Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Supplementary Information

Presentation from Bruce Power Inc.

In the Matter of

Bruce Power Inc. – Bruce A and B Nuclear Generating Station

Request for a ten-year renewal of its Nuclear Power Reactor Operating Licence for the Bruce A and B Nuclear Generating Station

Commission Public Hearing – Part 1

March 14, 2018

Renseignements supplémentaires

Présentation de Bruce Power Inc.

À l'égard de

Bruce Power Inc. - Centrale nucléaire de Bruce A et Bruce B

Demande de renouvellement, pour une période de dix ans, de son permis d'exploitation d'un réacteur nucléaire de puissance à la centrale nucléaire de Bruce A et Bruce B

Audience publique de la Commission – Partie 1

Le 14 mars 2018

Canada

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Innovation at work

Bruce Power Operating Licence Renewal

Part 1 Hearing – March 14, 2018

Overview




Mike Rencheck
President and CEO

Bruce Power™
Innovation at work

Nuclear excellence

- Safety First and Always

  You can count on me.
  EVERY STEP. EVERY TIME. **EVERY DAY.**

- Engaged, well-trained and sustainable people
- Reliable operations
- Innovative technology / environmental science
- Effective communications
- Community and public engagement

Safe, reliable, clean, low-cost operation

- Generated 30% of Ontario's electricity at 30% less than the average cost to generate residential power
- Produced more power than ever before including site output records in 2016 & 2017 and long-run records for Units 1, 3, 7 & 8
- Ensured a reliable supply of Cobalt-60 for the world's medical community; sterilizing once use medical devices and treating brain tumors
- Closure of coal plants resulting in zero Toronto smog days in 2014, 2015, 2016 and 2017

Recognition

Over the last 3 years:

- Top Employer of Young People for the 7th straight year (Canada's Top 100 Employers)
- Canada’s Most Admired Corporate Cultures (Waterstone Human Capital)
- Outstanding Nuclear Site Achievement Award for keeping Ontario’s air clean while adding jobs to its economy (Information System on Occupational Exposure North American Technical Centre)
- Top Innovative Practice Award for work on Cobalt-60 (Nuclear Energy Institute)
- Major Component Replacement ranked as the top infrastructure project of 2017 (ReNew Canada)
- Gold level certification for Progressive Aboriginal Relations (Canadian Council for Aboriginal Business)

Investments in Plant and Community




John Soini
EVP Finance and Commercial Services

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Continued safe, reliable operations

- The Province of Ontario, through its Long Term Energy Plan, has included 6,400 MW of generation from Bruce Power to meet the Province's energy needs
- This is enabled through a contract Bruce Power has with the Independent Electricity System Operator
  - Enables a long-term investment program to continue safe, reliable operations
  - Allows the organization to have a stable, long-term view to secure the future of the facility
- Under this framework, Bruce Power's owners will continue with their demonstrated commitment to investments in the facility

Secured the investment and policy support for 6,400 MW of safe, reliable operations.

Sustainable Supply Chain in the Region

Positive impacts touch the whole region:

- Formed a joint Economic Development & Innovation Initiative with the County of Bruce
- To date, more than 20 nuclear companies have opened offices, production facilities & warehouses in Bruce, Grey and Huron counties
- Local municipalities are reporting record permits for residential and commercial development and investing in local infrastructure projects

Community impacts

Doubled supply chain presence in local communities through corporate expansions in 2017:

- Abraflex (Paisley)
- Amec Foster Wheeler (Kincardine)
- Black & McDonald (Tiverton)
- BWXT (Port Elgin, Owen Sound)
- EMC Power Canada (Kincardine)
- Kinectrics (Kincardine, Teeswater)
- RCM Technologies (Kincardine)
- Rolls Royce (Port Elgin)
- Sargent & Lundy (Kincardine)
- SNC Lavalin (Port Elgin)
- Stantec (Kincardine)

Operational Performance




Len Clewett
EVP and Chief Nuclear Officer

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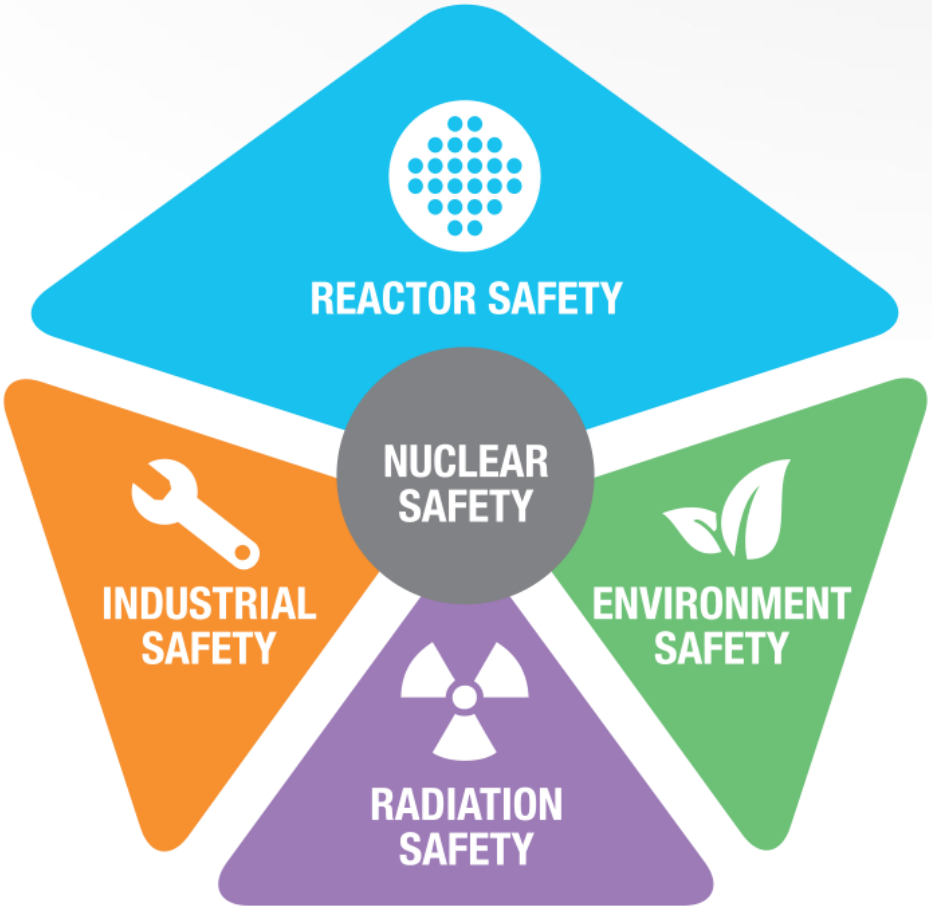
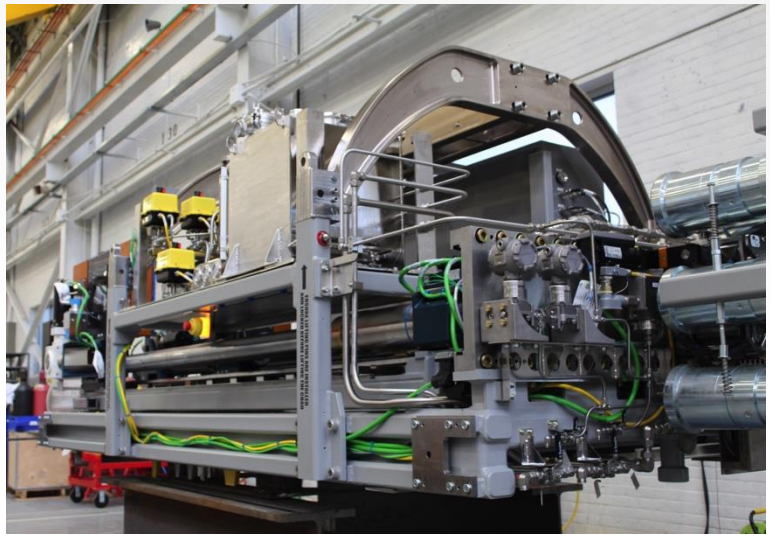
Pillars of nuclear safety



Innovations in radiation safety

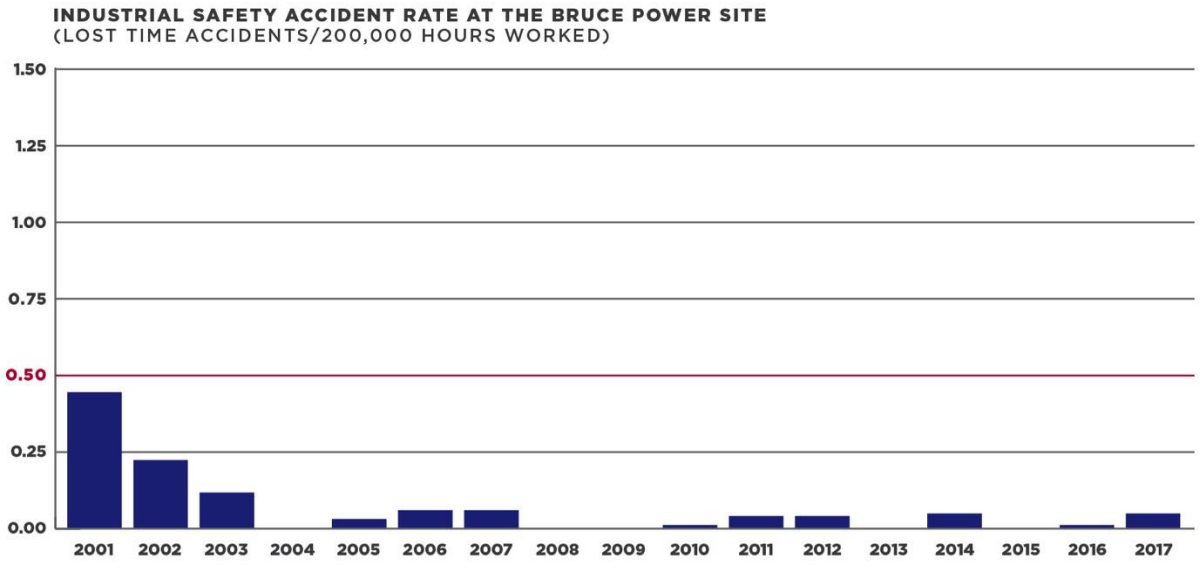
- Collective radiation exposure reduced by >2 Sv (200 rem) over last two years
  - Units 2 & 8 in the top quartile of CANDU reactors worldwide
- Personal contamination events (PCE) have decreased since 2013
  - 0.4 PCE's per outage day in 2016, against industry standard of 1.0
  - Improved pressure tube inspection technology has resulted in collective dose savings of 400 mSv per outage

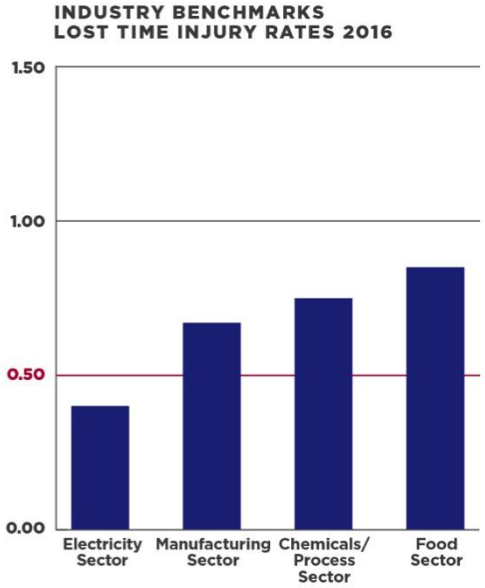


Bruce Power's performance in personal contamination events are top decile in the global nuclear industry.

Industrial safety

- Industrial Safety Accident Rate remains low compared to industry standards, but renewed focus owing to lost-time injury in 2016 and two in 2017
  - "You Can Count on Me" campaign in 2017 to ensure everyone is committed to consistently following standards
  - Other initiatives include new machine guarding program, improved hazard recognition, observations and & coaching

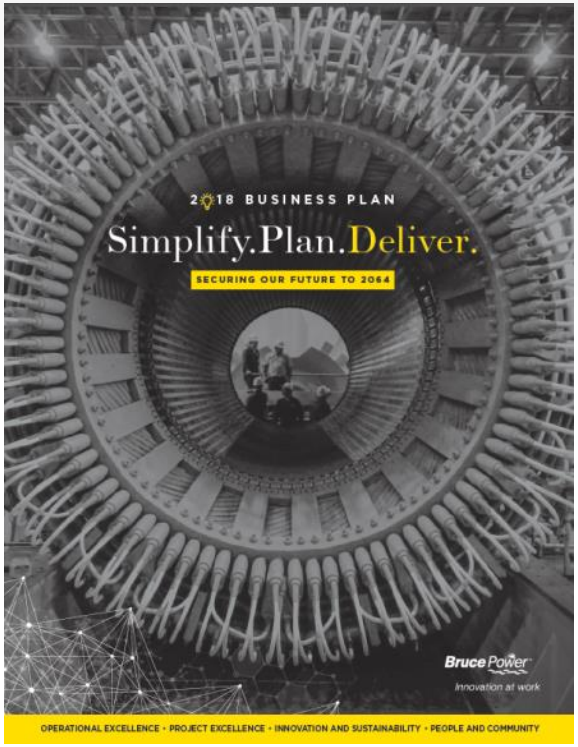




Investing in safe, reliable operations

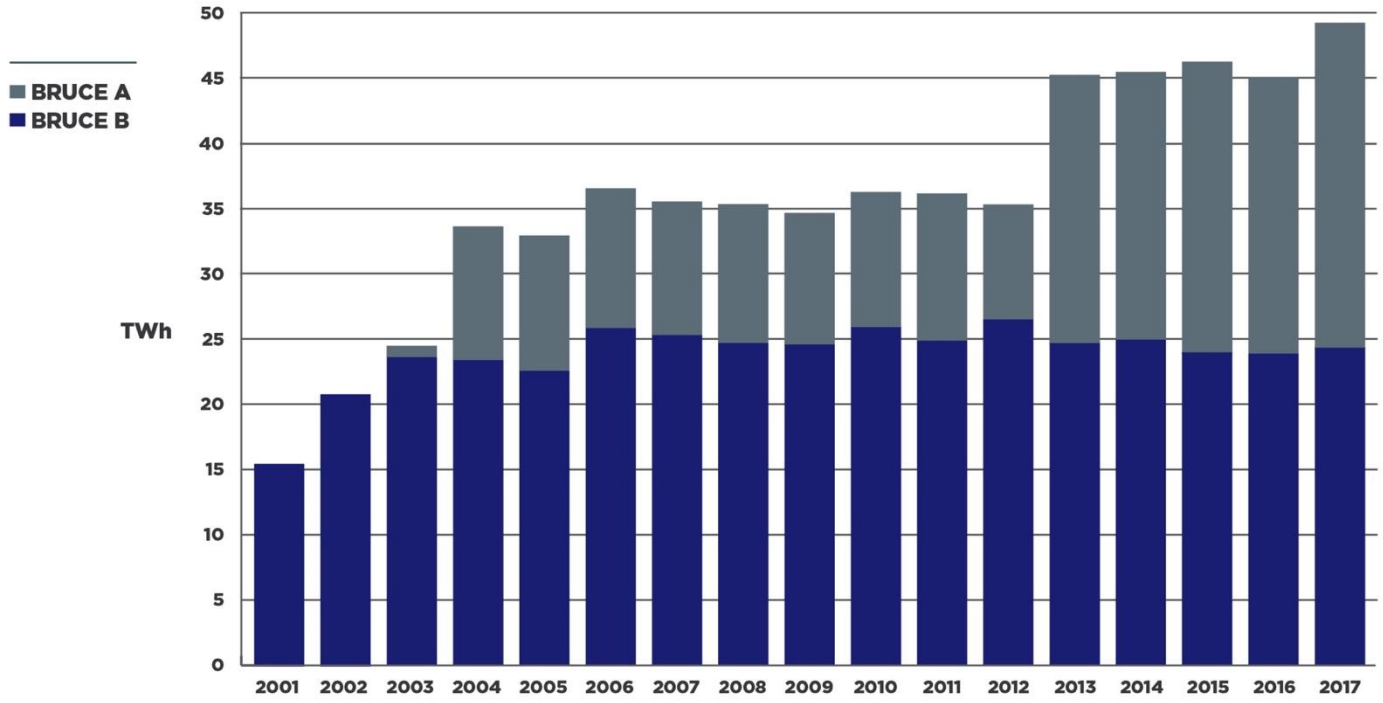
Investing in plant assets is an ongoing program and not limited to MCR. For example between 2013-2017 $1.9 billion was invested in improvements such as:

- Bruce B Condenser Steam Discharge Valve overhaul & actuator upgrades
- Bruce B generator rotor rewinds
- Unit 2 generator stator & rotor rewind
- Unit 3 & 4 Main Output Transformer replacements
- Bruce A Low Pressure Turbine replacements
- Bruce A Instrument Air Compressor replacement
- Bruce B Main Boiler Feed Pump refurbishments/replacements
- Bruce B Fuel Handling Inverter replacements
- Bruce A and B Safety System Monitoring Computer replacements & Primary Heat Transport pump motor refurbishment

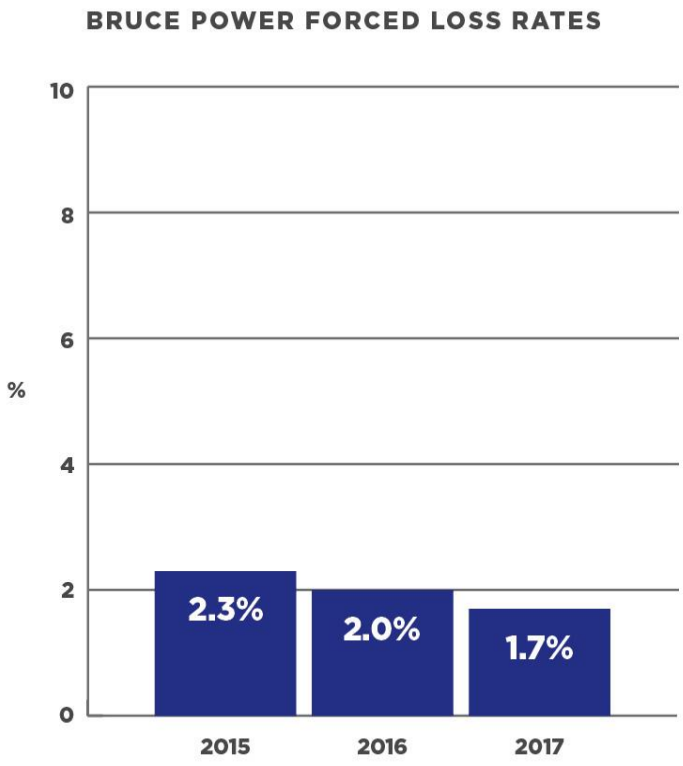


Predictable, reliable operations

- Investments in our plants & people lead to reliable performance and increased output
- New site output records set in 2013, 2014, 2015 & 2017



Improved forced loss rate



- Achieved lower forced loss rates in 2015 (2.3%), 2016 (2.0%) and 2017(1.7%)
- Lowering the forced loss rate has reduced challenges to the operating crews and strengthened the safety of our units
- Industry top decile corrective maintenance backlogs

Investment program has led to improved equipment reliability

Independent performance reviews

- Operational Safety and Review Team (OSART) mission held at Bruce B in 2015
- International Atomic Energy Agency (IAEA) follow up to OSART in 2017
- World Association of Nuclear Operator peer review of Bruce A in 2016
- Nuclear Safety Review Board each quarter
- Independent Project Oversight panel each quarter

Continuing safe, reliable operation




Gary Newman
Chief Engineer & SVP Engineering

Bruce Power™
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Programmatic approach

Life cycle management

- Monitors condition of critical structures, systems & components ensuring safe, reliable plant operation

Asset management

- Evaluates replacement & maintenance strategies to ensure safe, reliable operation

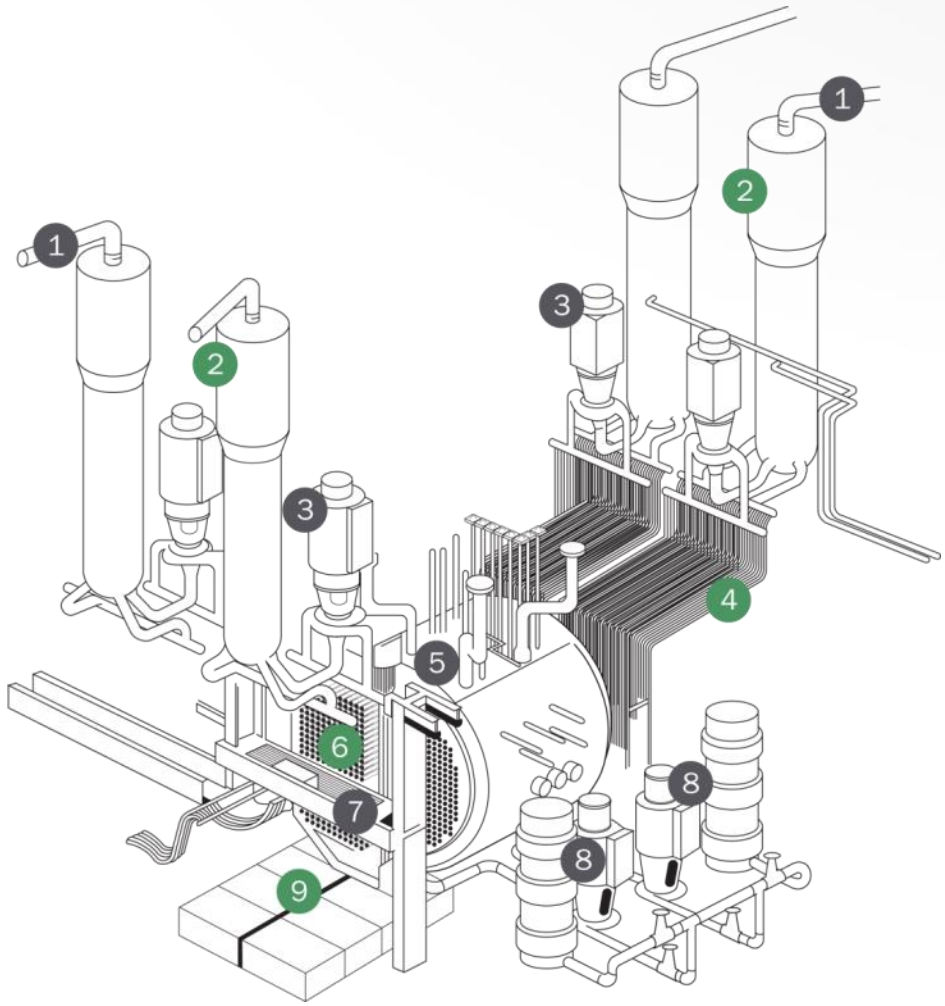
Long-term planning

- Integrates business and work planning to ensure all work is completed as required

Asset management and Major Component Replacement

- The condition of plant systems, structures and components is managed through the asset management program. Data is monitored; the condition of various systems, structures and components is analyzed; future performance is predicted; and necessary maintenance/replacement activities are planned
- Major Component Replacement activities are a subset of asset management work that encompasses those activities that require greater than a six month unit outage

Major Component Replacement



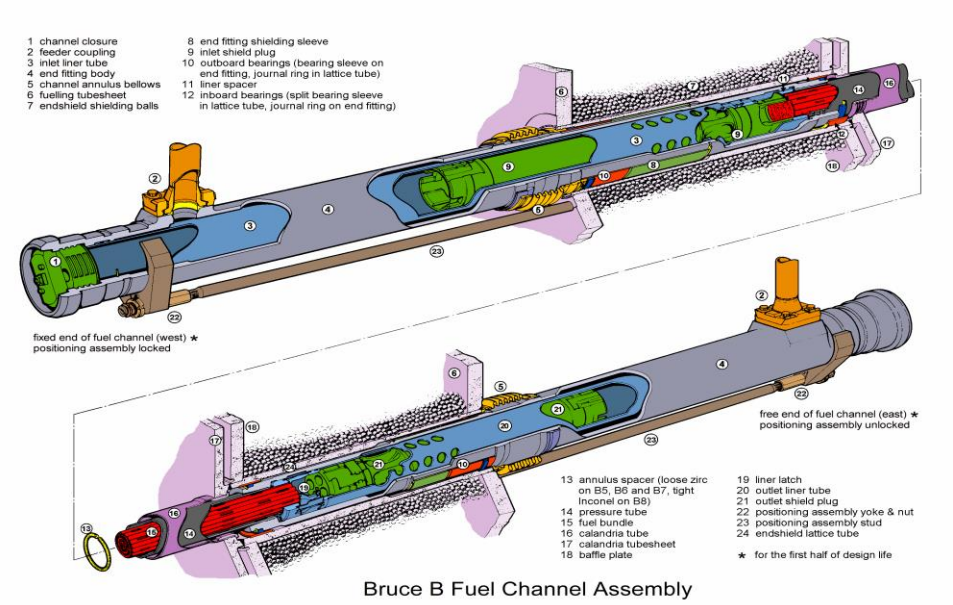
● = MAIN PROJECTS

LEGEND

1. Main Steam Supply Piping
2. Steam Generators
3. Main Primary Supply Pumps
4. Feeders
5. Calandria Assembly
6. Fuel Channel Assemblies
7. Fuelling Machine Bridge
8. Moderator Circulating System
9. Bulkheads

Fuel channel assembly health & longevity

- Decades of Bruce Power-specific and industry-wide research used to support current monitoring program
- Regular communication with CNSC via semi-annual updates, industry meetings, CSA standard requirements and Integrated Implementation Plan commitments



Bruce B Fuel Channel Assembly

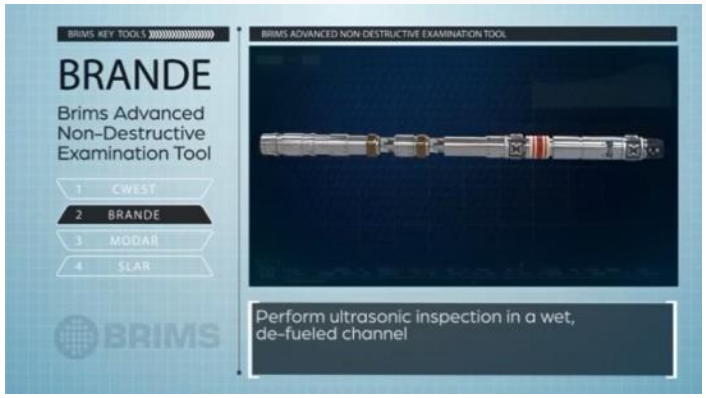
Pressure tube condition monitoring

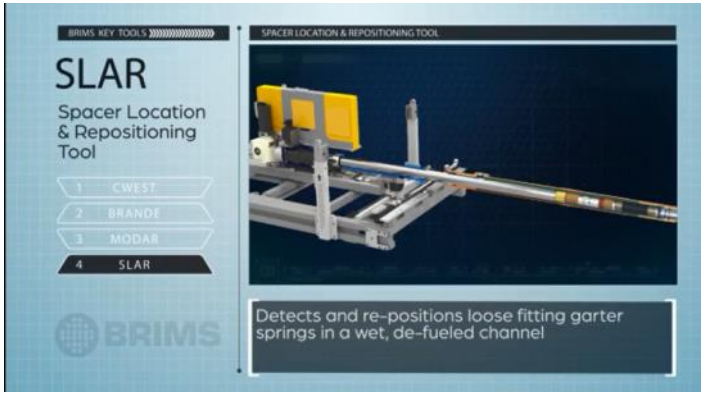
- Two fracture toughness models demonstrate that pressure tubes support safe operations now & in the future
  - Models are key inputs to leak-before-break & fracture protection assessments
  - Reviewed by two independent third-party experts
- Before current licence, models were validated to a hydrogen equivalent (H_{eq}) concentration of 124 ppm (corresponded to 247,000 EFPH)
- Burst tests being conducted at an H_{eq} concentration of ≥160 ppm to demonstrate fitness for service up to 300,000 EFPH
  - Tests of 144 ppm and 204 ppm conducted - results consistent with model predictions
  - Burst tests planned through 2022

State of the art data acquisition

Bruce **R**eactor **I**nspection **M**aintenance **S**ystem

One-of-a-kind innovation in safe, efficient fuel channel inspection

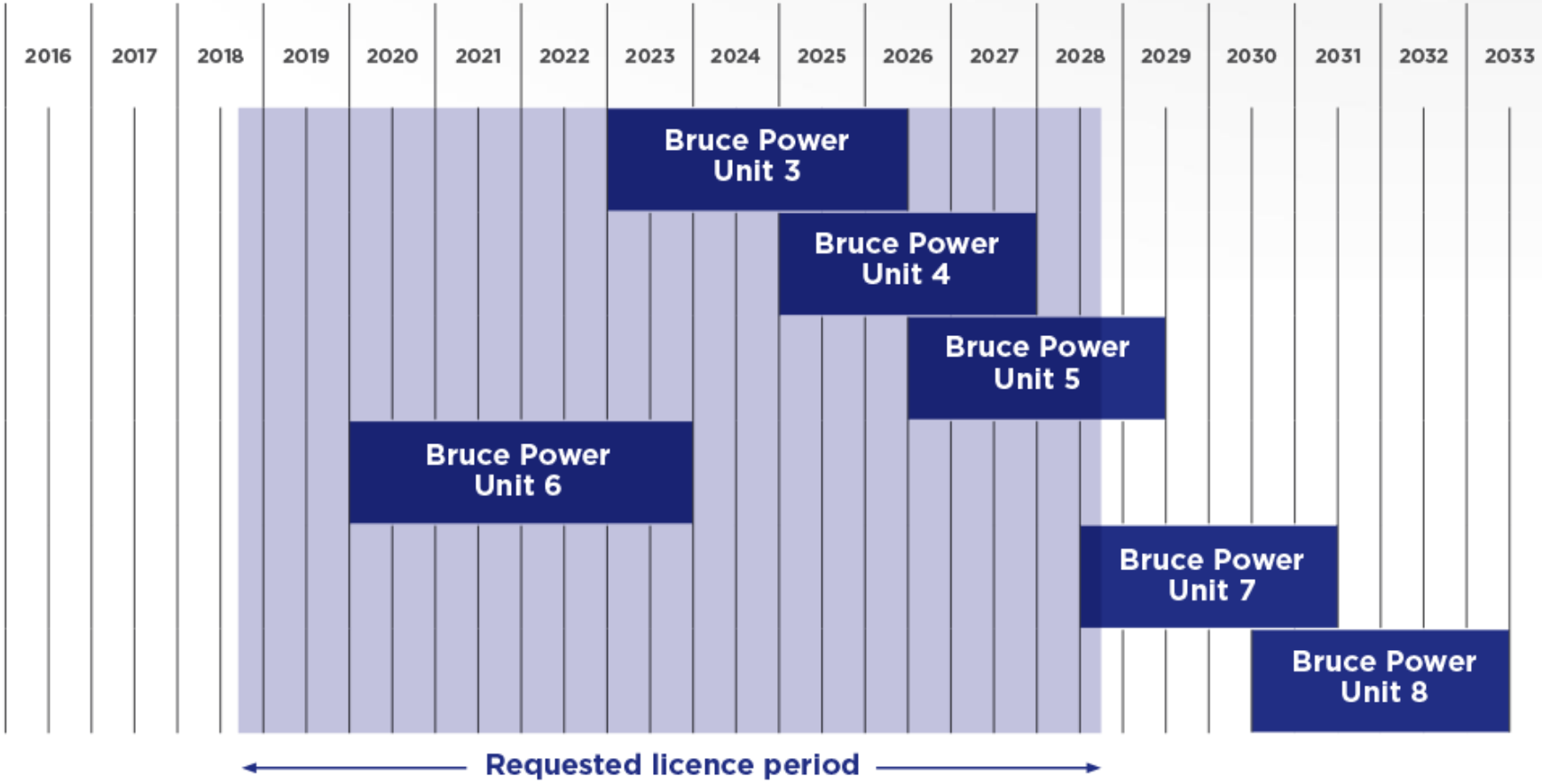




High pressure burst tests

Note: The irradiated tube segments used in the high pressure burst tests need to be notched, to simulate a crack, in order to get them to burst.

Major Component Replacement



Projected Heq at replacement

MCR outage date, Equivalent Full Power Hours, and projected maximum [H_{eq}] at the outlet rolled joint region for Units 3-8			
Unit	**MCR outage date**	**Replacement**	**Maximum [Heq]**
3	2023	242,000	102 ppm
4	2025	251,000	104 ppm
5	2026	294,000	151 ppm
6	2020	243,000	121 ppm
7	2028	297,000	147 ppm
8	2030	298,000	139 ppm

***Test up to 204 ppm have been conducted; bounds predicted operations**

Site safety




Frank Saunders
VP Nuclear Oversight & Regulatory Affairs

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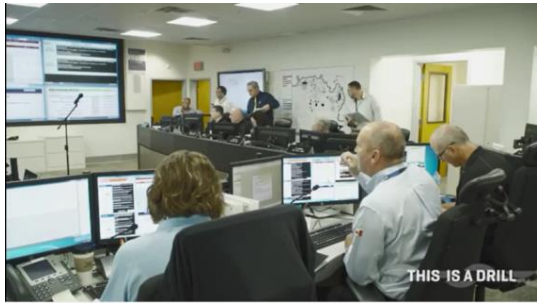
One of the safest industries in the world

Public safety has always been paramount in the nuclear power industry.

Post-Fukushima plant modifications have added additional layers of safety even in very rare but extreme natural events:

- Additional emergency mitigating equipment operational and tested
- Advanced emergency preparedness in place
- Response capability and multiagency coordination tested in large scale exercises



Fukushima enhancements

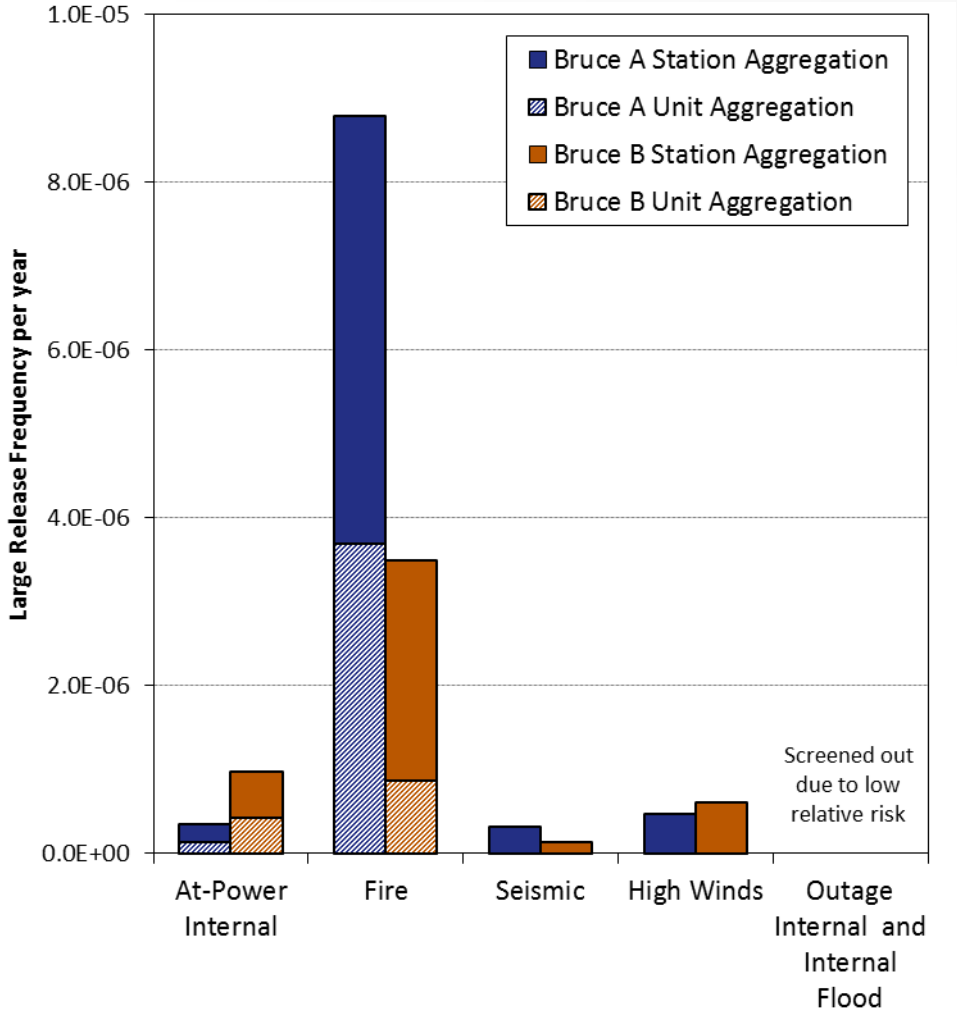
Modification	Station/unit	In-service date	Status
Short-term actions to provide make-up water	—	—	—
Installation of dry hydrants	AB	2012	Complete
Redundant EME connections to steam generators	AB	2013	Complete
Redundant EME connections to irradiated fuel bays	AB	2013	Complete
Procurement of EME	n/a	2012	Complete
Strengthening defence in depth	—	—	—
Additional provisions for make-up water	—	—	—
EME connection to Primary Heat Transport System	56	2019	In progress
EME connection to Moderator System	56[1]	2019	In progress
SAMG connection to Primary Heat Transport System	12345678	2016	Complete
SAMG connection to Moderator System	12345678	2016	Complete
SAMG connection to Shield Tank	12345678	2016	Complete
Installation of Shield Tank overpressure protection	5[1]6	2019	In progress
Wide-range ECI sump level indication	A	2018	In progress
External power supply enhancements	—	—	—
Procurement of portable generators, cables, trailers	AB	2011	Complete
Installation of receptacle panel for quick connections	AB	2012	Complete
Connecting quick-connect panel to QPS/EPS buses	AB	2012	Complete
Passive filtration for containment	—	—	—
Installation of containment venting connection point	AB	2016	Complete
Installation of filtered containment venting system	AB	2022	In progress
Passive Autocatalytic Recombiners	0A12340B5678	2015	Complete
Enhancing emergency response	—	—	—
New Emergency Management Centre (EMC)	—	—	—
Commissioning of new state-of-the-art facility	n/a	2014	Complete
Procurement of mobile emergency centre	n/a	2013	Complete
Backup power for emergency facilities, equipment	—	—	—
Portable generator for EMC	n/a	2014	Complete
Fuel truck, portable generator for fuel transfer pumps	n/a	2012	Complete
Communications upgrades	—	—	—
Radio, satellite phone upgrades at EMC, CMLF	n/a	2014	Complete
Installation of VSAT at EMC	n/a	2014	Complete
Offsite monitoring capability	—	—	—
Installation of remote gamma monitors	n/a	2014	Complete
Installation of remote aerosol monitors	n/a	2015	Complete

Note 1: installation was partially completed.

Probabilistic Safety Assessment (PSA)

- Probabilistic Safety Assessment updated at both stations to include internal events at high power & during planned shutdowns
  - Confirmed safety goals met at each station
- As part of post-Fukushima improvements the assessments considered:
  - Whole site with a focus on multi-unit implications of beyond design basis events
  - Additional scenarios such as fire, flood, earthquake, high winds, lightning, snow & low-lake events
- Installation of a passive Containment Filtered Venting System will positively impact the assessment results
- Routinely updated on a 5-year cycle
- Integration of on-line assessment capability in operation/maintenance work planning to identify/eliminate risks

Probabilistic Safety Assessments

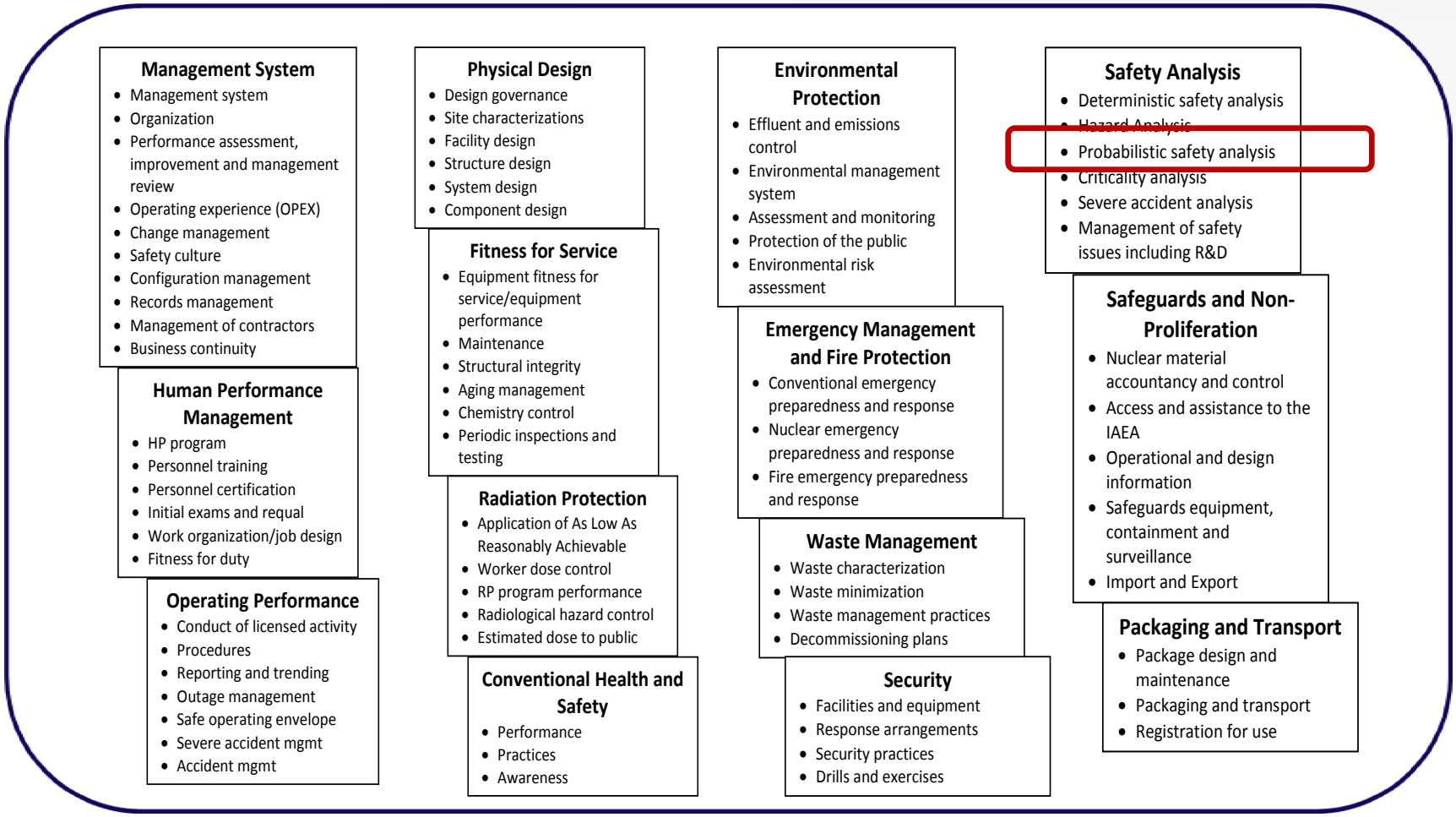


Results for Bruce A and Bruce B Large Release Frequency.

Modeling is realistic for At-Power Internal; conservative for Fire, Seismic, and High Winds.

Uncertainty: low for At-Power Internal events; moderate for Fire, Seismic, and High Winds.

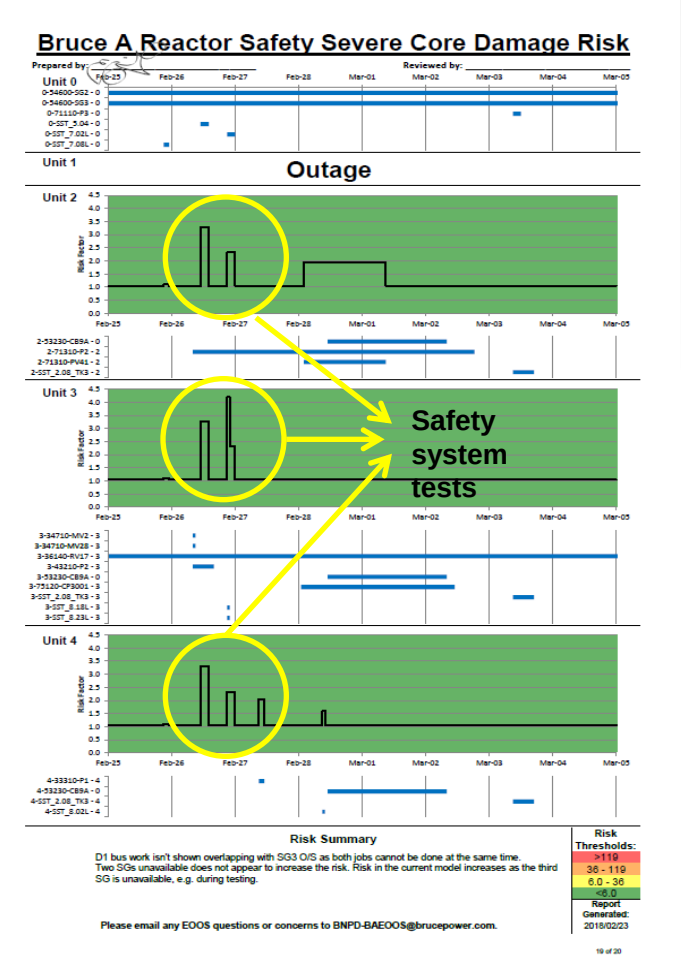
Many safety processes and indicators



Enhanced safety monitoring

Probabilistic Safety Assessments utilized to enhance safety through work planning:

- Equipment out of service assessment tool helps in work planning process to assess on-going risk on a real time basis
- Allows work planners to shift work on safety related equipment to minimize risk



Fire Training Facility

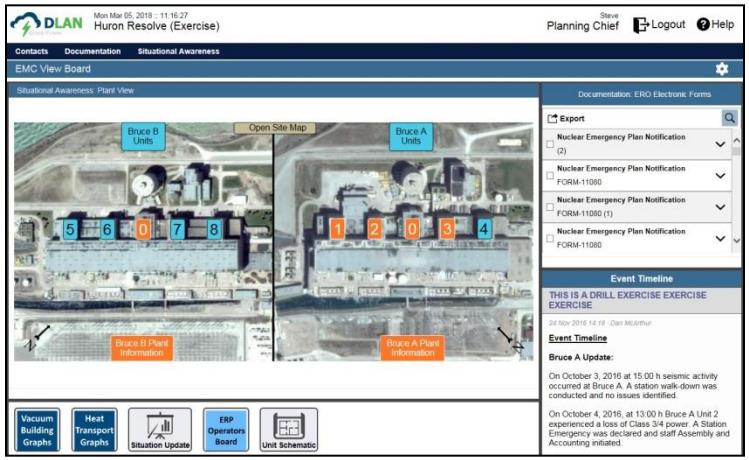
Emergency preparedness

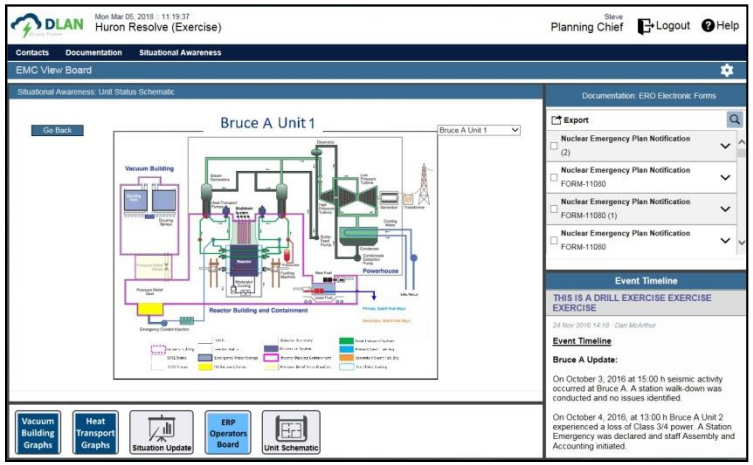
- During the current licence period, Bruce Power's capability to respond to all hazards has been enhanced through improved training, robust data sharing & physical enhancements to both nuclear facilities & supporting infrastructure
- Specifically:
  - Mapping software demonstrated during the 2017 corporate exercise provided the capability to track on-site and off-site response equipment through real-time geolocation technology
  - All hazard Emergency Mitigating Equipment deployment simulation developed to assess probability of successful deployment & support training
  - Enhanced plume dispersion modelling software has been tested & fully implemented

Emergency data transmission system

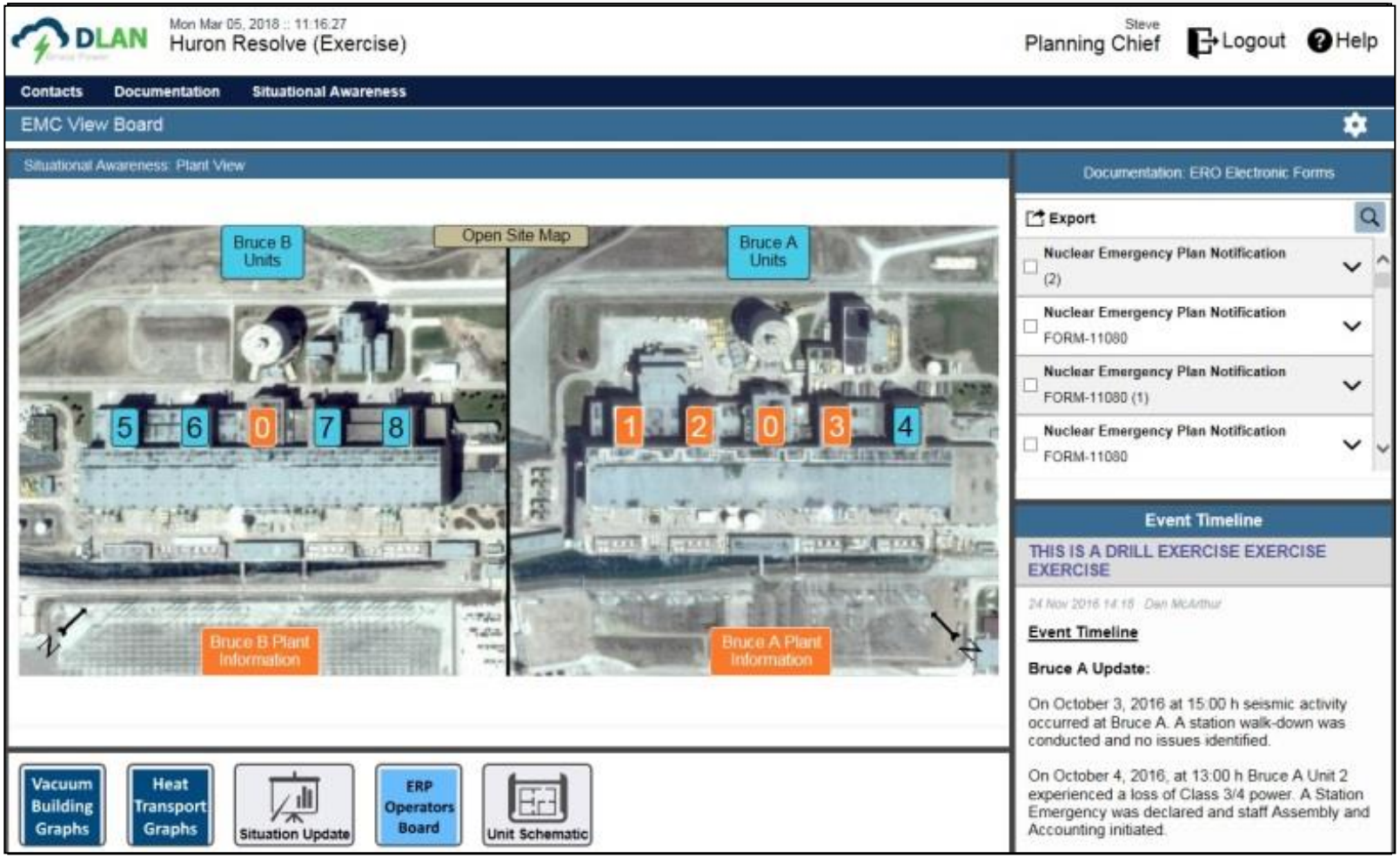
DLAN - Emergency data transmission system developed and implemented:

- Timely, reliable, accurate data
- Robust and operable in all design basis and beyond design scenarios
- Independent of local grid
- Digital transfer of same data to all stakeholders
- Digital storage of data remote from the site



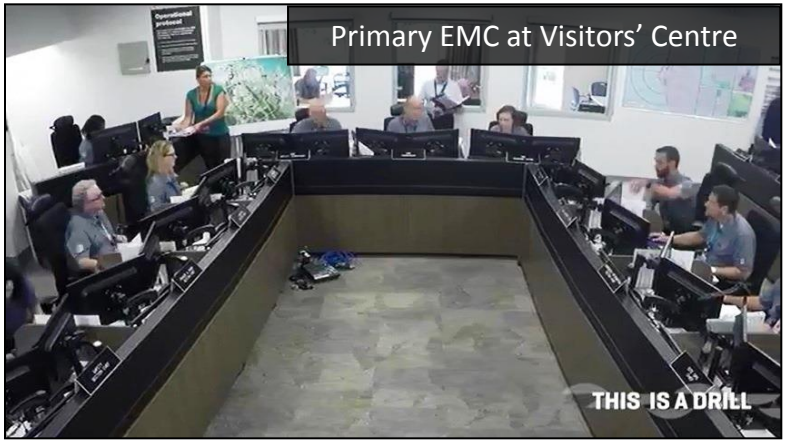


DLAN – layers of informaton



Emergency preparedness continued

- Alternate Emergency Management Centre locations established in Kincardine and Port Elgin to support primary Emergency Management Centre adjacent to site
- A new systematic approach to training implemented across emergency response regime
- Potassium Iodide distribution complete & updated each year
- Evacuation study complete



Emergency preparedness continued

A completed study demonstrates that employing Emergency Mitigating Equipment prevents significant dose to the public even in severe accident multi-unit events:

- No releases before approximately 20 hours even if no plant systems operational and Emergency Mitigating Equipment not deployed in simultaneous multi-unit event
- Deployment of only limited Emergency Mitigating Equipment even 2 hours after core is postulated to be uncovered limits sheltering zone to approximately 3 km with no evacuation action levels exceeded
- Utilization of plant systems or deployment of Emergency Mitigating Equipment will prevent large releases
- Installation of passive containment venting will further reduce (likely by orders of magnitude) the quantity of radionuclides that could be released in a severe event even if other action is not taken

Huron Resolve

Provincial-level exercise held over five days in October 2016

- >1,000 participants from 30 agencies successfully responded to mock radiological event & other all-hazard incidents
- Emergency mitigating equipment successfully deployed to provide back-up power and cooling water
- Automated on-site and off-site remote radiation monitoring network used to provide scenario simulations
- Transportation emergency response procedures also tested
- Emergency Management Centre relocated to one of two newly-designated back-up facilities
- Crisis Management Team activated, with full involvement of CEO and other executive team members

Commitment to the Environment and Engagement




James Scongack
VP Corporate Affairs

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Environmental safety

- Bruce Power's commitment to the environment extends beyond regulatory compliance. Continuous improvement and environmental stewardship are also key principles in Bruce Power's Environmental Policy.
- Bruce Power has been successful in registering to the newest version of the ISO 14001 standard for Environmental Management Systems.
- Continued implementation of CSA N288 series of Standards and guidelines on environmental management of nuclear facilities.
- Our established environmental monitoring program is based on regulations, standards, and best practice and continues to improve with a focus on meaningfully incorporating public input and Indigenous knowledge.
- Our environmental outreach assists community organizations achieve mutual environmental goals.
- Tackling climate change and reducing our environmental footprint key areas of focus for the company.

Safe for our Neighbours

In 2016, our monitoring showed 1.6 microsieverts of radioactivity in the area, just a fraction (0.16%) of the safe, allowable limit to the public of 1,000 microsieverts/year as set by the Canadian Nuclear Safety Commission.

Environmental Risk Assessment (ERA)

- The Bruce Site has been the subject of numerous environmental assessments and studies since its formation in 2001 that has fully captured all operational and life extension activities, including Major Component Replacement.
- Bruce Power submitted an Environmental Risk Assessment in 2015 and an update to the ERA in 2017 meeting CSA standards. The Environmental Risk Assessment characterized baseline environmental conditions and the impact of on-going operations.
- Bruce Power also conducted a Predictive Effects Assessment to identify the impact from baseline conditions resulting from future activities, including Major Component Replacement.

There is no work being carried out by Bruce Power in the future that has not been previously characterized, assessed and confirmed to not have a significant adverse impact.

Key Issues

- The role Bruce Power plays in meeting Ontario's Greenhouse Gas Reduction targets.
- Explaining radiological emissions in a manner that enhances public confidence.
- Continuing to demonstrate thermal impacts and the impingement and entrainment of fish do not pose a significant adverse impact on Lake Huron as concluded in multiple assessments since 2001.
- Connecting on-going investment in safe reliable operation, including Major Component Replacement, to further reduction of environmental interaction.

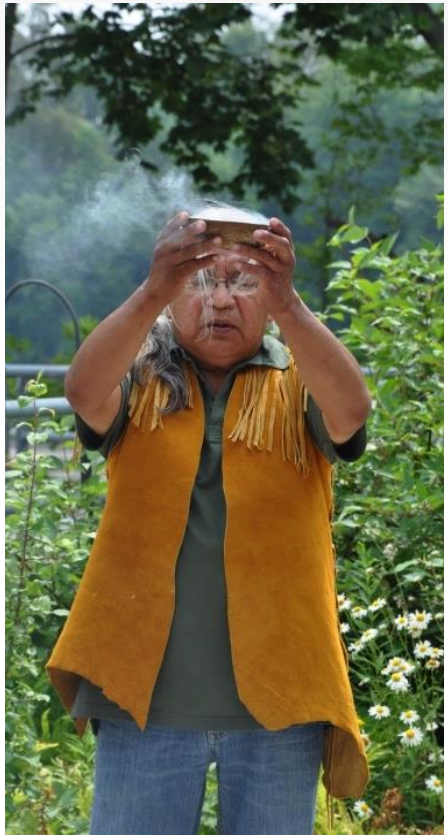
Bruce Power is committed to being an environmental leader and making a positive contribution to sustainability on and off site.

Environment – anticipating the future

- Independent university-based Research & Development:
  - Ongoing investment of $7 million since 2010, with additional $1.7 million of granting agency funding awarded to:
    - Quantify effects of thermal, chemical and radiological exposures on Lake and Round Whitefish
    - Determine population distribution of Lake and Round Whitefish in Lake Huron and the Great Lakes
    - Investigate the biological effects of low-dose radiation
- Research results improve understanding of very low risk to Whitefish
  - Thermal regime shows low risk to developing embryos
  - Complex cumulative effects of multiple stressors, very low risk
  - No “local” genetic or ecological populations (Lake Huron)

Indigenous Relations

- Recognize our Site is located on the traditional territories of Indigenous Peoples.
- Active and ongoing dialogue to further understanding of First Nations and Métis rights and way of life.
- Formal Protocol Agreements in place covering regulatory engagement, capacity and community development.
- Ongoing work with employment, education, training, business opportunities and economic development, environmental stewardship and community investment.
- Bruce Power has invested significantly in capacity funding and other initiatives in our local Indigenous communities

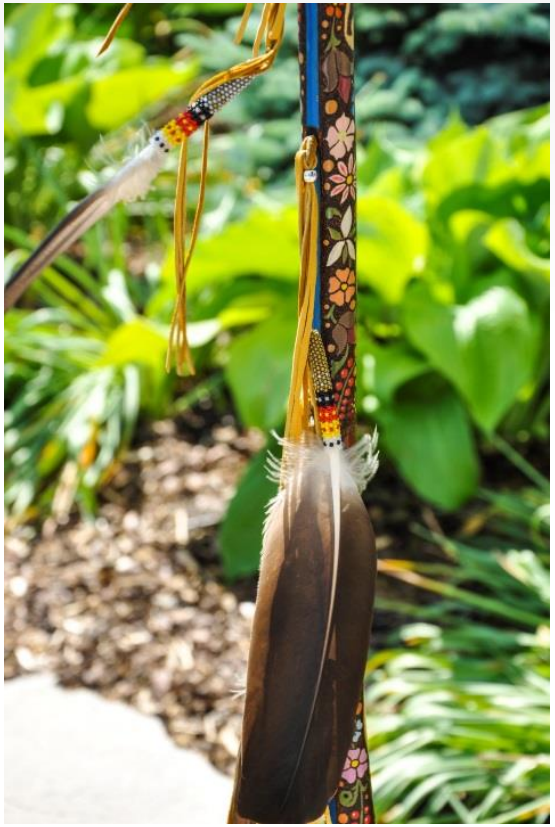


Indigenous Relations

- An active participant and gold level member of the Canadian Council for Aboriginal Business – recertified in 2017
- Created Indigenous Relations Suppliers Network in 2018
- Indigenous Community Investment Fund
- Indigenous Employees Network

BRUCE POWER
INDIGENOUS RELATIONS
SUPPLIER NETWORK

Progressive Aboriginal RELATIONS GOLD LEVEL
Canadian Council for Aboriginal Business



Strong local & provincial support

- Support for nuclear refurbishment high throughout Ontario.
- Confidence in Bruce, Grey and Huron Counties
  - 93% - Bruce Power Operates safely
  - 90% - Bruce Power is a good community citizen
  - 87% - confidence in security measures at Bruce Power
- Community and public support is something that Bruce Power will never take for granted and we work hard to earn everyday.

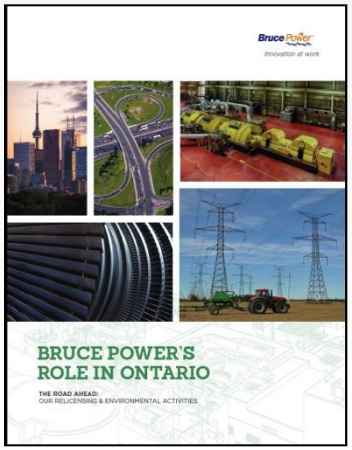
Community impacts

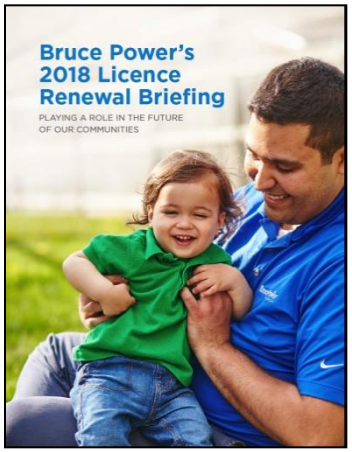
Improved employment opportunities:

- 22,000 direct & indirect jobs supported by an 8-unit Bruce Power site
- 5,000 additional direct and indirect jobs/year during Major Component Replacement
- $4 billion/year in economic benefit in Ontario from operations
- New 129,000 square foot office complex & training facility in Kincardine
- New Bruce B Protected Area Office Complex

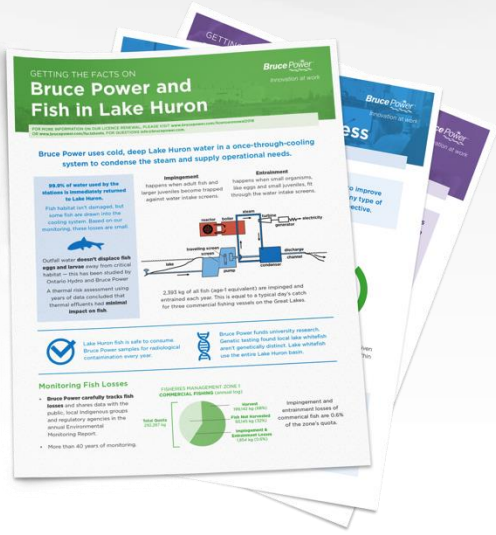
Actively Engaging on License Renewal

- Process commenced in late 2015 starting with Indigenous Communities.
- Publications on licensing process released: first in August 2016, second in September 2017.
- Online and Social Media Engagement.
- Stakeholder meetings and workshops
- Community information mailings and open houses.
- Active dialogue with County and Municipal Governments.
- Independent public opinion polling.





The numbers



- 5 **Webinars** on licensing process
- 14 **Fact Sheets**
- 29 related **Public Inquires**
- 5 **face-to-face community sessions**
- 4,400 people provided information during 2017 **summer bus tour program**
- 104,000 people received **Community update** which highlighted Licence Renewal

Conclusions




Frank Saunders
VP Nuclear Oversight & Regulatory Affairs

Bruce Power™
Innovation at work

Conclusions

Bruce Power will continue to make adequate provision for the environment, health and safety of persons, and maintenance of national security and measures required to implement international agreements to which Canada has agreed, as described in the Nuclear Safety and Control Act, Section 24(4)(b)

Bruce Power requests:

- Renewal of Bruce Power's Nuclear Power Reactor Operating Licence PROL 18.00/2020 for a period of 10 years from September 1, 2018
- Acceptance of the Integrated Implementation Plan
- Approval of the regulatory scope of the major component replacement outages in Units 3 – 8
- Incorporation of activities currently authorized by licences 13152-1-20.4 (nuclear substances and radiation devices), 13152-2-21.1 (operation of a Class II nuclear facility), and 13152-3-20.2 (conduct of radiography), into PROL 18.00/2020 upon renewal