for pending completion of AN#1 requesting a graded approach to selection of oversight of FASA review selection.

Initially, it was expected that a new procedure on graded approach to selecting FASAs would be implemented in a new procedure BP-PROC-00955, "Graded Approach …". This was one of the options initially considered along with inserting requirements in BP-PROG-01.06 (OPEX). BP-PROC-0955 was never issued, and ultimately Bruce Power found a more logical place to insert the governance.

Bruce Power's return reply in January 2016 [182] provided the rationale for implementing the selection requirement in BP-PROG-01.02:

> *"…, after further review, it was determined that a new procedure was not required as the Graded Approach would be better reflected by revising the existing BP-PROG-01 .02 Bruce Power Management System (BPMS) Management document."*

Prior to this letter, Bruce Power had already provided the completed revision of the PROG to the CNSC under the normal notification of change to an LCH document. Based on the afore-mentioned Bruce Power reply the CNSC staff accepted Bruce Power's position and closed the action item [183].

The updated BP-PROG-01.02 R009 (December 2015) [184] provides the following definition for graded approach:

> *"3.1.10 Graded Approach The Graded Approach is a systematic method of rating the BPMS Program Suite Functional Areas for complexity and importance relating to a defined set of criteria. This rating then determines which of those areas will be considered for evaluation by the NORA and Finance and Commercial Services."*

Section 4 of the program document provides requirements for where the graded approach may be applied and documented.

> *"Where the graded approach is used in any Program or process, the aspects that are to be graded must be documented, including how decisions on grading will be made. Implementing procedures in this Program are owned by the position holder defined in PASSPORT and are not repeated in this document."*

A new Appendix in BP-PROG-01.02 R009 assigns responsibility for applying the graded approach to selecting the most relevant areas to audit and provides the conceptual basis for evaluating Complexity and Importance; it defines the grading mechanism (a potential sample was provided on page 7 in the Bruce Power letter [182]):

> *"The graded approach is completed as part of the annual State of the Functional Area (SOFA) review process (defined in BP-PROC-00016, Business Assessment Process) and is based on rating the COMPLEXITY and IMPORTANCE (SIGNIFICANCE) of each Program Suite in each Functional Area.*
>
> *COMPLEXITY relates to the DESIGN complexity, PROCESS complexity, and/or complexity of REQUIREMENTS.*
>
> *IMPORTANCE relates to the SIGNIFICANCE of the REQUIREMENTS, PROCESSES, PRODUCTS, and/or ACTIVITIES."*

Overall, the collaborative dialog following the inspection yielded a first-order systematic approach to ensuring the most important programs receive the most oversight.

7.4. Performance Indicators

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

Bruce Power monitors and trends a number of OPEX performance indicators, including the following:

- Number of events reported
- Timeliness of event reporting
- External OPEX screening and action rate for Operations, Maintenance, Engineering, Radiation Protection, Industrial Safety and Work Management
- External OPEX screening in other support areas or programs, including Fire Protection and Emergency Preparedness, OPEX, Training, Environment, Chemistry, Supply Chain and Projects
- Bruce Power items posted to COG
- Actions taken by other COG members on Bruce A OPEX and Bruce B OPEX
- External OPEX "other industry" items screened.

The following figures extracted from the March 2016 report to Bruce Power management with data sources selected from the above list demonstrate the kinds of performance indicators tracked on a monthly basis by the Bruce Power OPEX program staff. While equivalent Bruce A figures exist and some combined Bruce A and Bruce B samples are included in this description, the overall emphasis is on Bruce B for this Safety Factor Report.

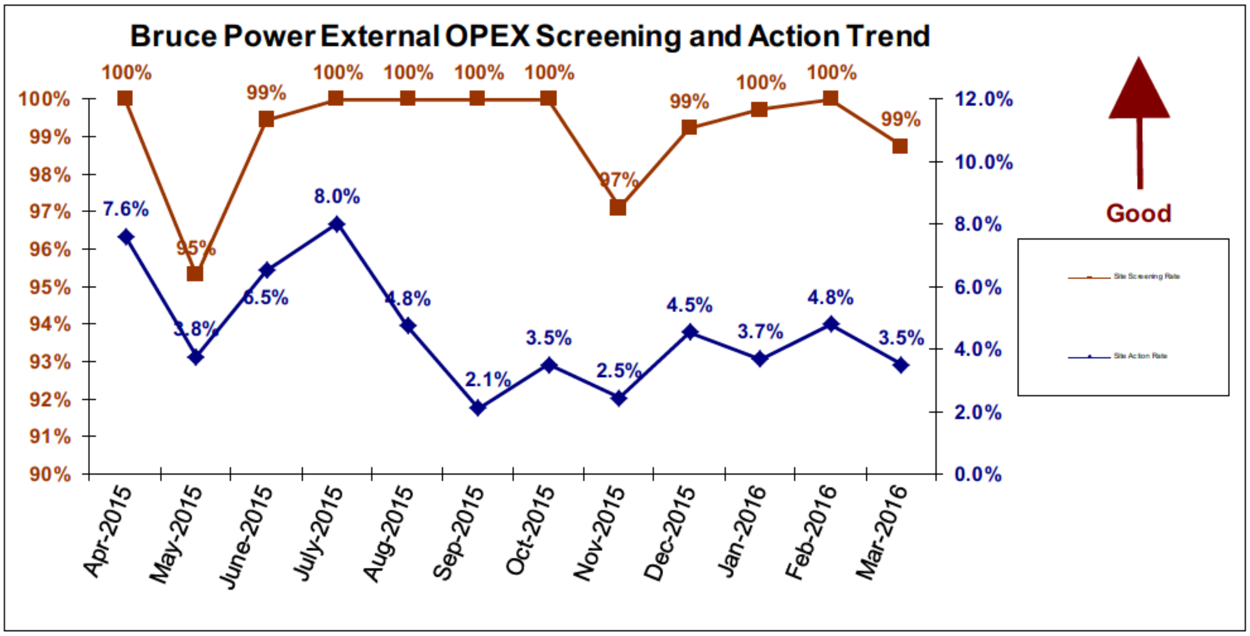

Figure 2: Bruce Power External OPEX Screening Performance, March 2016

In Figure 2, the overall Bruce Power external OPEX screening rate is substantially better than the target 90% (see Section 7.1.7) and the overall action rate is nominally in the neighbourhood of the 5% target. As noted, variations are to be expected for seasonal or companion events (e.g., outages, scheduled or forced). Figure 3 is the corresponding screening and action rate for Bruce B on its own. It reveals that Bruce B is performing well against targets, with screening and action rates better than targets overall.

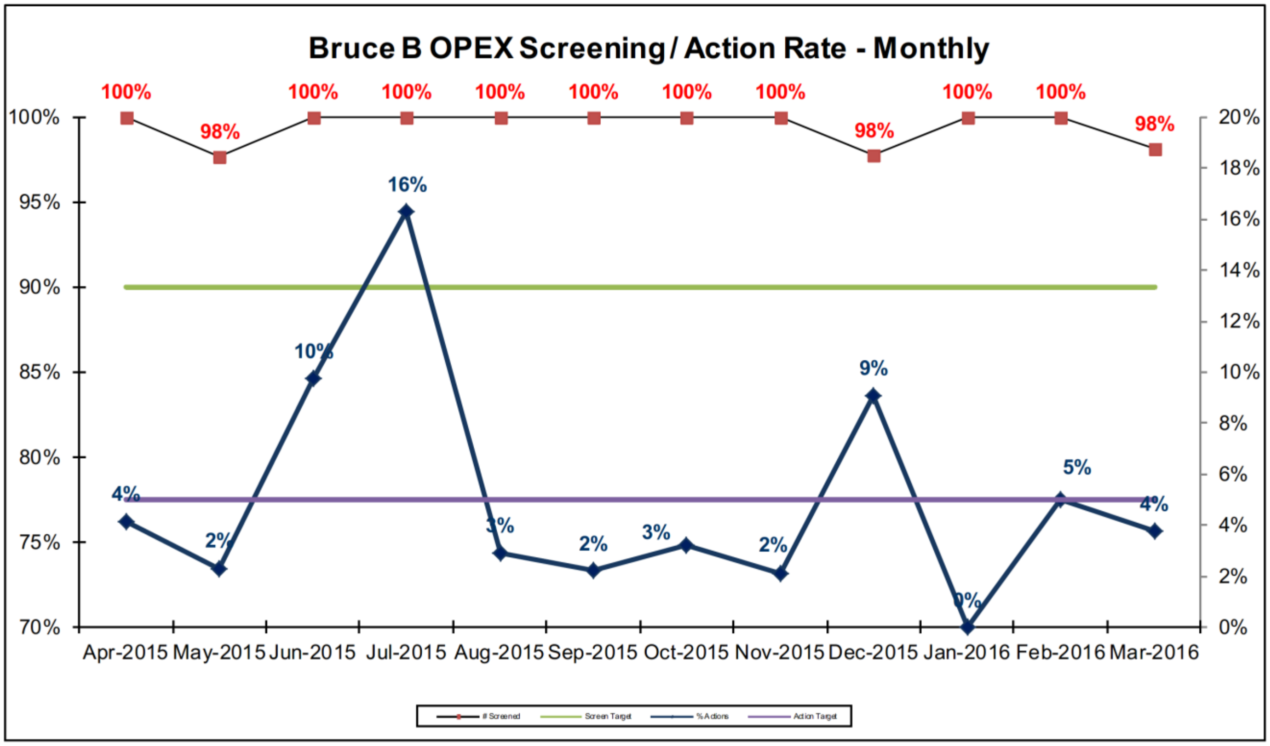

Figure 3: Bruce B External OPEX Screening and Actions Performance, March 2016

The External OPEX Screening by Department depends on a range of parameters including the time of year and associated events (e.g., outages, scheduling of annual requirements). Engineering has been selected as the sample for this category. Figure 4 shows that Bruce B Engineering screened virtually all external OPEX over the one year window, with an average action rate more than double the 5% target.

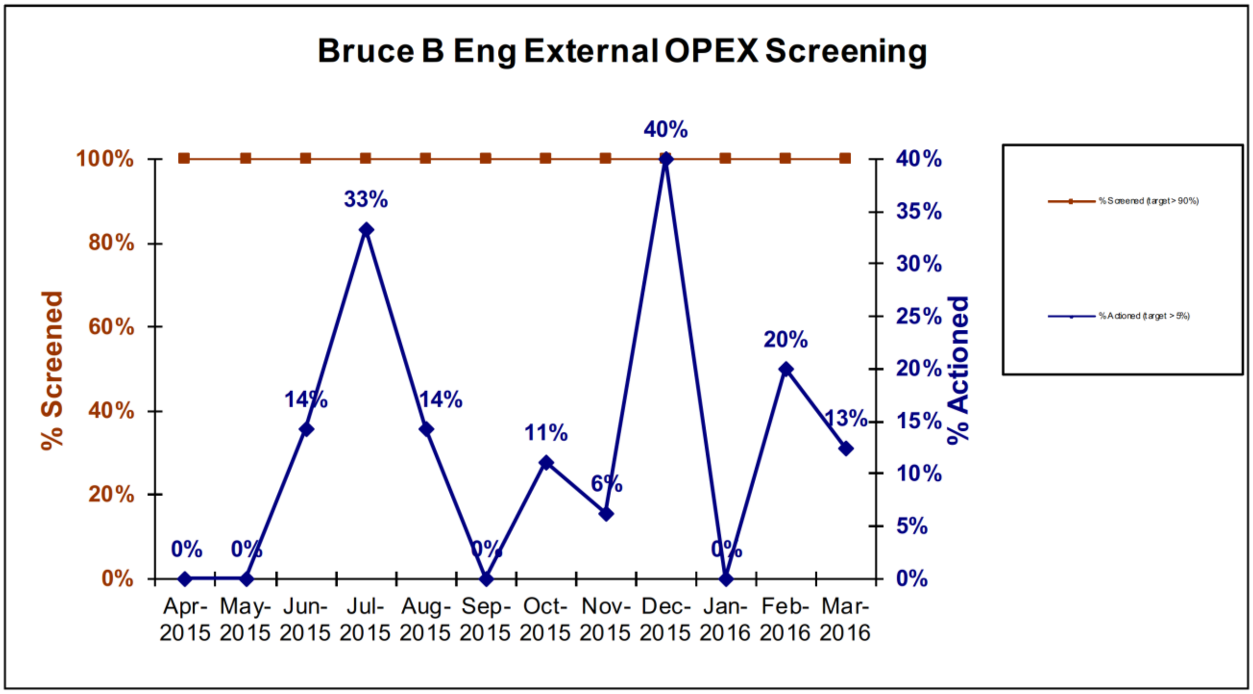

Figure 4: Bruce B Engineering External OPEX Screening and Actions Performance, March 2016

Figure 5 is the one year trend for items submitted by Bruce Power to COG. The average is quite close to the target of 12%.

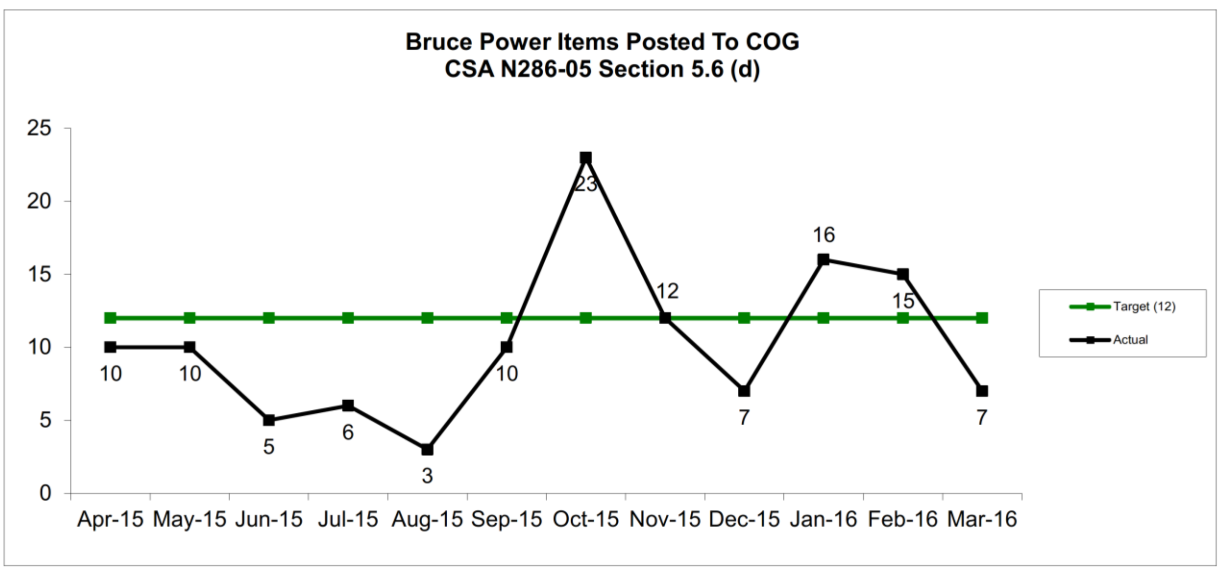

Figure 5: Bruce Power Items Posted to COG per CSA N296-05, March 2016

Figure 6 shows a significant number of external OPEX events are considered by Bruce Power staff every month.

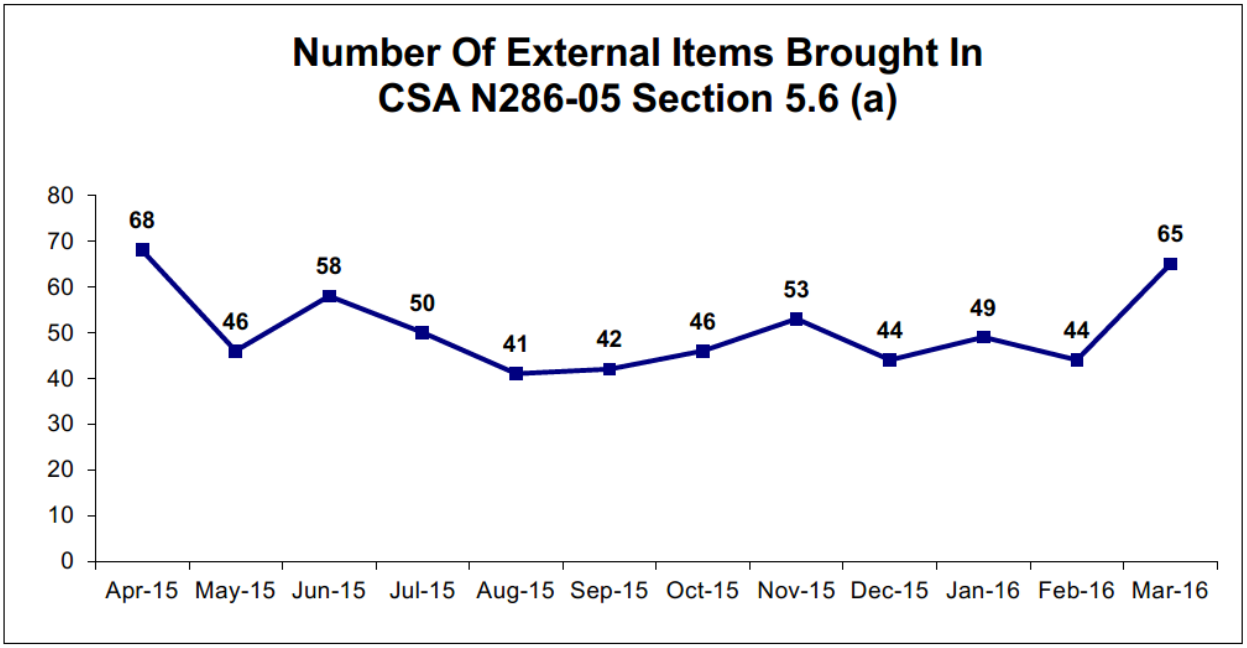

Figure 6: OPEX Items Imported to Bruce Power per CSA N286-05, March 2016

In summary, the above performance indicator graphs show that Bruce Power is managing the collection, assimilation, and distribution of OPEX through continuous monitoring and reporting to management. Overall, Bruce Power is meeting or exceeding its current goals that are consistent with industry best practice.

8. Summary and Conclusions

The overall objectives of the Bruce B PSR are to conduct a review of Bruce B against modern codes and standards and international safety expectations, and to provide input to a practicable set of improvements to be conducted during the MCR in Units 5 to 8, as well as U0B, and during asset management activities to support ongoing operation of all four units, that will enhance safety to support long term operation. The specific objective of the review of this Safety Factor is to determine whether there is adequate feedback of safety experience from nuclear power plants (both internal and external), the search for and assimilation of relevant OPEX from non-nuclear facilities, and of the findings of research. This specific objective has been met by the completion of the review tasks specific to OPEX and R&D.

The review demonstrates that Bruce Power's OPEX Program and its implementation provides for adequate feedback of safety experience from nuclear power plants (both internal and external) and of the findings of research in support of continued safe and reliable operation. In addition, the review demonstrates that Bruce Power does not confine itself to utilizing OPEX from nuclear power plants only, but makes use of pertinent OPEX from any industrial process plants. Moreover, research activities are being pursued and results are used to enhance nuclear safety and equipment performance and reliability. This is regarded as a strength in Bruce Power's OPEX Program.

Section 8 of the Bruce A Integrated Safety Review [17] included a gap SF9-1 indicating no specific governance could be found to ensure participation in external conferences, symposia, research projects. This has been addressed through a January 2016 revision of BP-PROG-01.06 [24] where wording from BP-PROC-00147 has been moved to Section 4.3, making it governance. In addition, Section 7.2.2.3 of this Safety Factor Report notes that 78 conferences and benchmarking activities had already been scheduled at the beginning of 2016 by the various functional area managers. This demonstrates that the responsible managers are performing the function.

Table 9 summarizes the key issues arising from the Integrated Safety Review of Safety Factor 9.

Table 9: Key Issues

Issue Number	Gap Description	Source(s)
SF9-1	While the cerebral transport of knowledge is implicit in the stature and qualifications of the staff appointed to the CSA committees, governance surrounding their collection and use of OPEX in performing their duties in the various committees has not been found.	Section 5.3.1.2

The overall conclusion is that, with the opportunity for improvement noted in Table 9, Bruce Power's programs meet the requirements of the Safety Factor related to OPEX and R&D.

9. References

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

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

No codes or standards relevant to Safety Factor 9 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 relevant to Safety Factor 9 were subjected to a clause-by-clause assessment. This Appendix is retained only for consistency with the Appendix numbering scheme in all other Safety Factor Reports.

Appendix C – List of FASAs, Audits and Inspections (2009-2015)

This appendix lists the Potential Focus Area Self Assessments (FASAs), Audits and Inspection Correspondence in the period nominally from 2009 to 2015-12-31. This Appendix is to be read in concert with Section 7 of the main report.

C.1. FASAs

FASA Number	FASA Title
SA-AUD-2015-10	MCR Lessons Learned & Documentation Processes
SA-BPL-2013-01	Corporate Benchmarking FASA
SA-BPMS-2010-04	Benchmarking Process
SA-CAP-2009-01	Inclusion of OPEX into Maintenance Procedures
SA-COM-2010-01	Drafting Office Benchmark – Master Equipment List (MEL) Tag Out Project
SA-COM-2013-11	Corrective Action Effectiveness in Engineering
SA-ELCE-2010-06	SECERI SPHC Effectiveness
SA-EPS-2014-06	Assess Employee Awareness and Safety Culture re Extreme Events*
SA-ERI-2014-04	SPHC Effectiveness BB
SA-HP-2011-01	Screening and Evaluating External OPEX*
SA-NSAS-2010-03	Use of OPEX in Fuel Channels Life Cycle Management & Life Extension of Fuel Channels*
SA-PE-2009-05	WANO AFI SOER 99-1 Rec 3 Loss of Grid
SA-PI-2012-02	OPEX Training Materials*
SA-PI-2013-02	OPEX - Utilization of significant Internal OPEX*
SA-PI-2013-08	External OPEX applicability responses
SA-PI-2014-02	Evaluation of Significant Operating Experience Reports (SOERs & SERs)
SA-PI-2014-04	Effectiveness of FASA Process Improvements
SA-PI-2014-05	Benchmarking and Conference Program Effectiveness
SA-PI-2014-07	OPEX Screening Process
SA-PI-2015-01	Effectiveness of OPEX Implementation*
SA-PI-2015-03	BP-PROC-00059 Rapid Learning*
SA-PI-2015-04	BP-PROC-00506 Actions MFIX*

FASA Number	FASA Title
SA-PI-2015-05	OMS interaction with the SCR and OPEX processes
SA-PI-2015-09	NORA Assessment Effectiveness - Bruce B*
SA-PI-2015-10	BP-PROC-00644 Common Cause Analysis*
SA-PMC-2014-01	PMC Lessons Learned Adherence and Effectiveness
SA-RA-2014-01	S-99 Preliminary Reporting Timeliness
SA-RPR-2013-02	COG RP Benchmark Assessment Evaluation Matrix
SA-SAC-2010-16a	Commissioning Readiness FASA for BP-PROG-01.06, 01.07 & 00.07
SA-SAC-2010-16b	Commissioning Readiness FASA for BP-PROG-01.06, 01.07 & 00.07
SA-SAC-2010-16c	Commissioning Readiness FASA for BP-PROG-01.06, 01.07 & 00.07
SA-TRGD-2014-11	Generals MCQ Format Delivery and Examination Lessons Learned

FASAs marked with * are referenced in the main body of this Safety Factor Report.

C.2. Audits

Number	Title
AU-2009-00012	CAMEO Review SCR B-2007-08565
AU-2009-00025	Benchmarking Effectiveness Surveillance
AU-2009-00026	CAMEO Review SCR B-2006-07441*
AU-2010-00007	S99 Reporting Surveillance*
AU-2010-00019	Restart Maintenance and Maintenance Programs
AU-2010-00024	Root Cause Investigation*
AU-2010-00027	PHT Feeder Management
AU-2010-00037	Bruce A RV Field Repairs
AU-2011-00007	RV Field Repairs
AU-2011-00010	Performance Improvement*
AU-2011-00028	Performance and Condition Monitoring
AU-2012-00007	RV Field Repairs
AU-2013-00005	RV Field Repairs*
AU-2013-00018	Fluid Leak Management Program*
AU-2014-00013	Effectiveness Reviews*
AU-2015-00017	Processing Internal and External Operating Experience

Audits marked with * are referenced in the main body of this Safety Factor Report.

C.3. CNSC Inspections

Doc #[40]	Doc #[41]	Title
-06987	-08135	QUARTERLY FIELD AND CONTROL ROOM INSPECTIONS FOR BRUCE A AND B [April 2009]
-07380 -07619 -07677 -08126	n/a	Bruce A Units 1 and 2 Restart-Lessons Learned Inspection (Eventually Action Item 090741) [opening letter September 2009]
-07665	-08616	QUARTERLY FIELD SURVEILLANCE INSPECTIONS FOR BRUCE A AND B
-07705 -07789	-08639 -08691	OPERATING EXPERIENCE (OPEX) ISSUES RELATING TO THE OPERATION OF LARGE OIL-FILLED TRANSFORMERS IN NPPS - QUESTIONNAIRE
-07764	-08676	QUARTERLY SUMMARY INSPECTION REPORT FOR THE COMPLETED FIELD SURVEILLANCE INSPECTIONS FOR BRUCE A AND B
-07902	-08773	QUARTERLY FIELD SURVEILLANCE INSPECTIONS FOR BRUCE A AND BRUCE B
-07941	-08806	CONFIDENTIAL - ANNUAL COG RESEARCH AND DEVELOPMENT REPORTING [2010]
-07979	-08834	BRPD-2010-AB-001, BRUCE A AND B GENERATING STATIONS FOURTH QUARTER RESULTS FROM CNSC FIELD SURVEILLANCE INSPECTIONS
-08156	-08997	FIRST QUARTER 2010 FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2010-AB-005
-08438	n/a	BRUCE A UNITS 1 & 2 RETURN TO SERVICE: TYPE 2 COMPLIANCE INSPECTION REPORT - BRPD-2011-R-002 FOLLOW UP ON S-99 EVENT B-2011-28232206
-08537	-09296	QUARTERLY FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2010-AB-014
-08638 -08673 -08746	n/a	ACTION ITEM 110719: BRUCE A UNITS 1 AND 2 RETURN TO SERVICE: IIP COMPLETION INSPECTION - OPEX PROGRAM BRPD-2011-R-010
-08672	-09413	2011 ANNUAL COG RESEARCH AND DEVELOPMENT REPORTING

[40] All document numbers preceded by NK21-CORR-00531

[41] All document numbers preceded by NK29-CORR-00531

Doc #[40]	Doc #[41]	Title
-08724	-09461	CANDU Category III Safety Issues: Annual Update
-08749	-09486	FOURTH QUARTER FIELD SURVEILLANCE INSPECTION FOR BRUCE A AND B BRPD-2011-AB-006
-08956	-09654	QUARTERLY FIELD INSPECTIONS FOR BRUCE A AND B BRPD-2011-AB-012
-09184 -09263 -09582 -09720 -10020	-09817 -09889 -10124 -10218 -10442	BRUCE A AND B GENERATING STATIONS QUARTERLY FIELD INSPECTION REPORT BRPD-2011-AB-015 - ACTION ITEM 1107-2949
-09267	-09894	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT BRPD-2011-AB-019
-09436	-10020	CANDU Category III Safety Issues: Annual Update
-09565	-10115	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT BRPD-AB-2012-005
-09566	-10116	2012 ANNUAL COG RESEARCH AND DEVELOPMENT REPORTING
-09826 -11808	-10298 -12198	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q1 BRPD-AB-2012-008 ACTION ITEM 1207-3510
-10080	-10496	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q2, BRPD-AB-2012-014
-10247	-10656	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q3, BRPD-AB-2012-017
-10454	-10854	CANDU CATEGORY III SAFETY ISSUES: ANNUAL UPDATE
-10469	-10866	2013 ANNUAL COG RESEARCH AND DEVELOPMENT REPORTING
-10539	-10945	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q4, BRPD-AB-2013-005
-10731 -10930 -11243 -11311 -11383	-11118 -11309 -11650 -11715 -11786	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q1 BRPD-AB-2013-010 - ACTION ITEM 1307-4270
-10926 -11707*	-11305 -11449 -12096*	NEW ACTION ITEM 1307-4427: COMPLIANCE INSPECTION REPORT BRPD-AB-2013-011 - ENGINEERING CHANGE CONTROL PROCESS (asterisk notation is for closure)
-11018	-11414	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q2 BRPD-AB-2013-015

Doc #[40]	Doc #[41]	Title
-11194	-11598	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q3 BRPD-AB-2014-001
-11276 -11319 -11507 -11547* -11684	-11684 -11725 -11891 -11929* -12074	CNSC TYPE II COMPLIANCE INSPECTION - S99 REPORTING (Action Item 2014-07-5293 evolved from this inspection; number with asterisk is where the action was assigned, the previous two were administrative set up items.)
-11339	-11742	2014 ANNUAL COG RESEARCH AND DEVELOPMENT REPORTING
-11347	-11763	CANDU Category III Safety Issues: Annual Update
-11354	-11755	BRUCE A AND B QUARTERLY FIELD INSPECTION REPORT FOR Q4 OF 2013-14 BRPD-AB-2014-003
-10925 -11382 -11706 -12548* -12708*	-11304 -11785 -11904 -12095 -12974* -13142*	Action Item 2014-07-5109: CNSC Type II Compliance Inspection Report BRPD-AB-2014-004 Assessments (Self and Independent) (Asterisk documents are 2016. Final BA/BB set indicates closure.)
-11551	-11932	Bruce A and B Quarterly Field Inspection Report for Q1 of 2014-15 BRPD-AB-2014-008
-11613	-11992	Bruce A and Bruce B Quarterly Operations Report - Second Quarter of 2014
-11698	-12088	Bruce A and B Quarterly Field Inspection Report for Q2 of 2014-15 BRPD-AB-2014-011
-11896 -11946 -12092 -12144[42]	-12283 -12327 -12499 -12555	Action Item 2015-07-5155: CNSC Type II Compliance Inspection Report: BRPD-AB-2014-020, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q3 2014-15
-12091	-12497	CANDU Category III Safety Issues: Annual Update
-12107	-12514	2015 Annual COG Research and Development Reporting
-12153	-12565	CNSC Type II Compliance Inspection Report: BRPD-AB-2015-003, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q4 2014-15

[42] Title: Action Item 2015-07-5155: Extended Storage Work Area Approval (ESWAA) Corrective Action Plan, July 2015.

Doc #[40]	Doc #[41]	Title
-12285 -12353 -12413	-12715 -12779 -12826	Action Item 2015-07-5489: CNSC Type II Compliance Inspection Report: BRPD-AB-2015-006, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q1 2015-2016
-12492	-12910	CNSC Type II Compliance Inspection Report: BRPD-AB-2015-011, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q2 2015-16
-12619	-13047	CNSC Type II Compliance Inspection Report: BRPD-AB-2015-013, Bruce A and B Generating Stations Quarterly Field Inspection Report for Q3 2015-16

Appendix D – Bruce Power – Canadian Standards Association Nuclear Program Membership (2016)

Number	CSA Standard or Committee Name	Number of BP Reps
NSSC	**Strategic Steering Committee**	3
N285A TC	**Pressure Retaining Components and Systems**	1
N285B TC	**Periodic Inspections** of CANDU Nuclear Power Plant Components, *Includes N285.5*	5
N285.4 TSC	Periodic inspection of CANDU nuclear power plant components	
N285.5 TSC	Periodic inspection of CANDU nuclear power plant containment components	2
N285.7 TSC	Periodic inspection of nuclear power plant pressurized conventional systems	
N285.8 TSC	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	4
N286 TC	**Management Systems for Nuclear Facilities**	2
N286.7 TSC	Quality assurance of analytical, scientific, and design computer programs	1
N286.10 TSC	Configuration management for reactor facilities (NPPs and small reactors)	1
N299 TSC	Quality assurance program requirements for supply of items and services for nuclear power plants	
N287/N291 TC	**Concrete Containment / Safety Related Structures**	1
N287.1 TSC	General requirements for concrete containment structures for nuclear power plants	1
N287.2 TSC	Material requirements for concrete containment structures for CANDU nuclear power plants	1
N287.3 TSC	Design requirements for concrete containment structures for nuclear power plants	1
N287.4 TSC	Construction, fabrication and installation requirements for concrete containment structures for CANDU nuclear power plants	1
N287.5 TSC	Examination and testing requirements for concrete containment structures for nuclear power plants	1
N287.6 TSC	Pre-operational proof and leakage rate testing requirements for concrete containment structures for nuclear power plants	1
N287.7 TSC	In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants	1
N287.8 TSC	Aging management of concrete containment structures for nuclear power plants	1
N291 TSC	Design requirements for safety-related structures for nuclear power plants (2016 title)	1
N288 TC	**Environmental Radiation Protection**	1

Number	CSA Standard or Committee Name	Number of BP Reps
N288.1 TSC	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2
N288.2 TSC	Guidelines for calculating the radiological consequences to the public of a release of airborne radioactive material for nuclear reactor accidents (2015 title)	1
N288.3.4 TSC	Performance testing of nuclear air-cleaning systems at nuclear facilities	2
N288.4 TSC	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	2
N288.5 TSC	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	1
N288.6 TSC	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	2
N288.7 TSC	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2
N288.8 TSC	Guidelines for establishing and implementing environmental action levels to control emissions from nuclear facilities	1
N289 TC	**Seismic Design**	1
N289.1 TSC	General requirements for seismic design and qualification of CANDU nuclear power plants	1
N289.2 TSC	Ground motion determination for seismic qualification of nuclear power plants	
N289.3 TSC	Design procedures for seismic qualification of nuclear power plants	1
N289.4 TSC	Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	
N289.5 TSC	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	1
N290A TC	**Reactor Control Systems, Safety Systems, and Instrumentation**	1
N290B TC	Reactor Safety and Risk Management *currently drafting N290.16 BDBA standard*	2
N290.1 TSC	Requirements for the shutdown systems of nuclear power plants	2
N290.2 TSC	Requirements for emergency core cooling systems of nuclear power plants	3
N290.3 TSC	Requirements for the containment system of nuclear power plants	2
N290.4 TSC	Requirements for reactor control systems of nuclear power plants	2
N290.5 TSC	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	2
N290.6 TSC	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	2
N290.7 TSC	Cyber security for nuclear power plants and reactor facilities	2
N290.8 TSC	Technical specification requirements for nuclear power plant components	3
N290.11 TSC*	Requirements for reactor heat removal capability during outage of nuclear power plants	2
N290.12 TSC	Human factors in design for nuclear power plants	2

Number	CSA Standard or Committee Name	Number of BP Reps
N290.13 TSC	Environmental qualification of equipment for CANDU nuclear power plants	2
N290.14 TSC	Qualification of digital hardware and software for use in Instrumentation and Control applications for nuclear power plants	2
N290.15 TSC*	Requirements for the safe operating envelope of nuclear power plants	2
N290.17 TSC	Probabilistic safety assessment for nuclear power plants	2
N290.18 TSC	Periodic safety review for nuclear reactor facilities	2
N292 TC	**Radioactive Waste Management**	2
N292.1 TSC	Wet storage of irradiated fuel and other radioactive materials	1
N292.2 TSC	Interim dry storage of irradiated fuel	1
N292.3 TSC	Management of low- and intermediate-level radioactive waste	2
N292.5 TSC	Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances	1
N293 TC	**Fire Protection for NPP**	3
N294 TC	**Decommissioning of Nuclear Facilities**	1
N393 TC	**Fire Protection for Facilities that Process, Handle or Store Nuclear Material**	2
N1600 TC	**General Requirements for Nuclear Emergency Management Programs**	2
B149.1	Installation Code for Natural Gas and Propane Appliances	1
B149.2	Propane Storage & Handling	1
B149.3	Field Approval of Fuel Burning Equipment	1
B167	Overhead Travelling Cranes	1
JB102.4	Piping, Tubing and Fittings	1
JB122.1	Valve Trains	1
S1101(36)	S1101(36) - Electrical Code Part I, Section 36, High-Voltage Installations	1
S356	S356 - Scaffolding	1
Z1006	Z1006 - Management of Confined Space Entry	1
Z462	Z462 - Workplace Electrical Safety	2
Z462.3	Z462.3 Drafting Committee - Workplace Electrical Safety	1
Z463	Z463 - Industrial and Commercial Electrical System Maintenance	1