



CNSC Regulatory Oversight of Maintenance Programs at Nuclear Power Plants in Canada

CMD 20-M21



CNSC Staff Presentation

Commission Meeting

September 16, 2020

e-Doc 5890146 (PPTX)

e-Doc 6375158 (PDF)





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Presentation Outline

- Power reactor regulatory program oversight
- Maintenance related regulatory documents and standards
- Required elements of a NPP maintenance program
- Interfacing licensee programs
- Maintenance oversight team
- Regulatory oversight of maintenance program
(baseline inspections / compliance assessments / safety performance indicators)
- Conclusion



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Power Reactor Regulatory Program

The Power Reactor Regulatory Program (PRRP)

provides effective, efficient and risk-informed regulatory oversight of the operating nuclear power plants in Canada.

The PRRP is supported by twenty-eight CNSC divisions

to ensure integration and collaborative execution of the PRRP through licensing and compliance activities.



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Safety and Control Areas

Safety and control areas are the technical topics used by the CNSC to assess, review and report on regulatory requirements and performance across all regulated facilities and activities.

SCA 1 - Management System

SCA 2 - Human Performance

SCA 3 - Operating Performance

SCA 4 - Safety Analysis

SCA 5 - Physical Design

SCA 6 - Fitness for Service

SCA 7 - Radiation Protection

SCA 8 - Conventional Health and Safety

SCA 9 - Environmental Protection

SCA 10 - Emergency Management
and Fire Protection

SCA 11 - Waste Management

SCA 12 - Security

SCA 13 - Safeguards and Non-Proliferation

SCA 14 - Packaging and Transport



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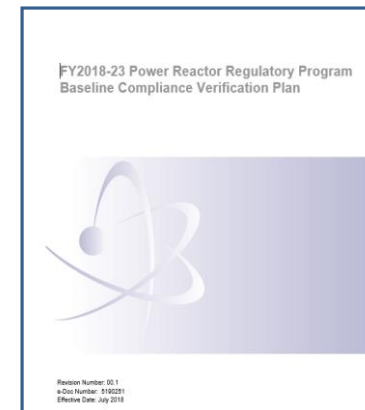
NPP Regulatory Oversight



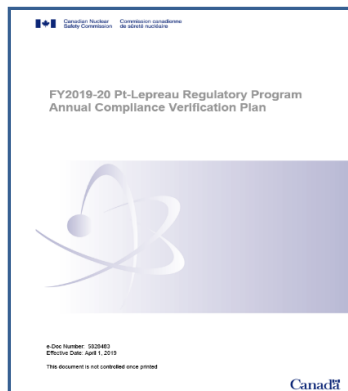
Power Reactor Operating Licence (PROL)



Licence Conditions Handbook (LCH)



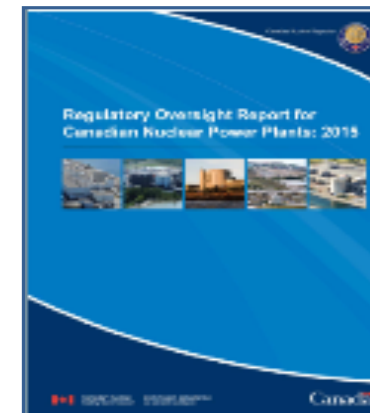
PRRP 5-year Baseline Compliance Verification Plan



NPP-specific Annual Compliance Verification Plan



Approved Procedures



Regulatory Oversight Report (ROR)

e-Doc 5890146 (PPTX)
e-Doc 6375158 (PDF)

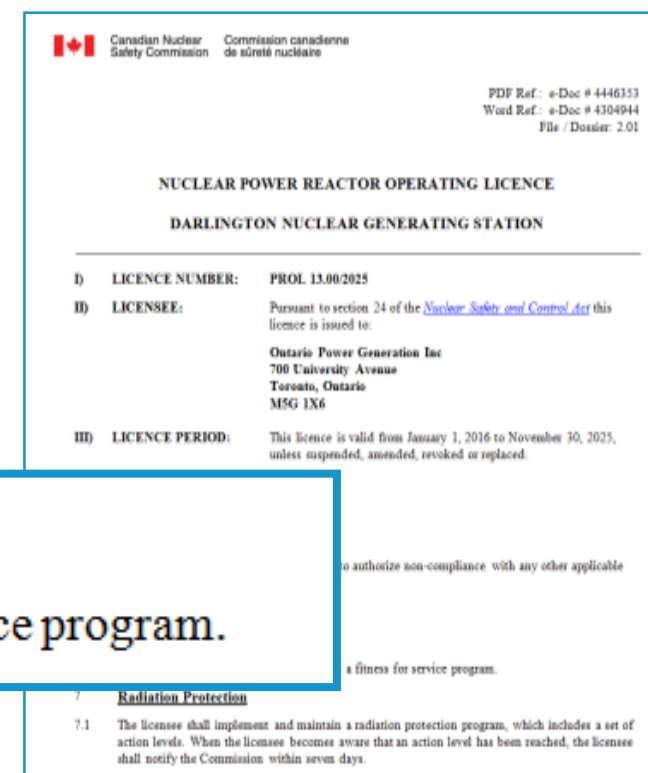


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PROL Licence Conditions Listed by SCA

Compliance starts with the licence issued.



6. Fitness for Service

6.1 The licensee shall implement and maintain a fitness for service program.

Licence Condition

Licence



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Compliance Verification (1/3)

The Licence Condition Handbook lists compliance verification criteria by Safety Control Area (SCA).

Canadian Nuclear Safety Commission / Commission canadienne de sûreté nucléaire

Licence Conditions Handbook (LCH-DNGS-R000) Effective Date: January 1, 2016

Darlington Nuclear Generating Station
Nuclear Power Reactor Operating Licence
[PROL 13.00/2025](#) (Effective: January 1, 2016)

Handbook

6.1 Fitness for Service Programs

Licence Condition 6.1:

The licensee shall implement and maintain a fitness for service program.

Licence Condition

Compliance Verification Criteria (CVC)

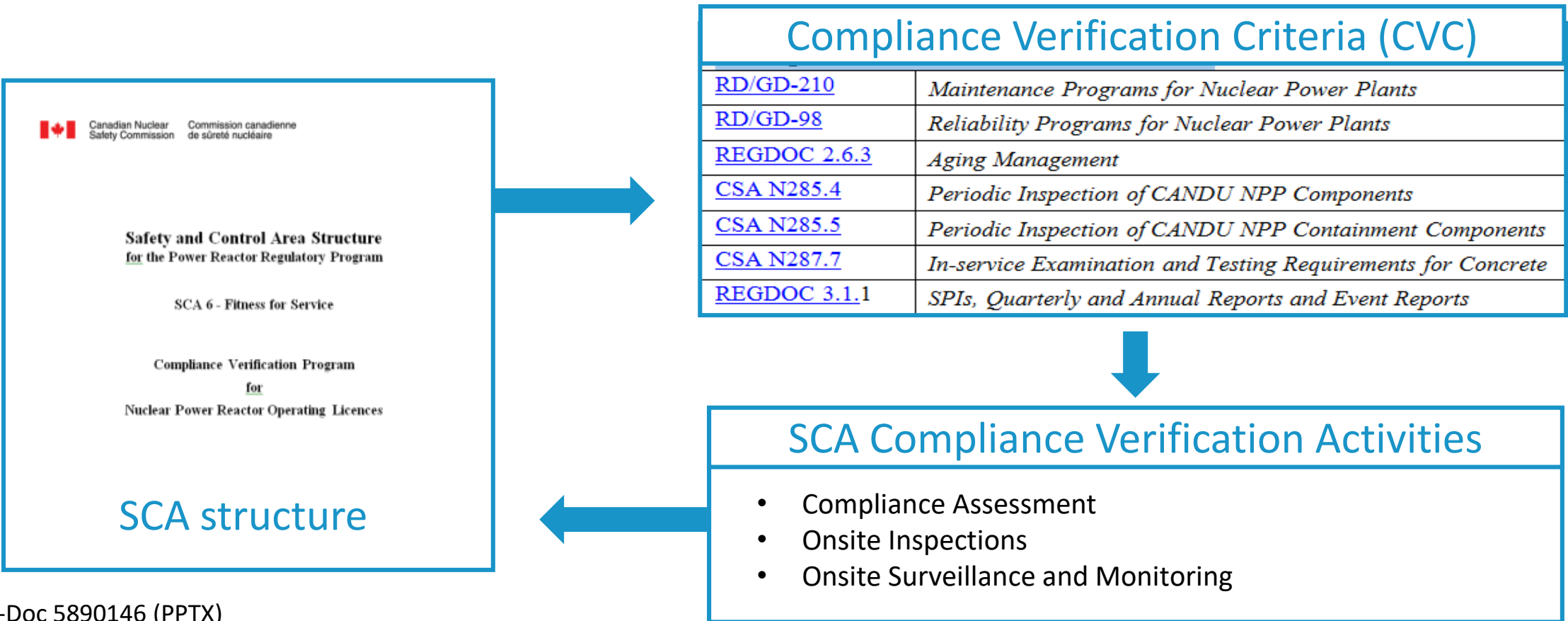
RD/GD-210	<i>Maintenance Programs for Nuclear Power Plants</i>
RD/GD-98	<i>Reliability Programs for Nuclear Power Plants</i>
REGDOC 2.6.3	<i>Aging Management</i>
CSA N285.4	<i>Periodic Inspection of CANDU NPP Components</i>
CSA N285.5	<i>Periodic Inspection of CANDU NPP Containment Components</i>
CSA N287.7	<i>In-service Examination and Testing Requirements for Concrete</i>
REGDOC 3.1.1	<i>SPIs, Quarterly and Annual Reports and Event Reports</i>



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Compliance Verification (2/3)

The SCA structure summarizes CVC and compliance verification activities.



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Compliance Verification (3/3)

All compliance verification activities are conducted using approved processes.

Compliance Assessment

- Technical assessment
- Examine event reports
- REGDOC-3.1.1 Report Review and Safety Performance Indicators
- Desktop Inspection

Site Inspections

- Type I Inspection
- Type II Inspection
- Field Inspection
- Reactive Inspection

Onsite Surveillance and Monitoring

- Surveillance and Monitoring
- Onsite daily observations
- Monitoring checklists



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Approved Inspection Guide Structured by SCA

TABLE OF CONTENTS

- SECTION 0 –EXECUTING THIS INSPECTION.....
- SECTION 1 – SCA – MANAGEMENT SYSTEM.....
 - 1.1 – SpA – ORGANIZATION (ROLES AND RESPONSIBILITIES)
 - 1.2 – SpA – RECORDS MANAGEMENT (DOCUMENT CONTROL)
 - 1.3 – SpA – RECORDS MANAGEMENT (DISTRIBUTION AND CONTROL)
- SECTION 2 – SCA – HUMAN PERFORMANCE MANAGEMENT .
 - 2.1 – SpA – PERSONNEL TRAINING (TRAINING AND QUALIFICATION)
 - 2.2 – SpA – HUMAN PERFORMANCE PROGRAMS (PROCEDURES)
- SECTION 3 – SCA – OPERATING PERFORMANCE
 - 3.1 – SpA – CONDUCT OF LICENSED ACTIVITY (PROBLEMS)
 - 3.2 – SpA – CONDUCT OF LICENSED ACTIVITY (PERFORMANCE)
 - 3.3 – SpA – PROCEDURES (PROCEDURE ADEQUACY)
 - 3.4 – SpA – REPORTING AND TRENDING (SELF-ASSESSMENT)
- SECTION 4 – SCA – FITNESS FOR SERVICE.....
 - 4.1 – SpA – MAINTENANCE- PRE-JOB BRIEFING.....
 - 4.2 – SpA – MAINTENANCE- MAINTENANCE SITE
 - 4.3 – SpA – MAINTENANCE- WORK EXECUTION.....
 - 4.4 – SpA – MAINTENANCE- POST MAINTENANCE, VERIFICATION
 - 4.5 – SpA – MAINTENANCE- CLOSEOUT ACTIVITIES AND RECORDS



CANADIAN NUCLEAR SAFETY COMMISSION

SED – TYPE II INSPECTION GUIDE

MAINTENANCE WORK PLANNING AND SCHEDULING



Key Approval

	Signature	Date
Prepared by:	Yong Chang Liu Specialist, SED	2016/09/21 YYYY/MM/DD
Endorsement:	Sean Burton PRSO's Representative	2016/09/21 YYYY/MM/DD
Approved by:	Eric Lemaire Director, SED	2016/09/23 YYYY/MM/DD
Approved by:	Kimberly Campbell Director, PHCID	2016/09/26 YYYY/MM/DD





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CNSC COVID-19 Response (1/2)

- Effective March 16, all CNSC staff in Ottawa and at regional and site offices were directed to work from home. Regulatory oversight continued by site staff via remote access.
- In April 2020, CNSC approved a procedure for the planning and conduct of compliance activities during the pandemic
 - The procedure provides direction for the conduct of oversight activities both remotely and onsite, as well as direction on revising the regulatory oversight plan for this fiscal year



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CNSC COVID-19 Response (2/2)

- CNSC has also developed a pandemic-related pre-job brief as additional instructions to be delivered prior to performing onsite oversight activities
 - Provision of PPE to site inspectors prior to any onsite activities forms part of this pre-job brief
- In May, DPRR resumed onsite oversight activities in a limited capacity
- Maintenance oversight activities are occurring remotely during the pandemic in accordance with the approved procedures



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Regulatory Oversight Report for NPPs



- Comprehensive review of performance of NPP licensees
- Review of all 14 Safety and Control Areas (SCAs)
- Written for the Commission, public and Indigenous groups
- Presented at a public Commission Meeting and webcasted
- Published in both official languages and available on the CNSC website

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Maintenance-Related Regulatory Documents and Standards

- **REGDOC 2.6.2**, *Maintenance Programs for Nuclear Power Plants*
- **REGDOC 2.6.1**, *Reliability Programs for Nuclear Power Plants*
- **REGDOC 2.6.3**, *Aging Management*
- **CSA N286-12**, *Management System Requirements for Nuclear Facilities*
- **CSA N290.9**, *Reliability and Maintenance Programs for Nuclear Power Plants*



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Relationship of Maintenance Concepts and Activities

From **REGDOC 2.6.2**

Maintenance Strategy

Preventive maintenance

Corrective maintenance

Periodic

Predictive

Planned

Run-to-failure

Unplanned failure

Time-based servicing, parts replacement or overhaul. Includes periodic inspection and lifetime replacement

Surveillance, monitoring, testing, in-service inspection

Condition-based servicing, parts replacement, overhaul, refurbishment, modification

Temporary repair, repair, overhaul, refurbishment, replacement or modification

Inspection and failure diagnosis

Optimization process for program and activities



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Required Elements in a NPP Maintenance Program

- Program basis
- Maintenance organization and roles
- Planning and scheduling of maintenance activities
- Monitoring of systems, structures and component
- Assessment and execution of maintenance work
- Procurement and supply of spare parts
- Management assessment and program review
- Record keeping



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Interfacing Licensee Programs

Maintenance program interfaces with and is also supported by many other plant programs, including:

- Management system program
- Reactor safety program
- Reliability program
- Aging management program
- Environmental qualification program
- Supply chain program
- Design program



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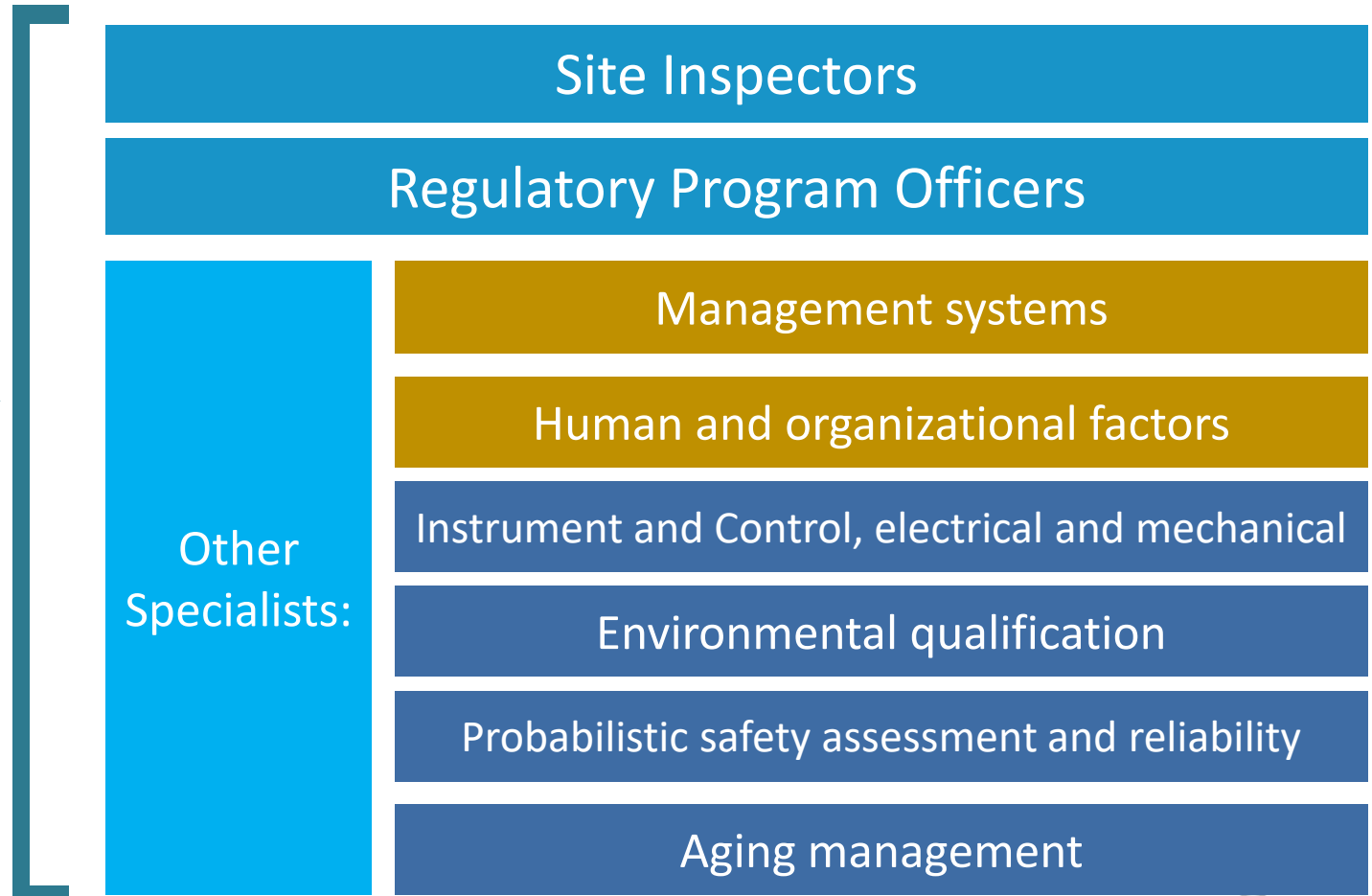


Maintenance Oversight Team

Maintenance Specialists



Maintenance is monitored by a multi-disciplinary oversight team.





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CNSC Maintenance Baseline Inspections (1/2)

5-year baseline plan requires a minimum combination of routine maintenance inspections:

Type II Inspections

- Maintenance work planning and scheduling
 - 1 per 5 years, per station
- Systems, structures and components monitoring
 - 1 per 5 years, per station
- Outage inspection
 - Dependent on the Licensee's outage plan



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CNSC Maintenance Baseline Inspections (2/2)

Field Inspections

- Maintenance work execution
 - 3 per year, per station
- Systems, structures and components monitoring
 - 2 per year, per station
- Safety significance rating of the inspection findings follows the risk-informed approach
- High confidence that there is good coverage of all elements of the maintenance program



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Other CNSC Maintenance Related Inspections

Other 5-year baseline inspections related to maintenance:

- System inspection
- Software maintenance
- Environmental qualification of equipment
- Instrument calibration

Reactive maintenance inspections may be conducted per the emerging risk, if needed



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CNSC Compliance Assessments

- Licensees' scheduled reports required under **REGDOC 3.1.1**, including the quarterly Safety Performance Indicator reports
- Licensees' unscheduled event reports required under **REGDOC 3.1.1**
- Licensees' additional submissions, including revised governance documents



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Safety Performance Indicators (SPIs) (1/3)

REGDOC 3.1.1 requires quarterly reporting of 4 maintenance-specific SPIs:

- **SPI 14:** Corrective maintenance backlogs
 - **SPI 15:** Deficient maintenance backlogs
 - **SPI 16:** Number of preventive maintenance deferrals
 - **SPI 18:** Preventive maintenance completion ratio
- For corrective and deficient maintenance
- For preventive maintenance



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Safety Performance Indicators (SPIs) (2/3)

- **SPI 14: Corrective maintenance backlogs**
 - Corrective maintenance work is required when an equipment has failed or its failure is imminent, and can no longer perform its design function
- **SPI 15: Deficient maintenance backlogs**
 - Deficient maintenance is planned when structures, systems, or components have been identified as degrading but still capable of performing their design function



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Safety Performance Indicators (SPIs) (3/3)

- **SPI 16:** Number of preventive maintenance deferrals
 - Defined as preventive maintenance that has received an approved technical justification for extension prior to its late date
- **SPI 18:** Preventive Maintenance Completion Ratio (PMCR)
 - Calculated as the ratio of completed preventive maintenance jobs divided by the sum of preventive maintenance plus corrective maintenance jobs completed

The criteria of collecting SPI 14, 15, and 16 were adopted from the COG Equipment Reliability Index Guideline to reduce the licensee's regulatory burden



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Role of SPIs and Method of Assessment

Role of SPIs

Measurement of the licensees' maintenance program performance informs subsequent inspections or compliance assessments. Safety significance is determined by follow-up compliance assessments and/or inspections.

Major steps to assessing the SPIs

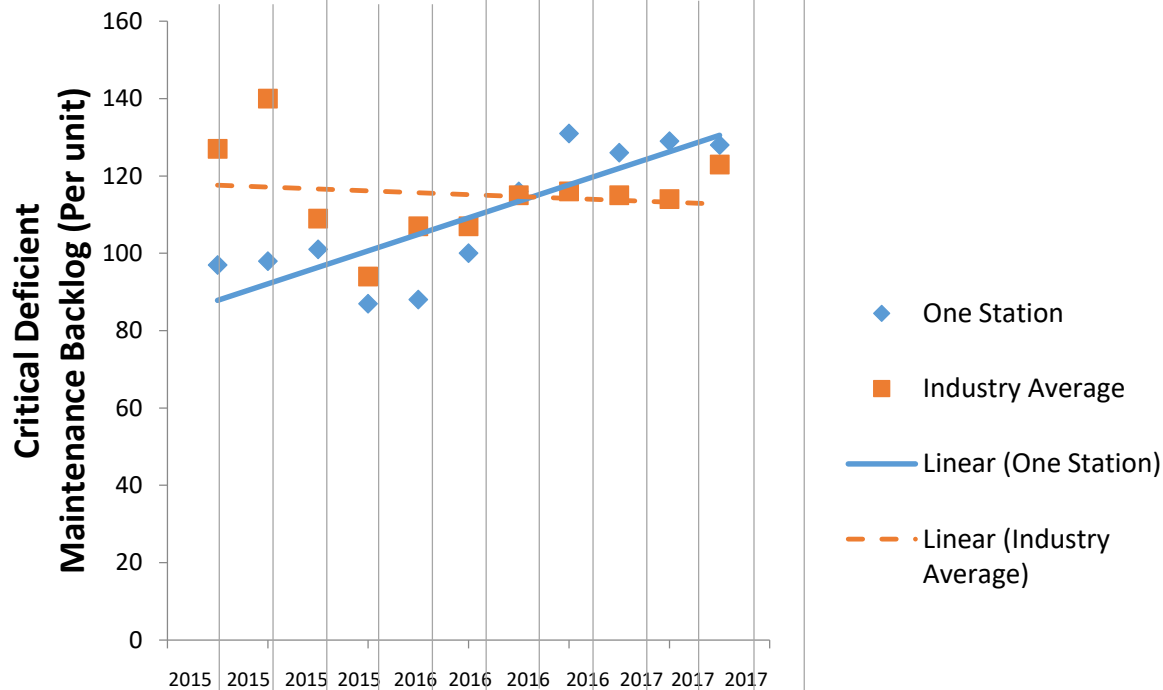
- Calculating the quarterly average for each SPI and each station
- Quarterly trend since 2015
- Comparing levels and trend with industry average
- If necessary, reactive inspection or compliance assessment per review findings to determine causes and safety significance



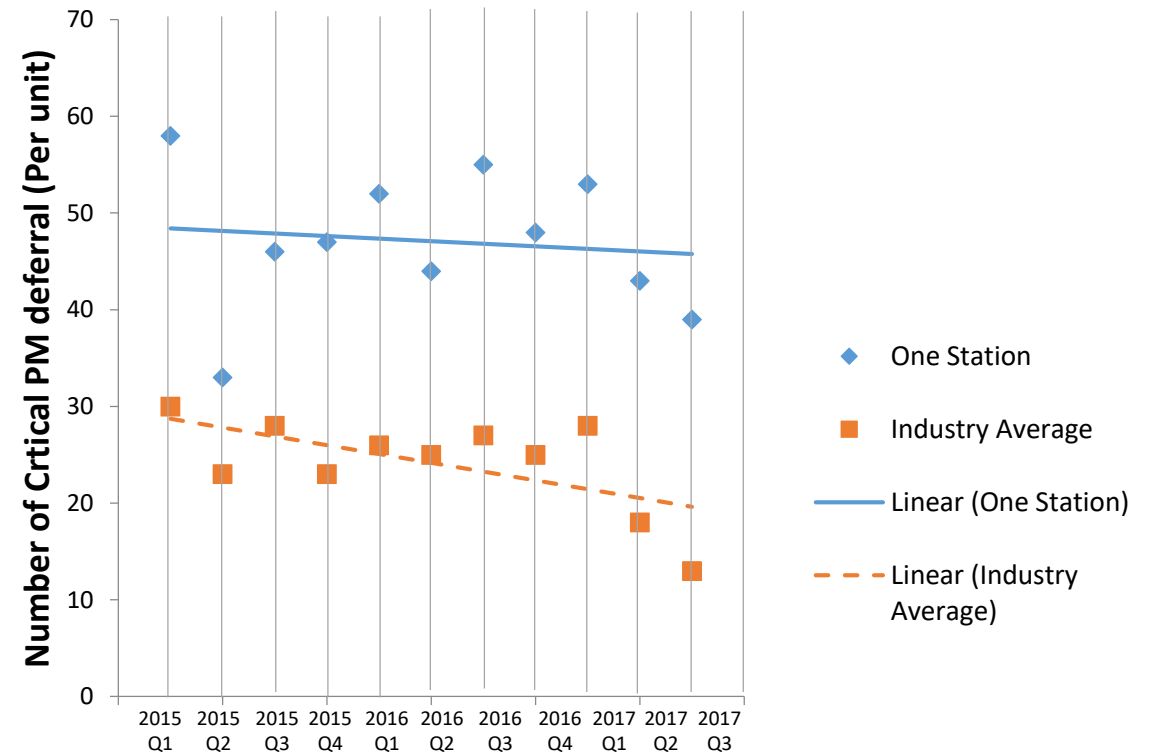
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Example of Assessing Maintenance SPIs for an NPP (1/3)

With up trending and above industry average



2015 Q1 to 2017 Q3 quarterly data (11 quarters)



2015 Q1 to 2017 Q3 quarterly data (11 quarters)



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Example of Assessing Maintenance SPIs for an NPP (2/3)

Quarterly SPI required in REGDOC 3.1.1	Average quarterly work orders per unit				
	2015	2016	2017	3 Year Trending	Industry Average 2017
SPI 14 - Corrective Maintenance Backlog	26	19	10	Down	5
SPI 15 - Deficient Maintenance Backlog	96	109	128	Up	118
SPI 16 - Deferrals of Preventive Maintenance	120	110	45	Down	20

Example:
 One station maintenance backlogs and deferrals for critical components, reported from 2015 to 2017



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Example of Assessing Maintenance SPIs for an NPP (3/3)

Steps followed in the assessment:

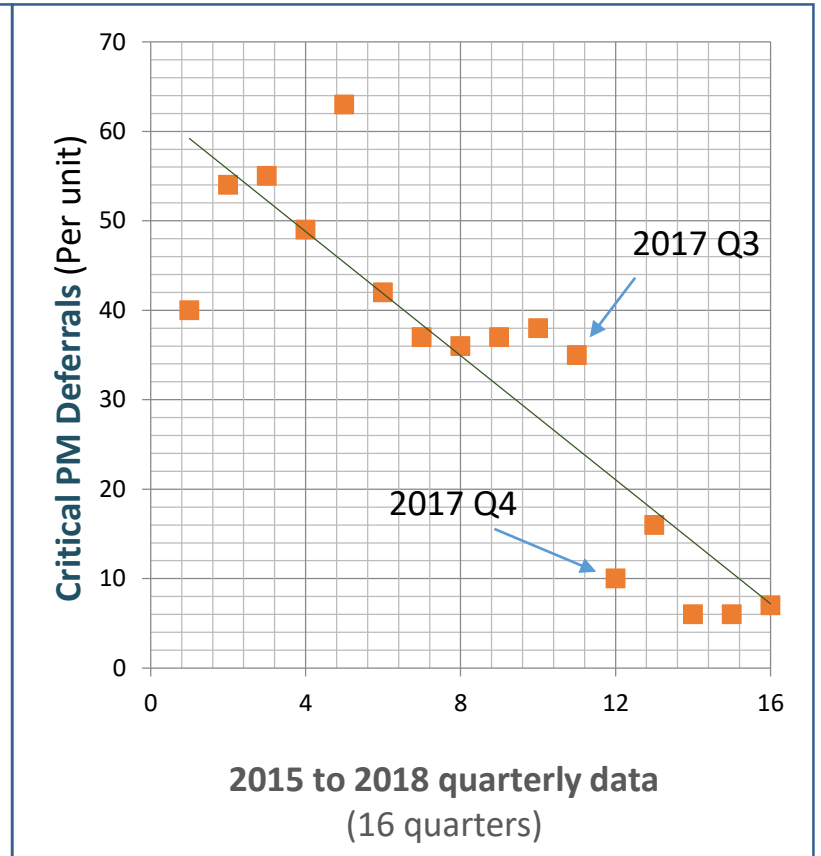
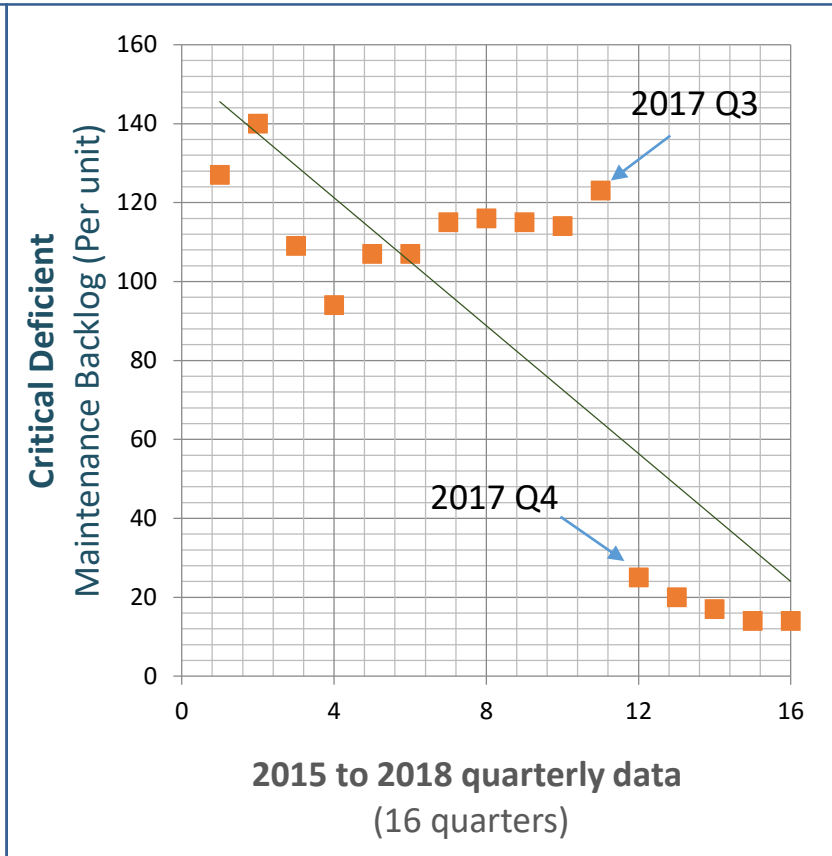
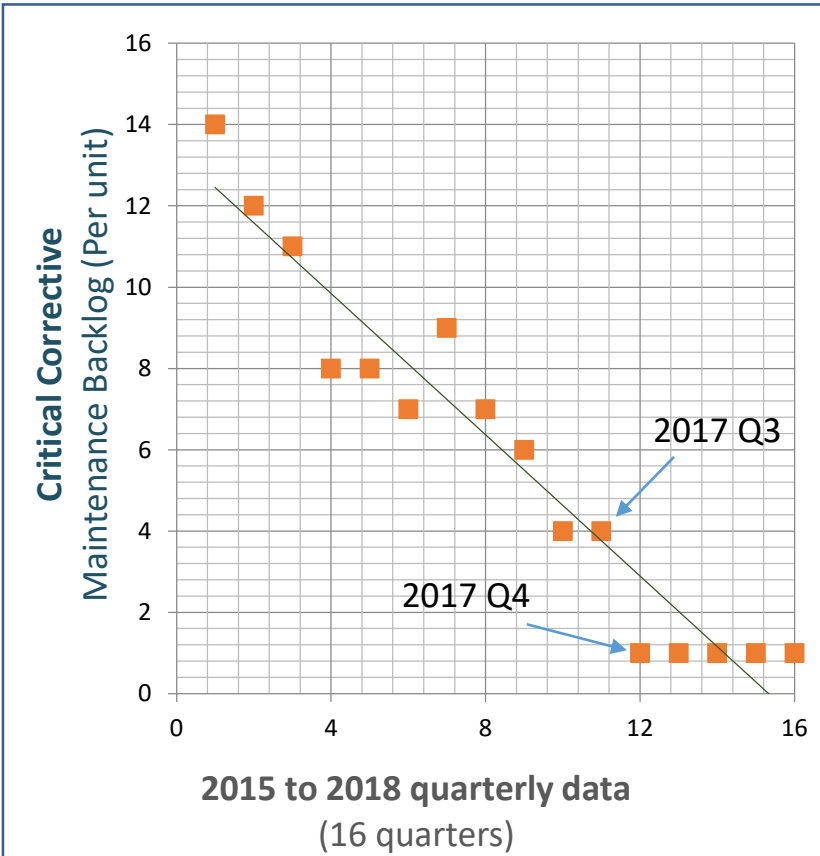
- Observed an up trending of the critical deficient maintenance backlogs
- There was a significantly higher number of critical PM deferrals in this station than the industry average
- Staff conducted a focused review in 2017
- An action item was raised to track the corrective actions to address the findings
- The safety significance of this issue has been determined to be low as safety function was always maintained



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Example of Assessing Maintenance SPIs for Industry (1/3) With significant change since 2017 quarter 4





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Example of Assessing Maintenance SPIs for Industry (2/3)

Steps followed in the assessment:

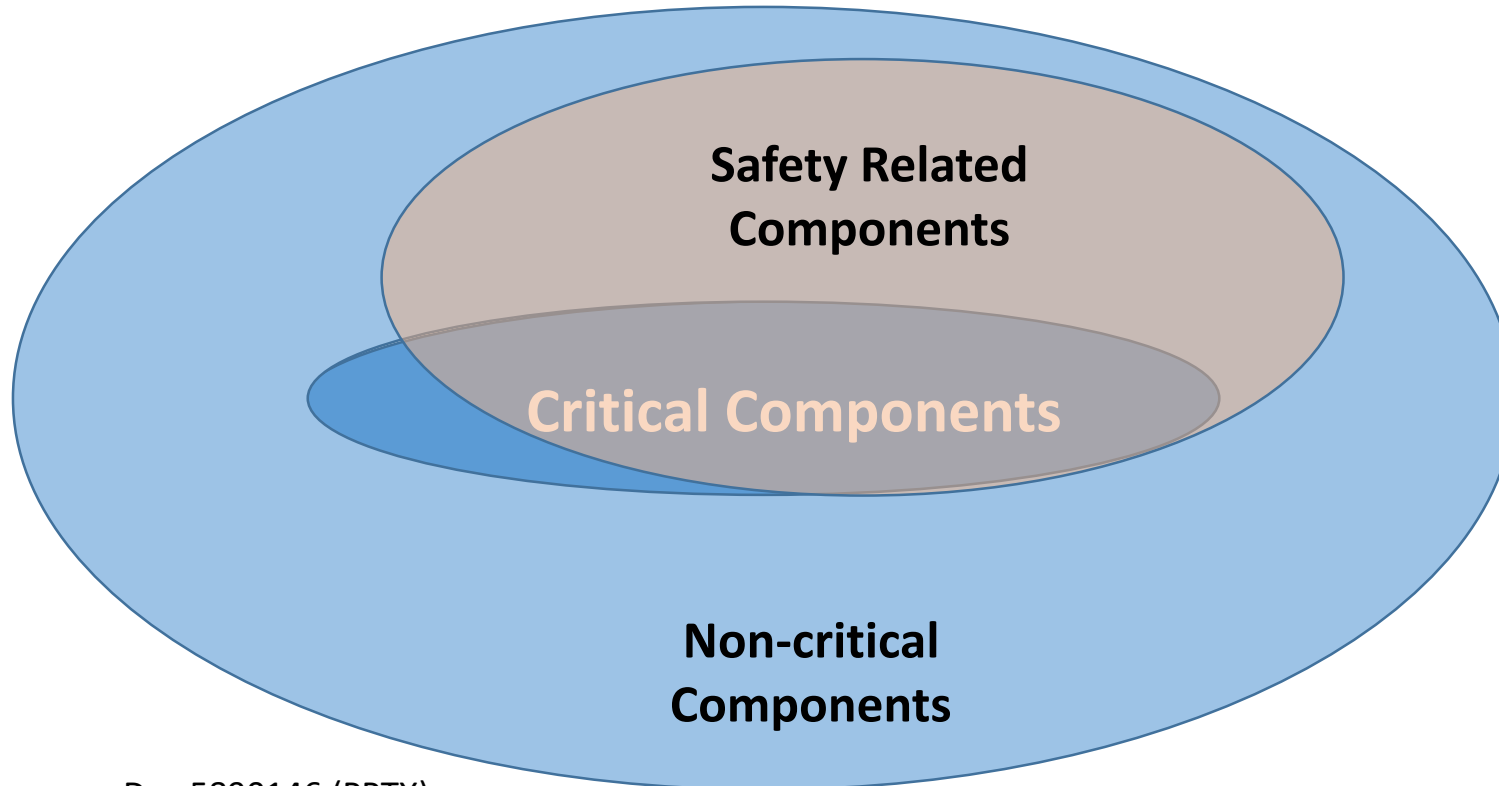
- Observed a significant reduction of maintenance backlogs and number of PM deferrals for critical components since the end of 2017
- Limited explanation was provided by the Industry in the reports about the change
- Staff raised a generic action item in May 2018 for all licensees to provide detailed explanations for the reduction
- Staff confirmed the change was mainly due to component re-categorization
- Safety significance of this issue has been determined to be negligible as the maintenance program itself was not affected by the re-categorization



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Example of Assessing Maintenance SPIs for Industry (3/3)

Relationship of critical, non-critical and safety related components.



- Critical and non-critical components are defined by industry
- Safety related components are the components monitored by CNSC



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Conclusion

CNSC regulatory oversight of maintenance programs at NPPs is systematic, modern, responsive and transparent.

Maintenance oversight is supported by three primary elements:

- Baseline and reactive inspections
- Compliance assessments of licensee submissions, including the **REGDOC-3.1.1** quarterly SPI reports.
- CNSC staff collaboration, surveillance and technical expertise

CNSC Staff continue to conduct oversight of NPP maintenance programs as part of PRRP to ensure Canadian nuclear power plants are safely operated.



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Back-up Slide to Explain the Relationship of Corrective Maintenance and Deficient Maintenance

Corrective maintenance
(Broad definition in slide 15 from REGDOC 2.6.2)

Corrective maintenance
(narrow definition adopted by
industry)

Used for SPI 14 and is only
applicable to failed components

Deficient maintenance
(adopted by industry)

Used for SPI 15 and is only
applicable to degraded but not
completely failed components



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Back-up Slide to Explain the Industry's Brief Definitions of Corrective Maintenance and Deficient Maintenance

Corrective maintenance (CM): any work on a plant component that has failed (or is imminent to failure), therefore cannot perform its design function.

- **Example:** Temperature switch on reactor building chiller failed, which prevents start of chiller.

Deficient maintenance (DM): any work on a plant component that has a potential or actual deficiency that does not threaten the component's design function or performance criteria

- **Example:** Circulating water pump vibration levels are at .376 in/sec., and the alert level begins at .300 in/sec. The action level is .500 in/sec.