2023 Nuclear Benchmarking Report

Safety • Reliability • Value for Money • Human Performance

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Controllership - Business Planning & Benchmarking

ONTARIO POWER GENERATION | Electrifying life

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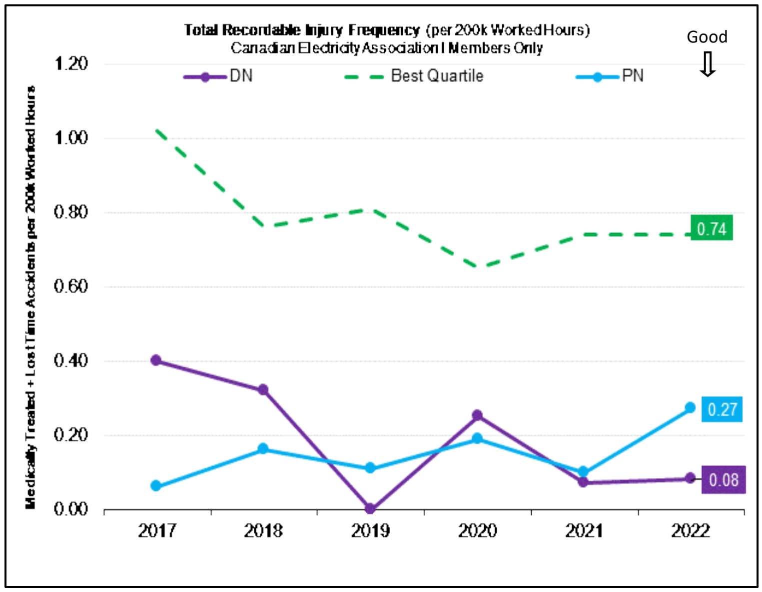
1.0 EXECUTIVE SUMMARY

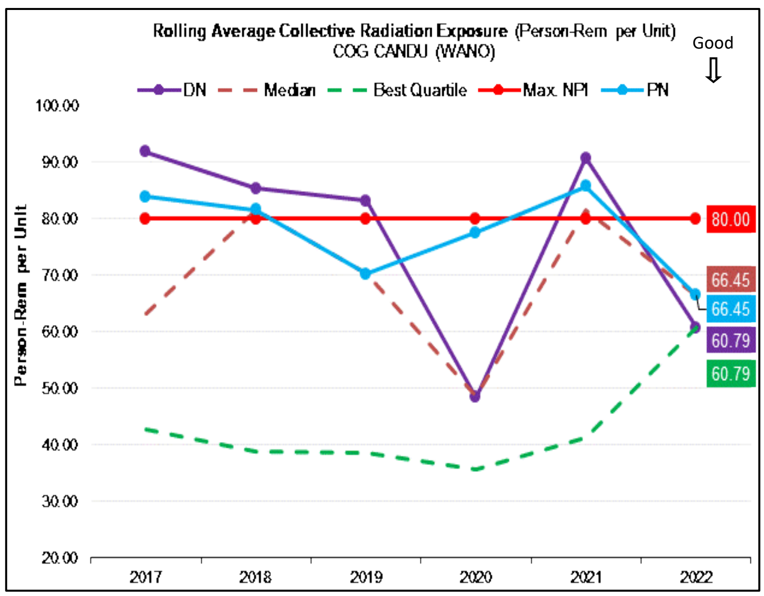
In 2022, Ontario Power Generation (OPG) demonstrated favorable results compared to its peer in number of key areas.

Safety

Total Recordable Injury Rate (TRIF)
Both Darlington Nuclear Generating Station (DNGS) and Pickering Nuclear Generating Station (PNGS) continued a long-standing pattern of excellent TRIF performance by exceeding industry top quartile.
To further strengthen safety performance, OPG continues to build on its Fail-Safe strategy with increased focus on high energy work, sequential control measures, proactive observation, and work planning strategies. In addition, innovative tools were developed and used to recognize and mitigate Significant Injuries and Fatalities (SIF) precursor conditions.

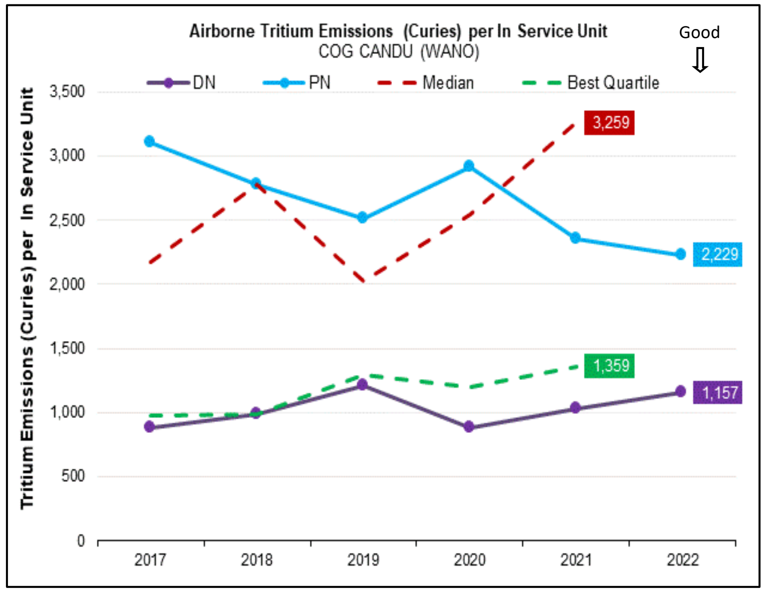


Collective Radiation Exposure (CRE)
DNGS and PNGS improved to achieve maximum Nuclear Performance Index (NPI) in 2022. DNGS' improved performance is due to the planned outage scheduled in 2022 had limited work scope focused on the installation of Mo-99 target delivery system. PNGS' best performance in the last five years is due to work group level focusing on dose reduction efforts (training, skilled staff, mock ups, better use of technology, radiation protection) and work group involvement in the work management process to ensure most effective utilization of shielding strategies.



DNGS and PNGS are utilizing dose reducing Laxness resin and magnetic shielding to reduce hot spot dose rates. PNGS is also utilizing remote monitoring technology to minimize personnel time in radioactive work areas.

Airborne Tritium Emissions

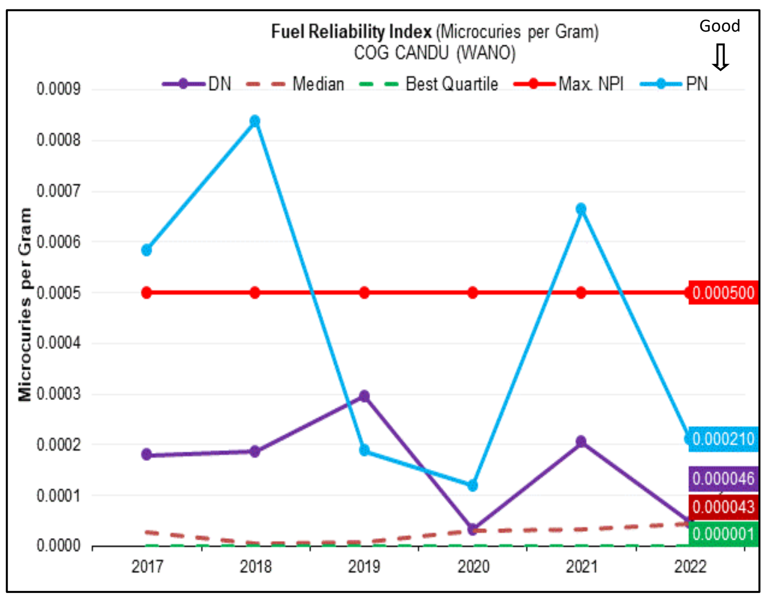


PNGS and DNGS Airborne Tritium Emissions per In Service Unit continues to be less than one percent of regulatory limits.

DNGS continues best quartile performance with only slightly higher emission for DNGS in 2022 compared to 2021 was due to the leak from Unit 2 outage related activities, and Unit 4 leaks/drier issues. PNGS continues to improve performance and performed better than industry Median.

Both sites have continued tritium reduction activities driven by a High Impact Team (HIT) which focuses on day-to-day tritium reduction activities such as heavy water leaks and repairs, drier performance, etc. In addition, collaboration to exchange operating experience, innovation activities on tritium mitigation, enhanced management oversight and communication of priorities to focus tritium reduction activities are communicated daily at the Integrated Station Brief (ISB) meetings.

Fuel Reliability Index (FRI)



DNGS continued to achieve maximum Nuclear Performance Index (NPI) points in 2022. PNGS improved from 2021 to achieve maximum Nuclear Performance Index (NPI) in 2022 as well.

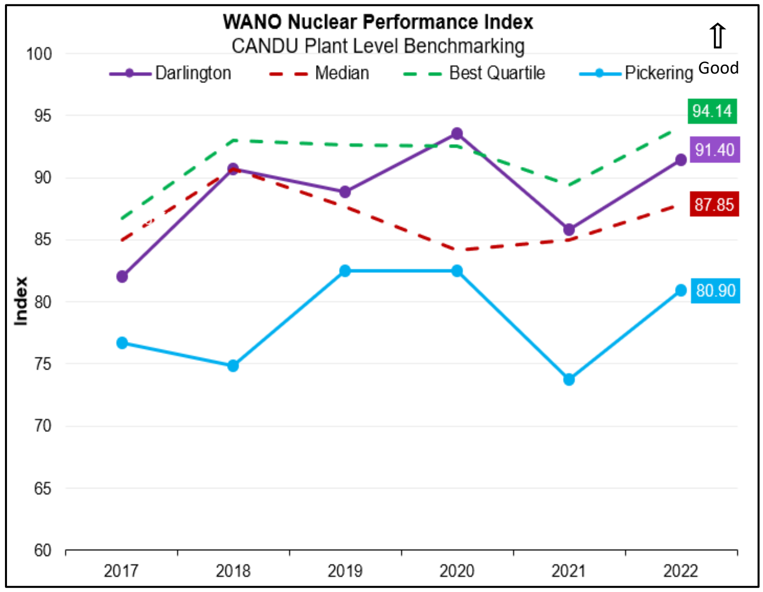
Zero fuel defects were observed for DNGS in 2022. Two fuel defects for PNGS were confirmed in 2022 which were due to debris fretting.

Continual focus on improving FRI performance by preventing potential fuel defects includes completing the fuel design manual and drawing update, controlling the manufacturing process, fuel operating, fuel handling and fuel performance limits. PNGS is also improving methods of surveillance and eliminating foreign materials from entering the Heat Transport System due to Fuel Handling and Outage practices.

The five other safety-related metrics at DNGS and PNGS were favourable and achieved green ratings in 2022. Both DNGS and PNGS achieved maximum World Association of Nuclear Operators (WANO) NPI results and best quartile performance for all NPI Safety sub-metric.

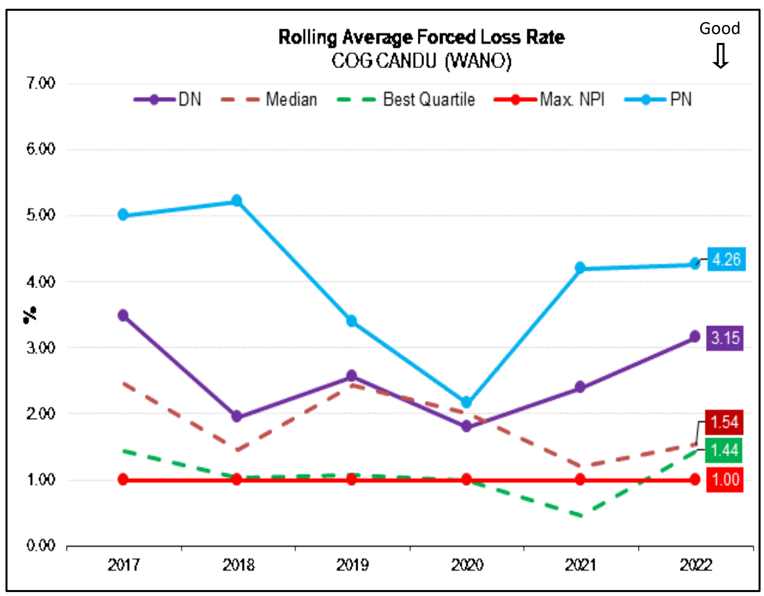
Reliability

Nuclear Performance Index (NPI)
In 2022, DNGS performance improved achieving second quartile due to improved performance for all seven of the safety metrics.



PNGS performance improved to third quartile, compared to fourth in 2021 due to Unit Capability Factor (UCF) and Forced Loss Rate (FLR) improving performance. PNGS' third quartile performance also reflects the need for extended outages to accommodate fuel channel inspection programs, which impacts UCF, Collective Radiation Exposure (CRE) and Chemistry Performance Index (CPI) Metrics.

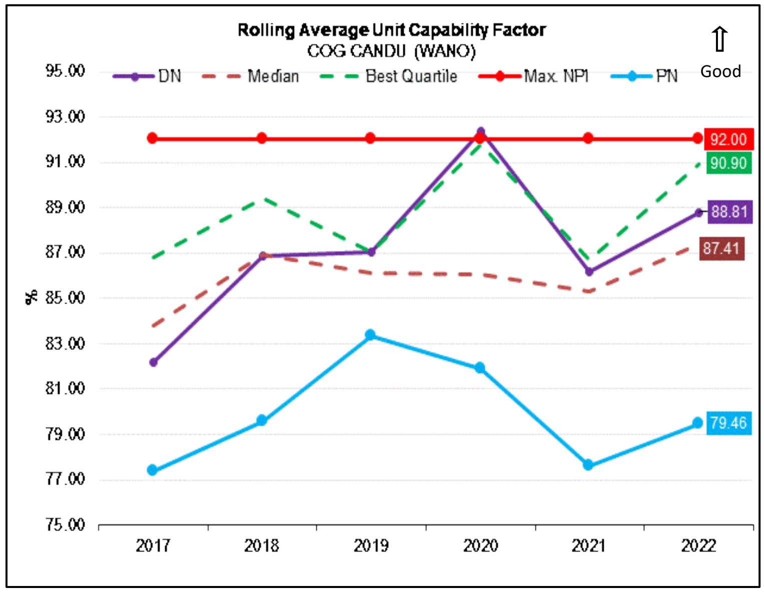
Forced Loss Rate (FLR)
Both DNGS and PNGS experienced an increase in FLR in 2022 due to forced outages.



PNGS experienced three forced outages while DNGS experienced one forced outage, resulting in third and forth quartile performance at PNGS and DNGS, respectively.

Fuel handling contribution reduced in 2022 and remains a focus area to build sustainability. Focused initiatives including vulnerability identification and elimination, equipment monitoring, proficiency building and project execution at both stations to increase Turbine Generator Reliability.

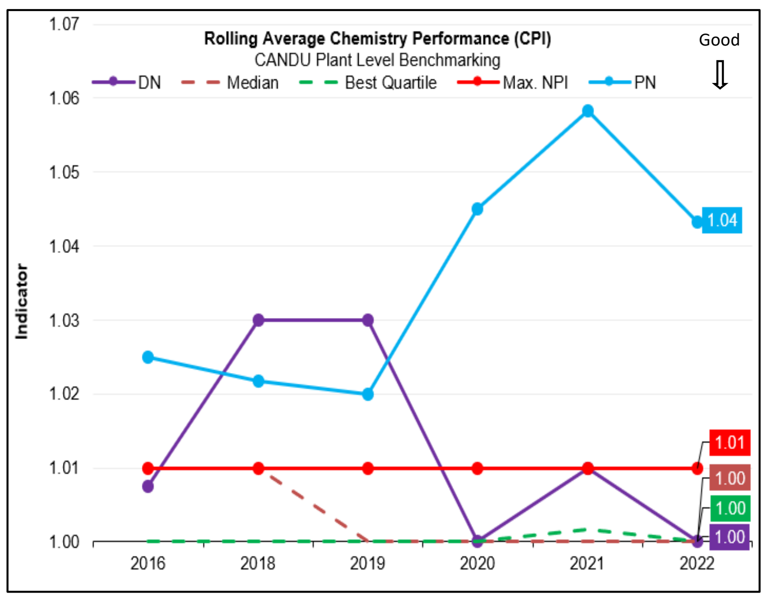
Unit Capability Factor (UCF)



In 2022, DNGS remained in second quartile and PNGS remained in fourth quartile. PNGS' forced loss events decreased through 2022, which had positive impact on performance compared to 2021, partially offset by maintenance outage execution. DNGS' forced loss events increased in 2022, which negatively impacted performance.

Fuel handling contribution reduced in 2022 and remains a focus area to build sustainability. Focused initiatives including vulnerability identification and elimination, equipment monitoring, proficiency building and project execution at both stations to increase Turbine Generator Reliability.

Chemistry Performance Index (CPI)



PNGS received perfect CPI scores of 1.00 for four consecutive quarters in 2022 due to Gaps Drivers Actions Results (GDAR) implementation. Declined performance in 2019-2021 was primarily caused by start-up boiler sulfates due to turbine maintenance activities during outage, and condenser tube leak resulted in elevated boiler ions.

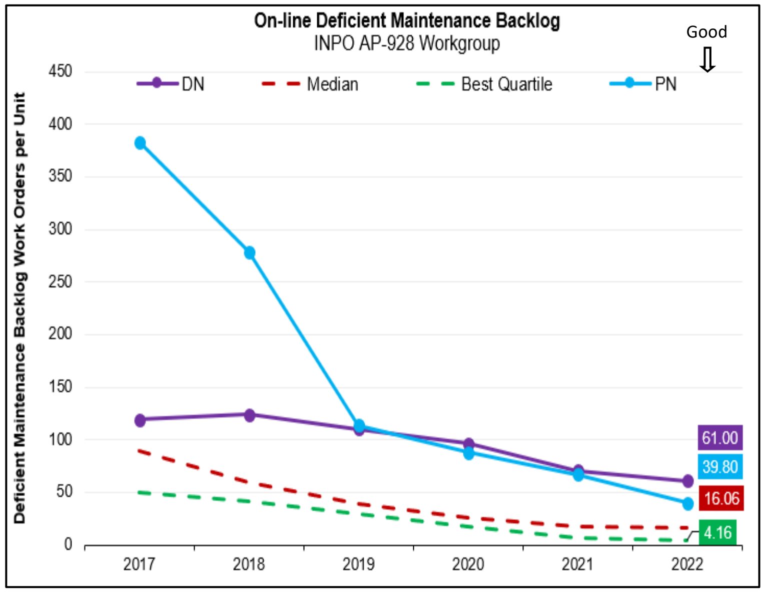
DNGS received CPI scores of 1.00 and achieved maximum Nuclear Performance Index (NPI) in 2022. The slight decline prior to 2021 can be attributed to elevated feedwater corrosion product transport post unit start-ups.

DNGS and PNGS continue to have a Chemistry Outage Single Point of Contact (SPOC) to provide improved coordination/planning such that system chemistry control is improved during outages/start-ups.

On-Line Deficient Maintenance Backlog and Deficient Critical Backlog

The favourable trend for Backlog performance at PNGS continued into 2022, with significant improvements for On-line Deficient Maintenance Backlogs (40% improvement) compared to 2021 results.

DNGS improved their On-line Deficient Maintenance Backlog by 13% and Deficient Critical Backlog improved to reach a top quartile score of 0 as a result of continued station focus, overall maintenance efficiency and improved schedule quality.



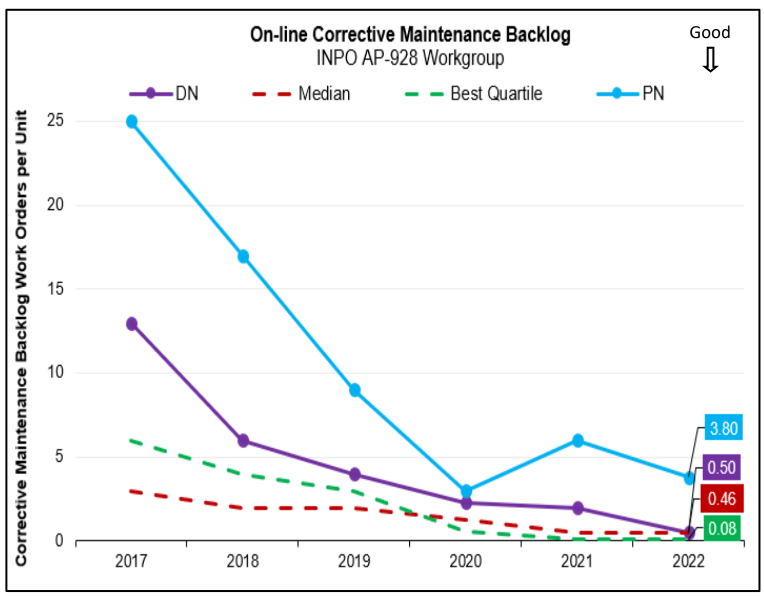
Deficient Maintenance Backlog (shown in the chart) is the sum of Deficient Critical Backlog and Deficient Non-Critical Backlog.

On-Line Corrective Maintenance Backlog and Corrective Critical Backlog

PNGS On-line Corrective Maintenance Backlog performance improved in 2022 due to decreases in the Corrective Non-Critical Backlogs.

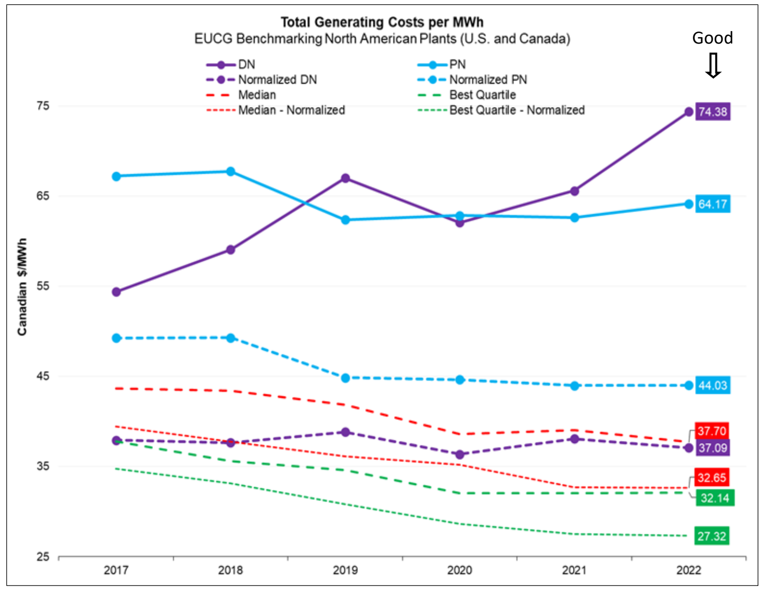
DNGS remained in the first quartile for the Corrective Critical Backlogs and maintained their On-line Corrective Maintenance Backlog performance from 2021.

Corrective Maintenance Backlog (shown in the chart) is the sum of Corrective Critical Backlog and Corrective Non-Critical Backlog.



Value for Money

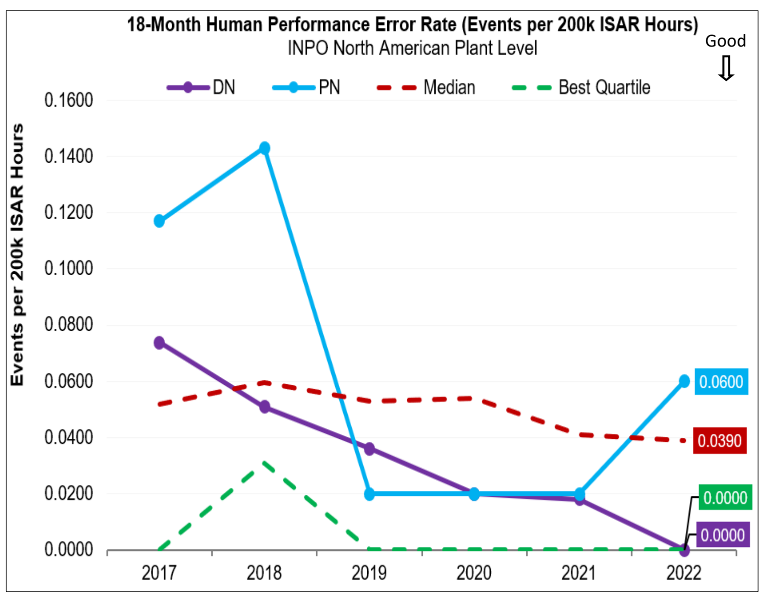
TGC/MWh
In 2022, normalized Total Generating Cost per Megawatt-hour (TGC/MWh) performance remained in the third quartile for DNGS and the fourth quartile for PNGS after normalizing[1] for refurbishment, technology including outage duration and age-related impacts.



DNGS normalized performance was impacted by reduced capital costs associated with Units 1 and 3 being in refurbishment outages and no planned outages in 2022, partially offset by reduced generation from the refurbishment outages.
PNGS normalized performance reflects continued reduction in capital investment as the station approaches shut-down in 2024/2026 (pending Canadian Nuclear Safety Commission (CNSC) approval).

Human Performance

Human Performance Error Rate In 2022 DNGS did not experience any Site Event Free Day Reset (S-EFDR)s, and improved from last year, achieving best quartile performance. PNGS experienced 2 S-EFDRs which contributed to third quartile performance. The event causes were identified, and corrective actions implemented to address the gaps.



Human performance continues to be a focus across the fleet with actions taken to further improve performance by continuously improving the Observation & Coaching program including revision to CORE 4+ as well as integration of Fail Safe strategies and trending processes to strengthen values and behaviours of Nuclear Professionals.

[1] See section 4.0 for more information about the TGC/MWh normalization methodology.

Benchmarking Results – Plant Level Summary

Table 1 provides a complete summary of 2022 performance compared to benchmark results.

Table 1: Plant Level Performance Summary

Metric	2022 Actuals					
	NPI Max	Best Quartile	Median	Third Quartile	Pickering	Darlington
Safety						
Total Recordable Injury Frequency (#/200k hours worked)		0.74	1.50	1.98	0.27	0.08
Rolling Average[2] Industrial Safety Accident Rate (#/200k hours worked)[1]	0.20	0.00	0.00	0.06	0.02	0.00
Rolling Average[2] Collective Radiation Exposure (Person-rem per unit)[1]	80.00	60.79	66.45	91.92	66.45	60.79
Airborne Tritium Emissions (Curies) per Unit [3]		1,359	3,259	5,723	2,229	1,157
Fuel Reliability (microcuries per gram)[1]	0.000500	0.000001	0.000043	0.000142	0.000210	0.000046
2-Year Reactor Trip Rate (# per 7,000 hours)[1]	0.500	0.000	0.000	0.140	0.140	0.000
3-Year Auxiliary Feedwater System Unavailability (#)[1]	0.0200	0.0000	0.0010	0.0070	0.0070	0.0000
3-Year Emergency AC Power Unavailability (#)[1]	0.0250	0.0003	0.0011	0.0037	0.0102	0.0000
3-Year High Pressure Safety Injection Unavailability (#)[1]	0.0200	0.00000	0.00000	0.00010	0.0000	0.0000
Reliability						
Rolling Average[2] WANO NPI (Index)[1]		94.14	87.85	76.81	80.90	91.40
Rolling Average[2] Forced Loss Rate (%)[1]	1.00	1.44	1.54	3.28	4.26	3.15
Rolling Average[2] Unit Capability Factor (%)[1]	92.00	90.90	87.41	81.21	79.46	88.81
Rolling Average[2] Chemistry Performance Indicator (Index)[1]	1.01	1.00	1.00	1.01	1.04	1.00
1-Year Online Deficient Maintenance Backlog (work orders per unit) [1]		4.16	16.06	22.63	39.80	61.00
1-Year Online Deficient Critical Backlog (work orders per unit) [1]		0.00	0.06	0.28	0.80	0.00
1-Year Online Deficient Non-Critical Maintenance Backlog (work orders per unit) [3]		4.16	16.06	22.63	39.80	61.00
1-Year Online Corrective Maintenance Backlog (work orders per unit) [1]		0.08	0.46	1.14	3.80	0.50
1-Year Online Corrective Critical Backlog (work orders per unit) [1]		0.00	0.00	0.00	0.00	0.00
1-Year Online Corrective Non-Critical Backlog (work orders per unit) [3]		0.08	0.46	1.14	3.80	0.50
Value for Money						
3-Year Total Generating Costs per MWh ($ per Net MWh) [1]		32.14	37.70	46.86	64.17	74.38
Normalized 3-Year Total Generating Cost per MWh ($ per Net MWh)		27.32	32.65	40.07	44.03	37.09
3-Year Total Generating Cost per Unit (M $ per Unit)		268.72	303.33	347.35	224.67	509.77
Normalized 3-Year Total Generating Cost per Unit (M $ per Unit)		230.95	271.25	312.71	166.16	218.74
3-Year Non-Fuel Operating Costs per MWh ($ per Net MWh) [1]		19.15	23.53	30.10	57.17	50.80
3-Year Normalized Non-Fuel Operating Cost per Net MWh ($/MWh)		19.15	23.53	30.10	--	39.17
3-Year Fuel Costs per MWh ($ per Net MWh)[1]		6.14	6.87	7.59	3.79	4.05
3-Year Capital Costs per MW DER (k$ per MW)[1]		30.85	53.15	96.02	21.84	147.91
Normalized 3-Year Capital Cost per MW DER (k$ per MW)		30.85	53.15	96.02	--	91.08
Human Performance						
18-Month Human Performance Error Rate (# per 200k ISAR and contractor hours) [1]		0.0000	0.0390	0.0620	0.0600	0.0000

1. Best Quartile, Median and Third Quartile are from Q4 2022 best available information.
2. Indicates a 2-Year Rolling Average for Pickering and a 3-Year Rolling Average for Darlington.
3. Best Quartile, Median, Third Quartile are from the Q4 2021 which is the most current available benchmark for these metrics.

Legend

4th Quartile Performance	3rd Quartile Performance	2nd Quartile Performance	Maximum NPI points achieved or Best Quartile

Background

This report presents a comparison of OPG Nuclear's performance to that of nuclear industry peer groups. Benchmarking results are used during business planning to drive top-down target setting with business improvement as the objective.

Performance Indicators

Good performance indicators used for benchmarking are metrics with standard definitions, reliable data sources, and utilization across a representative portion of the industry. Good indicators allow for benchmarking to be repeated year after year in order to track performance and improvement. Additionally, when selecting an appropriate and relevant set of metrics, a balanced approach covering all key areas of the business is essential. In accordance with these criteria, key performance indicators have been selected for comparison to provide a balanced view of performance and for which consistent, comparable data is available. These indicators are defined in Section 6.0.

Each indicator reflects a particular duration of historical performance in accordance with peer group expectations. For example, Electric Utility Cost Group (EUCG) data for Value for Money metrics are based on three-year average performance, whereas WANO NPI safety and reliability metrics reflect multi-year rolling averages based on each station's outage cycle. For NPI metrics, Darlington and Pickering's results reflect a three-year and two-year outage cycle, respectively.[2]

Industry Peer Groups

Peer groups were selected based on performance indicators widely utilized within the nuclear industry. Overall, six different peer groups were used as illustrated in Table 2 of Section 6.0 and panel members are detailed in Tables 3 to 8 of Section 6.0.

Report Structure

Sections 2.0 to 5.0 of the report focus on safety, reliability, value for money and human performance areas.

The Major Operator Section (historically Section 6.0) was removed from this report, consistent with ScottMadden's recommendations with respect to streamlining the report and ensuring consistency with leading practices and value for stakeholders. The Major Operator section provided a fleet operator level summary across a few key metrics, primarily across North America, utilizing a simple average of the results (mean) from each of their units/plants. While the operator level summary can be informative, it is more appropriate to look at OPG's two nuclear facilities individually given that they are at different stages of their lifecycle, have different sized units and reflect different generations of CANDU technology. This view is aligned with ScottMadden's most recent evaluation OPG Nuclear Benchmarking. The detailed data in sections 2.0 to 5.0 of the report provides a more complete picture of OPG's performance.

Section 6.0 provides an appendix of supporting information, including common acronyms, definitions, peer group and panel composition details.

[2] The planned outage cycle for each unit at Pickering is transitioning from a 24-month to a 30-month outage cycle. Pickering continues to assume a 24-month rolling average for benchmarking to be consistent with WANO reporting expectations.

2.0 SAFETY

Methodology and Sources of Data

The majority of safety metrics were calculated using data from WANO. Data labelled as invalid by WANO were excluded from all calculations. Indicator values of zero are not plotted or included in calculations except in cases where zero is a valid result. Current data was obtained and consolidated with previous benchmarking data.

The WANO Nuclear Performance Index (NPI), a maximum score of 100 is possible. The WANO NPI is an operational performance indicator comprised of 10 metrics, 7 of which are analyzed in this section:

- Industrial Safety Accident Rate (ISAR) [Rolling Average]
- Collective Radiation Exposure (CRE) [Rolling Average]
- Fuel Reliability Index (FRI) [Annual]
- 2-Year Unplanned Automatic Reactor Trips
- 3-Year Auxiliary Feedwater Safety System Performance Unavailability
- 3-Year Emergency AC Power Safety System Performance Unavailability
- 3-Year High Pressure Safety Injection Unavailability

The remaining three WANO NPI metrics are included in the Reliability Section (Section 3.0).

Note: To benchmark performance, Max NPI is used to indicate best quartile performance for metrics that perform better than the Max NPI benchmark. If metric performance is not better than Max NPI, quartile benchmarks are used to benchmark performance.

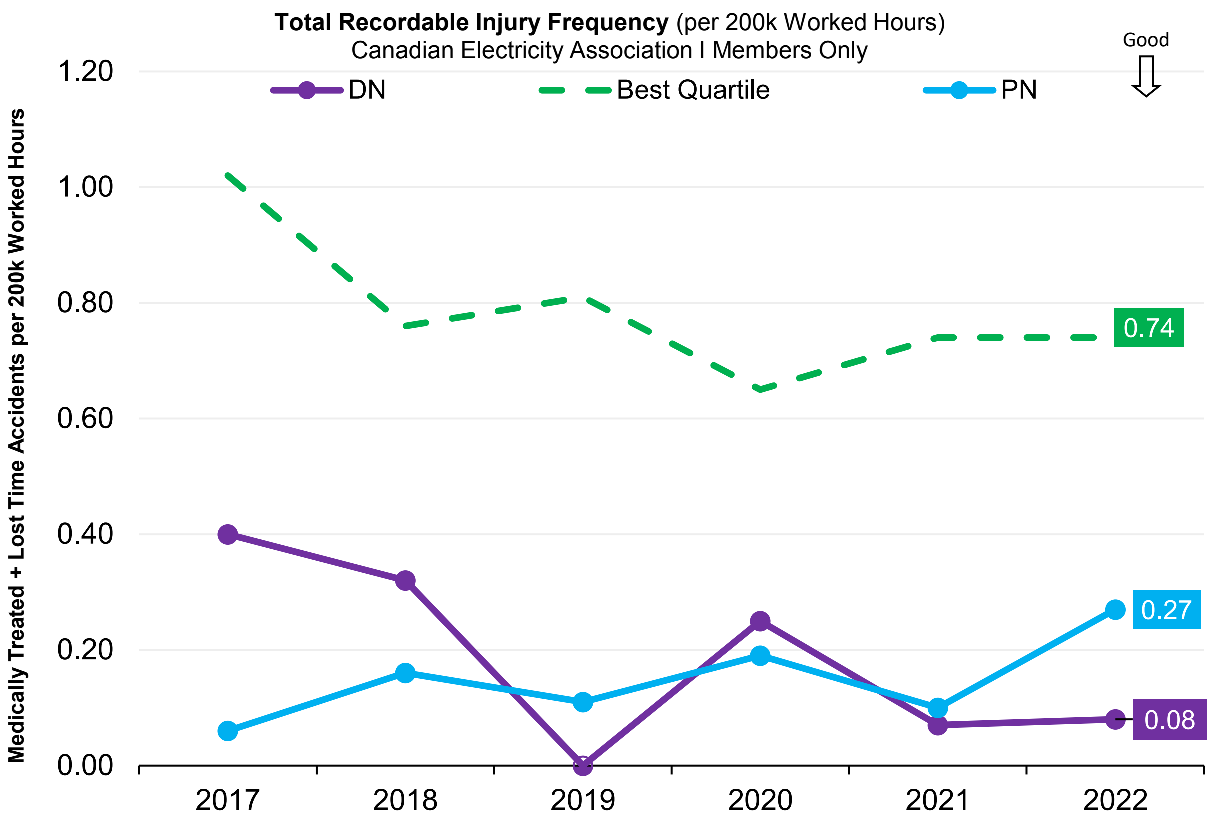
In addition to the WANO NPI safety sub-indicators listed above, Total Recordable Injury Frequency and Airborne Tritium Emissions per In Service Unit are included in this section of the report.

Total Recordable Injury Frequency (TRIF) was calculated using data from the Electricity Canada (EC). Median information and individual company information are not available for this metric. Therefore, only trend and best quartile information have been presented. The peer group are members of Electricity Canada (EC) (Section 6.0, Table 6).

- OPG benchmarks against EC Group 1 peers (a subset of all EC members), which incorporates organizations with more that 1,500 employees, including most provincial utilities, leveraging EC's Occupational Health & Safety Statistics 2022 Report.

Airborne Tritium Emissions per In Service Unit data was collected from the CANDU Owners Group (COG). The peer group for this metric is all CANDUs who are a member of COG. There is a one-year lag for the industry values associated with this metric.

Total Recordable Injury Frequency (TRIF)



Note: Annual Value

	2022 Value
DN	0.08
PN	0.27
Best Quartile	0.74

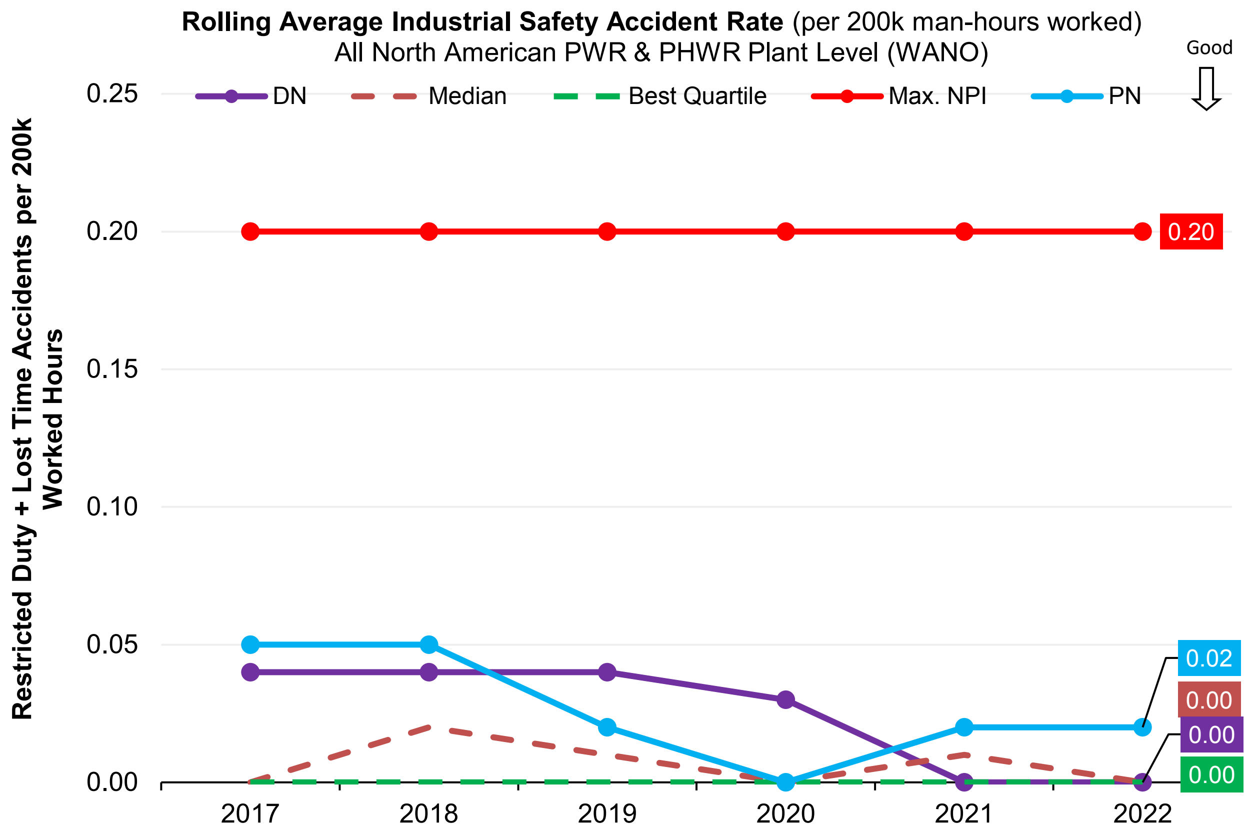
Factors Contributing to Performance

- DNGS and PNGS continued a long-standing pattern of excellent TRIF performance by exceeding the industry top quartile (top 25%) mark of 0.74 and top decile (top 10%) mark of 0.56, where DNGS reached 0.08 and PNGS achieved 0.27.

Initiatives to Improve and Sustain Favorable Performance Include:

- OPG continues to build upon its Fail-Safe paradigm shift by focusing on establishing and fortifying the capacity to mitigate the consequences of adverse events in the workplace. With a spotlight on safety fundamentals, work planning and execution, high-energy work, OPG's aim is to eliminate Significant Injuries and Fatalities (SIF). Over the past year OPG has prioritized the infusion of innovation into work planning and reporting processes (i.e., electrification of process, facilities utilizing advanced metrics and analytics) to enable early recognition and mitigation of SIF precursor conditions. These efforts are aimed at leading OPG to world-class safety performance.

Rolling Average Industrial Safety Accident Rate (ISAR) * +



* *Sub-indicator for WANO NPI*

\+ *2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)*

	2022 Value
DN	0.00
PN	0.02
Best Quartile	0.00
Median	0.00

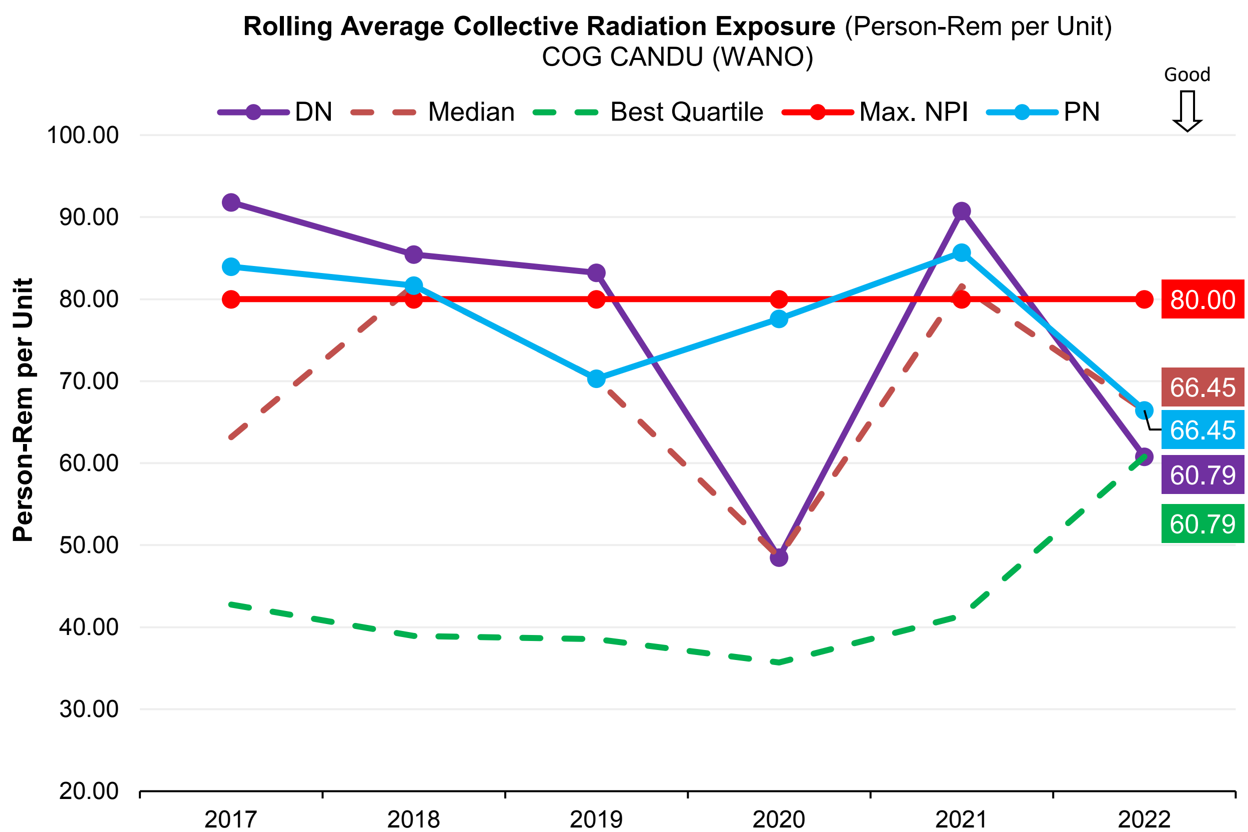
Factors Contributing to Performance

- DNGS and PNGS continued to achieve maximum Nuclear Performance Index (NPI) points in 2022.
- DNGS achieved top quartile performance with zero ISAR events during the 3-year rolling average reporting period.
- PNGS' performance was impacted by one event in 2021 leading to an increased rate for the 2-year rolling average reporting period.

Initiatives to Improve and Sustain Favourable Performance Include:

- OPG continues to focus on implementing the "Fail Safe" health and safety program, which focuses on high energy work, sequential control measures, event learning and various strategies:
    - Modernization of safety metrics to incorporate leading and monitoring metrics for early intervention includes the implementation of Quality of Safety Practices (QSP) which monitors high and low energy conventional safety risks to identify vulnerability and opportunities to increase capacity by implementing controls.
    - Development of Electronic Safe Work Plans (eSWPs) to assess the quality of direct controls implemented to address high-energy hazards within safe work plans.
    - Implementation of the safety classification and learning model to identify learning opportunities based on event classification and presence of direct controls.
    - Enhancing the oversight program consisting of a graded approach that monitors performance for prevention and early intervention by increasing oversight to address behaviours and/or program deficiencies through Observation & Coaching (O&C), metrics and events.

Rolling Average Collective Radiation Exposure (CRE) * +



* *Sub-indicator for WANO NPI*

\+ *2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)*

	2022 Value
DN	60.79
PN	66.45
Best Quartile	60.79
Median	66.45

Factors Contributing to Performance

- DNGS and PNGS improved from 2021 to achieve maximum Nuclear Performance Index (NPI) points in 2022
- DNGS' performance improved due to the 2022 planned outage scheduled had limited work scope focused on the installation of Mo-99 target delivery system.
  - One forced outage contributed to industry best quartile performance for CRE in 2022.
  - Major work programs involved repairs on feeder instrument lines, intercept stop valves and installation of Mo-99 target delivery system.

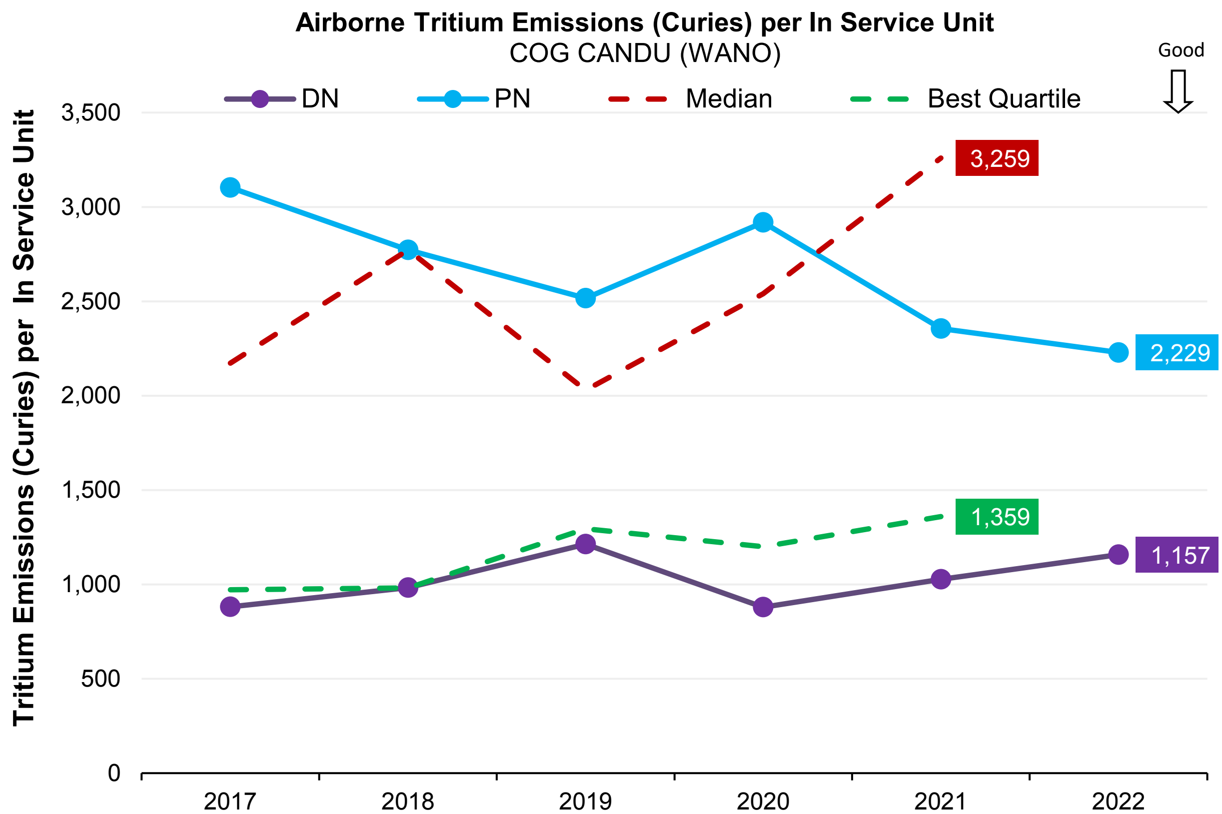
- PNGS best performance in the last five years is due to work groups level focusing on dose reduction efforts such as training, skilled staff, mock ups, better use of technology as well as Radiation Protection and work group involvement in the work management process to ensure most effective utilization of shielding strategies.
  - Three major planned outages, one unbudgeted planned outage, four forced outages, and one forced extension to a planned outage
  - Major work programs involved fuel channel shift, feeder and boiler inspections, single fuel channel replacement, grayloc leak repairs, removal of shutoff absorber rods, and vacuum structure inspections and repairs.
  - A first in a while evolution of the vacuum building outage was performed. Dose performance was lower than planned due to utilization of drone technology for inspections, work planning, training, and improved tooling.

Initiatives to Improve and Sustain Favourable Performance Include:

- DNGS continues to place emphasis on these initiatives and practices to reduce exposures:
  - Upcoming deployment of Rapid Delivery Machine (RDM) for automated fuel channel inspections during outages to eliminate personnel on the reactor maintenance platform and minimize collective dose.
  - Implementation of source term controls such as dose reducing Laxness resin in the purification systems, permanent isolation of containment equipment D_2O circulation supply lines, development and testing of ultrasonic technology to remove hot spots, and monitoring programs to detect changes in station's radiation source term.
  - Modification of Emergency Coolant Injection (ECI) lines to facilitate installation of magnetic shielding to reduce hot spot dose rates during outages.

- PNGS continues to improve performance by utilizing the following practices:
  - Use of remote monitoring technology for radioactive work planning, inspections and in access-controlled areas. This practice has been contributing to minimizing personnel dose and facilitating in leak detection for grayloc repairs (i.e., Drones).
  - Implementation of specialized source term reduction agents (i.e., Lanxess resin).
  - Implementing enhanced oversight from Radiation Protection (RP) staff on all radiological tasks.
  - Increasing focus on leak repairs and use of magnetic shielding.

Airborne Tritium Emissions



Notes:
- Annual Value
- Median and Best Quartiles are plotted until 2021 as the 2022 results were unavailable at the time of benchmarking (one-year lag).
- Darlington values exclude Tritium Removal Facility emissions consistent with COG benchmark results and associated West Annex, Unit 1 and Unit 3 refurbishment periods, and the Retube Waste Processing Building (RWPB).

	2022 Value
DN	1,157
PN	2,229
Best Quartile	1,359
Median	3,259

Factors Contributing to Performance

- Both sites have continued tritium reduction activities driven by a High Impact Team (HIT) which focuses on day-to-day tritium reduction activities such as heavy water leaks and repairs, drier performance, continued management oversight and communication of priorities, utilized enhanced monitoring system station wide to provide real-time tritium monitoring capability.

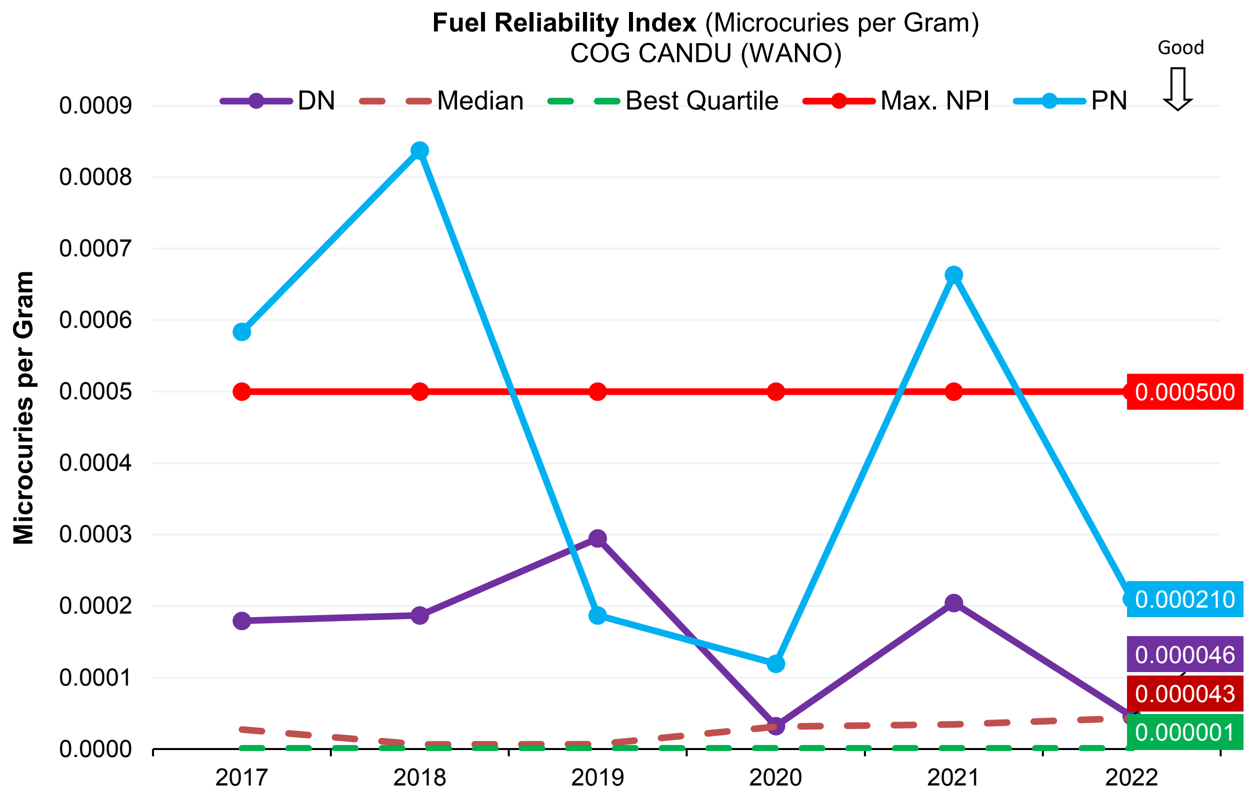
- DNGS continues to achieve industry best quartile performance. This was mainly attributed to efforts by the High Impact Team. The slightly higher emission in 2022 compared to 2021 was mainly due to the leak from Unit 2 outage related activities, and Unit 4 leaks/drier issues.

- PNGS continues to improve performance and performed better than the industry median threshold. The continued significant improvement in performance can be attributed to efforts by a High Impact Team as well as effectiveness of the newly installed Tritium Microscrubber on Unit 4, Operations timely response to equipment leaks clean up minimizing airborne impact.

Initiatives to Improve and Sustain Favourable Performance Include:

- Ongoing dedicated teams at both sites to enhance focus on tritium sources identification and elimination, including drier performance, heavy water leaks and repair.
- Collaboration to exchange operating experience and innovation activities on tritium mitigation, enhanced management oversight and communication of priorities to focus tritium reduction activities daily at the Integrated Station Brief (ISB) meetings.
- Source term reduction on heat transport and moderator water.
- Ongoing participation in COG environmental benchmarking of participating CANDU stations to determine best environmental practices.

Fuel Reliability Index (FRI) *



* *Sub-indicator for WANO NPI*
Note: 2022 Most Recent Operating Quarter

	2022 Value
DN	0.000046
PN	0.000210
Best Quartile	0.000001
Median	0.000043

Factors Contributing to Performance

- DNGS continued to achieve maximum Nuclear Performance Index (NPI) points in 2022.
- PNGS improved from 2021 to achieve maximum Nuclear Performance Index (NPI) points in 2022 as well.
- Zero fuel defects were observed at DNGS in 2022.
- Two fuel defects were confirmed at PNGS in 2022. Following discharge of the defected fuel bundles subsequent inspection in the irradiated fuel bays indicated that the defects were due to debris fretting.

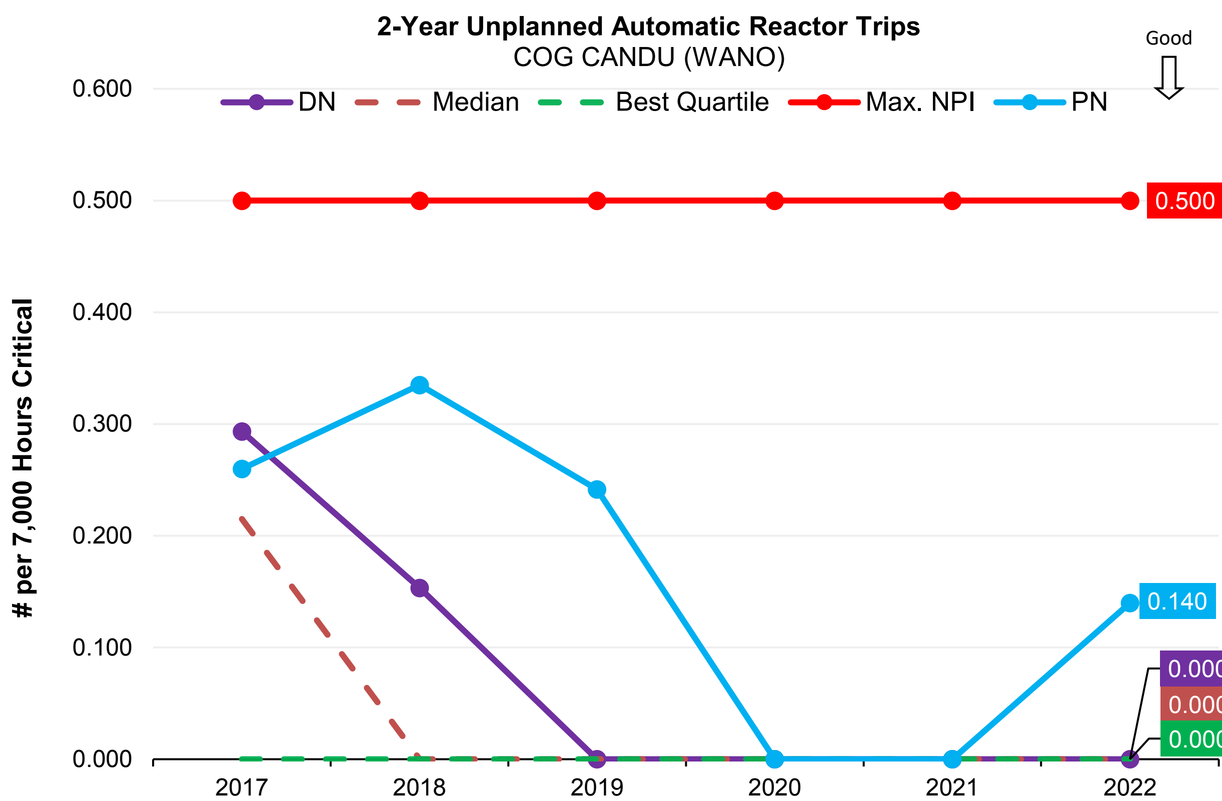
Initiatives to Improve and Sustain Favourable Performance Include:

- Both sites completed the fuel design manual and drawing update process. These documents strictly control the manufacturing process, fuel operating limits, fuel handling limits and the fuel performance limits.

- DNGS improvement initiatives include:
  - Foreign Material Exclusion practices have been improved as shown by the low number of fuel defects following the DNGS reactor refurbishment activities.
  - Producing new fuel with tighter manufacturing tolerances continues to be effective at eliminating certain modes of fuel defecting following fueling runs.

- PNGS improvement initiatives include:
  - Increasing scope of Heat Transport System (HTS) grab sampling and analysis when defects are in-core, continues to assist station in earlier detection.
  - Improving the methods of surveillance and elimination of the possibility of foreign materials entrance into the HTS due to Fuel Handling and Outage practices continues to mitigate entrance of micro-debris.
  - Improving and sustaining awareness of impact of foreign material in the Primary Heat Transport System (PHTS) on fuel performance.
  - Improving capability in Units 5 to 8 of detecting the defected fuel bundles during the discharge from the fuelling machines was accomplished.

2-Year Unplanned Automatic Reactor Trips *



* *Sub-indicator for WANO NPI*

	2022 Value
DN	0.000
PN	0.140
Best Quartile	0.000
Median	0.000

Factors Contributing to Performance

- DNGS and PNGS continue to achieve maximum Nuclear Performance Index (NPI) points.
- PNGS performance was impacted by the following two unplanned automatic reactor trips:
  - Unit 4: Steam Reject Valve (SRV) failed open resulting in a Unit 4 transient and reactor trip on Boiler Feedline Low Pressure (BFLP) trip parameter.
  - Unit 6: An incorrect push button operation on a circuit breaker that subsequently caused a primary heat transport main circuit pump trip leading to a reactor trip.

- DNGS had no unplanned automatic reactor trips. This excellent trend was a continuation for DNGS from 2019 and is due to the excellence in Human Performance fundamentals as well as excellence in Operator and Maintenance fundamentals.

Initiatives to Improve and Sustain Favourable Performance Include:

The following are being implemented in both PNGS and DNGS:

- On-going performance monitoring and improvement activities by Station Operations, Engineering, and Maintenance organizations.
- Operating Experience (OPEX) from each event has been shared at PNGS, DNGS and at external summits. To improve human performance, technical procedures have been revised. To improve equipment reliability, where possible, like-for-like parts replacement has taken place. System health teams are involved in obsolescence issues.
- OPEX and lessons learned from the continuous exchange of information among Canadian utilities are incorporated into the OPG governance and governance support documents.
- OPG methods and approaches in Operations, Engineering, and Maintenance are compared with other utility and the latest international standards through CANDU Owners Group (COG) projects. Under the COG sponsorship, OPG participates in the COG task teams for alignment of practices and staying current with best industry practices.
- Internal and external audits and inspections and self-assessments are performed to verify compliance and recommend future improvement opportunities.
- Training and qualification requirements are established and reviewed to be up-to-date to execute the job tasks at all levels of Operations, Maintenance and Engineering.

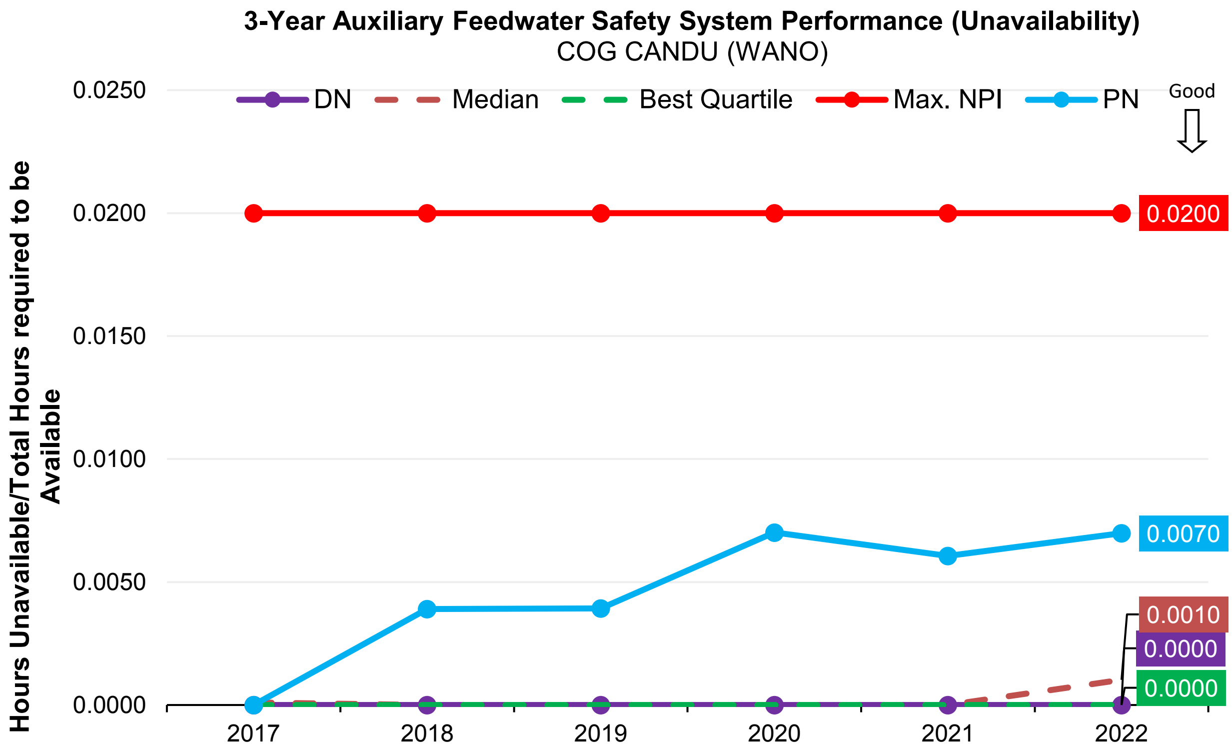
DNGS planned continuous actions are as follows:

- Engineering Technical Surveillance Program is being implemented at DNGS to ensure the best performance through Safety Related System Tests.

The following are being implemented at PNGS:

- Determine anomalies observed with Steam Release Valves (SRVs), prioritize and complete repairs to ensure SRV reliability; Replace positioner and air leaks; Perform diagnostic and calibration on east and west SRVs; Assess the cause of airline failure; Revise Operating Manual procedure to ensure SRV room temp is maintained during unit shutdown.
- Carry out human performance event communication and analysis; Perform simulator self-assessment.

3-Year Auxiliary Feedwater Safety System Performance (Unavailability)*



* *Sub-indicator for WANO NPI*

	2022 Value
DN	0.0000
PN	0.0070
Best Quartile	0.0000
Median	0.0010

Factors Contributing to Performance

- DNGS and PNGS continue to achieve maximum Nuclear Performance Index (NPI) points in 2022.

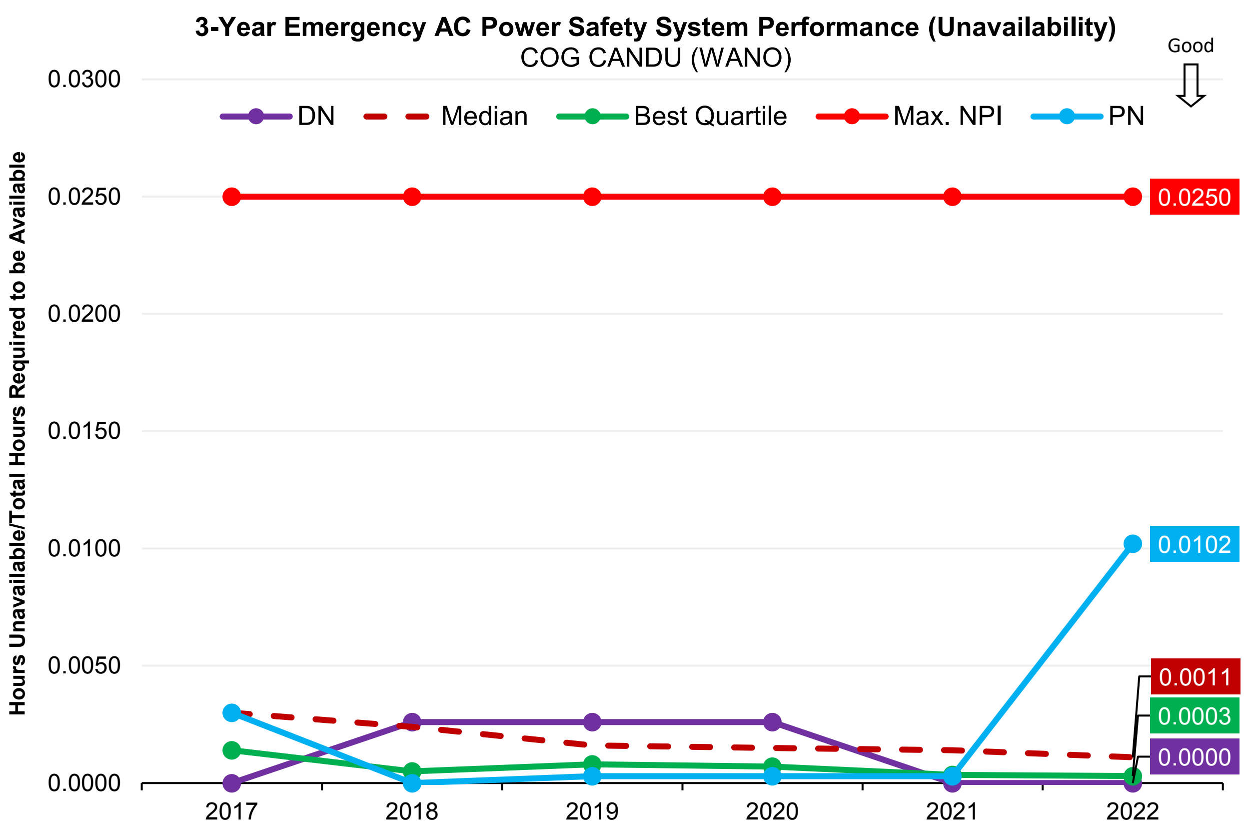
- Factors contributing to performance for PNGS include:
  - Unit 1: Steam leak occurred from the inboard side of the mechanical seal on Auxiliary Boiler Feed (ABF) pump; however, the pump remained available.

- DNGS continues to achieve the best quartile performance of zero unavailability by performing the following:
  - Identifying critical work on the plant reliability list.
  - Scheduling work using Integrated Planning Group and Cycle Plan processes.
  - Adhering to the cycle planning.
  - Following the System Performance Monitoring Plan.
  - Adhering to the Health Report 10-Year Improvement Plan.

Initiatives to Improve and Sustain Favourable Performance Include:

- The following was implemented in PNGS to improve the ABF system performance:
  - Replacing of Unit 1 ABF pump mechanical seal.
- DNGS design changes to the ABF system include:
  - Installing gland injection cooling on pump seals to resolve mechanical seal O-ring failure.
  - Replacement of reverse rotation device for main and ABF pumps.

3-Year Emergency AC Power Safety System Performance (Unavailability) *



* *Sub-indicator for WANO NPI*

	2022 Value
DN	0.0000
PN	0.0102
Best Quartile	0.0003
Median	0.0011

Factors Contributing to Performance:

- DNGS and PNGS continue to achieve maximum Nuclear Performance Index (NPI) points.

- DNGS Emergency AC Power system achieved the best quartile performance of zero unavailability by performing the following:
    - Identifying critical work on the plant reliability list.
    - Scheduling work using Integrated Planning Group and Cycle Plan processes.
    - Adhering to the 10-year Outage Maintenance Strategy for the Standby Generators (SG) and Health Report Improvement Plan.
    - Following the System Performance Monitoring Plan.
    - Adhering to the Health Report 10-Year Improvement Plan.

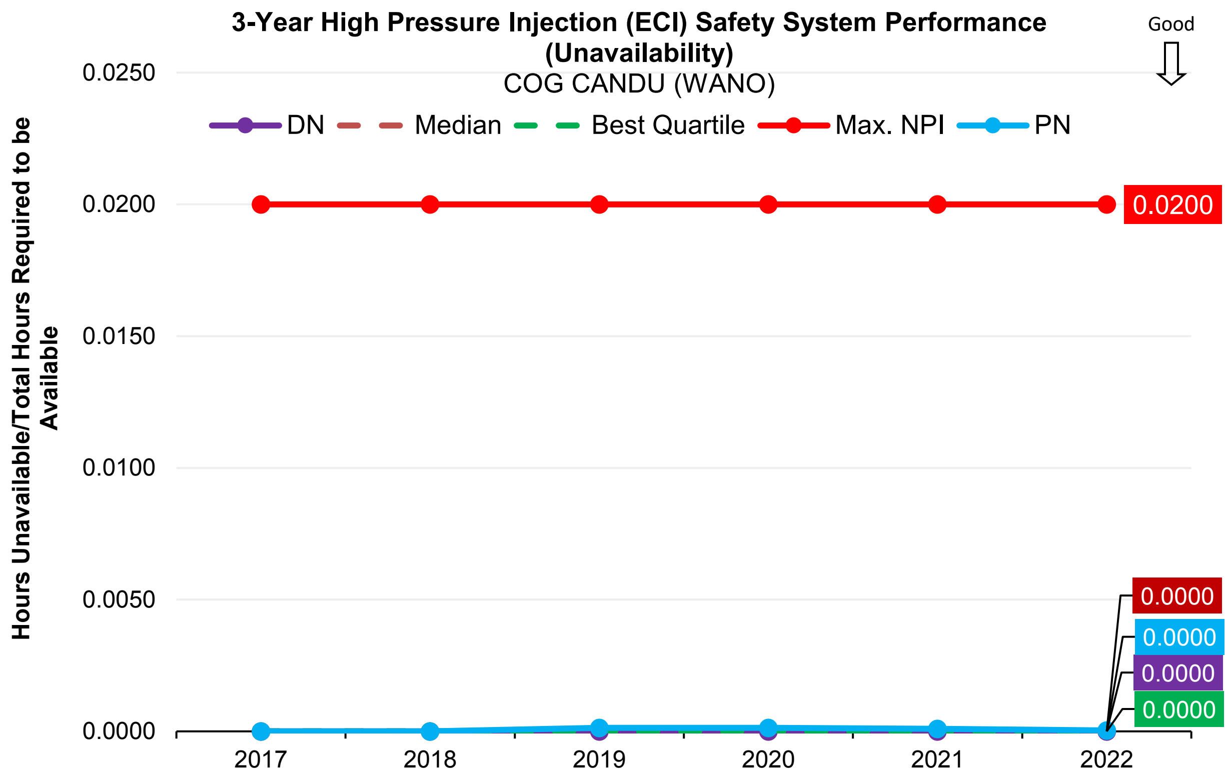
- PNGS Emergency AC Power system unavailability was 0.0102. The factors contributing to the performance include:
    - Unavailability of all three redundant standby generators (SGs) due to overlapping of the test performed on one SG, while the other two SGs were unavailable.

Initiatives to Improve and Sustain Favourable Performance Include:

- DNGS planned actions are as follows:
    - SGs Control System upgrades includes small updates to software and hardware to resolve aging/part obsolescence issue on the controls circuits.
    - A 10-year project is in progress on the SG protective relays to replace all the old electro-mechanical relays with modern digital versions.

- PNGS planned actions are as follows:
    - SG Relay Control Logic and Annunciator will be replaced under Standby Generator Reliability improvement modifications.
    - Enhanced monitoring system will be installed to aid in trending and troubleshooting.
    - SG's vibration monitoring system will be upgraded.
    - Electric driven fuel pumps used in SGs will be changed to shaft driven pumps, which do not suffer from machine breaker closure trips.
    - Corrective and routine outage maintenance will be performed.
    - Cracked power turbine casings will be repaired or replaced.

3-Year High Pressure Injection (ECI) Safety System Performance (Unavailability) *



* *Sub-indicator for WANO NPI*

	2022 Value
DN	0.0000
PN	0.0000
Best Quartile	0.0000
Median	0.0000

Factors Contributing to Performance:

- DNGS and PNGS continue to achieve maximum Nuclear Performance Index (NPI) points.
- DNGS continued with the best High Pressure Safety Injection (HPSI) quartile performance of zero unavailability.
- PNGS HPSI unavailability was 0.0000 (rounded from 0.00003). The factors contributing to performance include:
  - Unit 1 – Failure of Shutdown Cooling (SDC) Loop 1 depressurization Motorized Valve (MV) resulting in reduced Emergency Coolant Injection (ECI) header pipework pressure between check valves and leading to ECI Level 2 Impairment.

Initiatives to Improve and Sustain Favourable Performance Include:

- DNGS HPSI related activities include the following:
  - Units 1-4 injection valve internals were overhauled.
  - Completion of equipment reliability improvement work is driven via the 52-week cycle plan and Plant Reliability List (PRL) initiatives.
  - Performing preventive maintenance on schedule to reduce component failures and unplanned unavailability hours.
  - Scheduling work which could cause equipment unavailability as such that it maximizes system availability.
  - Overhaul or replacement of critical components increases the equipment reliability (i.e., ECI Hydraulic Power Unit (HPU)/ ECI Accumulator Control Module (AMCA)).

- PNGS HPSI related activities include the following:
  - Replacement of Recovery Relays.
  - Overhaul of active drainage pump after the identification of a trend of pump performance degradation.
  - Replacement of Alarm Units.
  - Procurement of a spare motor for the ECI Recovery pumps.
  - Adjustment of travel stops to improve seating of butterfly to avoid excessive passing of recovery sump isolator.
  - Clean ECI Heat Exchangers (HX) tube plugging.
  - Ongoing voltage check and routine calibration of logic instrumentation.
  - Mechanical maintenance and performed radiography of SDC Loop 1 depressurization motorized valve to confirm isolation.

Methodology and Sources of Data

The majority of reliability metrics were calculated using data from WANO. Any data labelled as invalid by WANO was excluded from all calculations. Indicator values of zero are not plotted or included in calculations except in cases where zero is a valid result. Complete data for the review period was obtained and averages are as provided by WANO.

For the WANO Nuclear Performance Index (NPI), a maximum score of 100 is possible. The WANO NPI is an operational performance indicator comprised of 10 metrics, three of which are analyzed in this section:

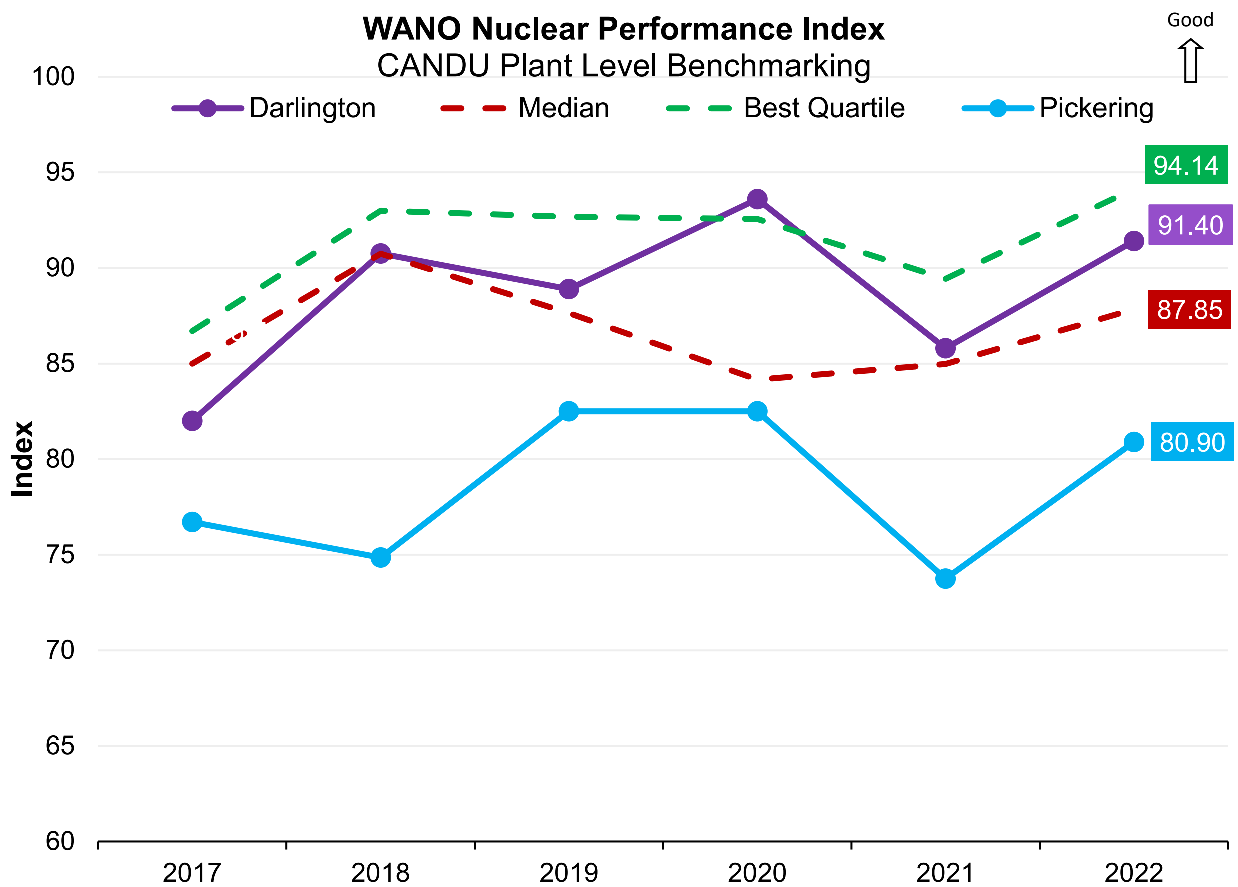
- Forced Loss Rate (FLR) [Rolling Average]
- Unit Capability Factor (UCF) [Rolling Average]
- Chemistry Performance Indicator (CPI) [Rolling Average]

The other seven WANO NPI components are shown in the Safety Section (Section 2.0).

Note: To benchmark performance, Max NPI is used to indicate best quartile performance for metrics that perform better than the Max NPI benchmark. If metric performance is not better than Max NPI, benchmark quartiles are utilized to indicate quartile performance.

Backlog metrics for On-line Deficient and Corrective Maintenance are also included within this section and the data comes from an industry sponsored Institute of Nuclear Power Operators (INPO) AP-928 subcommittee. Data points benchmarked on backlogs are annual, not a rolling average. All data is self-reported.

WANO Nuclear Performance Index (NPI) +



+ 2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)

	2022 Value
DN	91.40
PN	80.90
Best Quartile	94.14
Median	87.85

Factors Contributing to Performance:

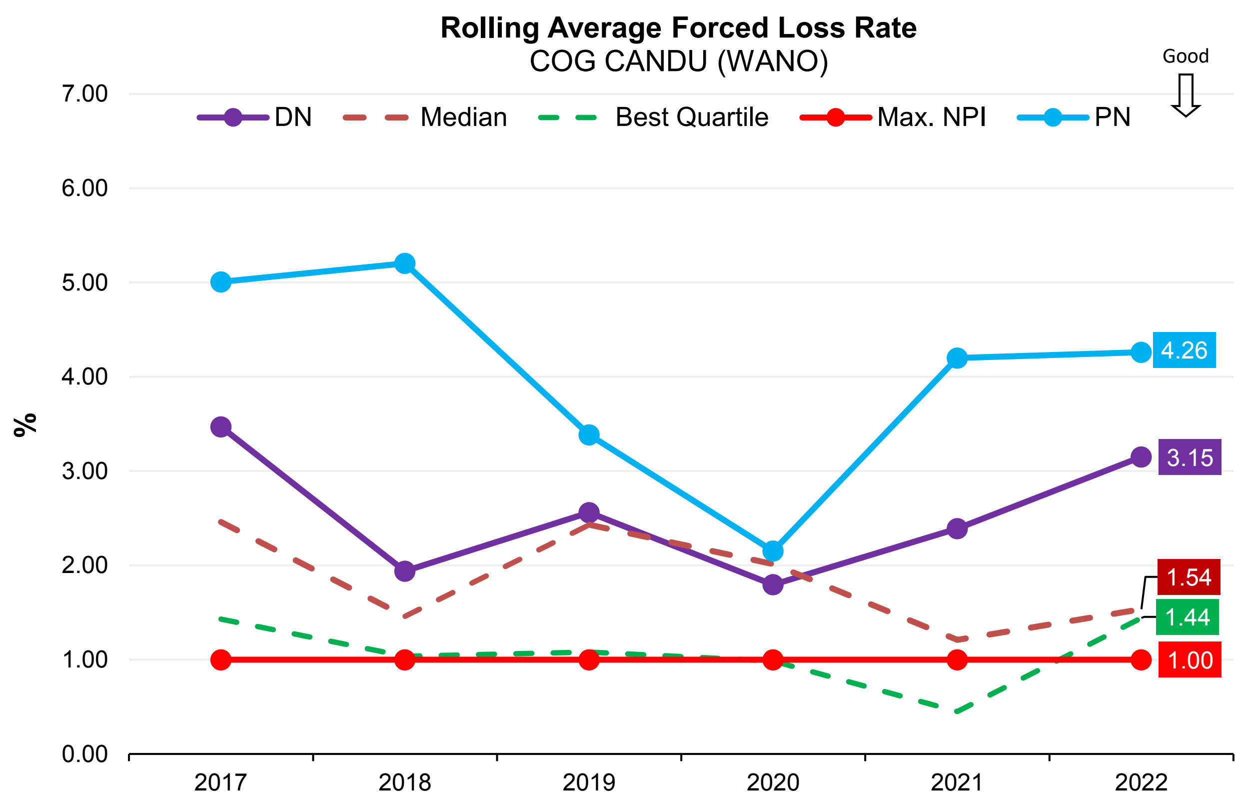
- PNGS performance improved by approximately seven points mostly due to Unit Capability Factor (UCF) and Forced Loss Rate (FLR) improving performance, resulting in a movement from fourth to third quartile. UCF and FLR have the most significant weighting within NPI calculation. Excellent performance for Reactor Trip Rate (RTR), High Pressure Safety Injection Unavailability (HPSI), Emergency AC Power Unavailability (EACP), Fuel Reliability Index (FRI) and Industrial Safety Accident Rate (ISAR) was offset by Auxiliary Boiler Feedwater Unavailability (ABF), Collective Radiation Exposure (CRE) and Chemistry Performance Indicator (CPI) performance.

  - PNGS NPI performance was impacted by the need for extended outages to accommodate fuel channel inspection programs, which impacts Unit Capability Factor, Collective Radiation Exposure and Chemistry Performance Index metrics.
  - Forced outages in 2022 have negatively impacted FLR, CRE and CPI.
  - Pump seal replacement for Auxiliary Boiler Feed (ABF) has contributed to unavailability of ABF and declining performance.

- DNGS achieved second quartile performance.
  - NPI score improved by 5.6 points, which was attributed to improved performance for all seven of the safety metrics.
  - Forced outage impacted FLR.

Further details on factors contributing to performance and initiatives to improve and sustain favourable performance are discussed within each respective NPI sub-metric in this report.

Rolling Average Forced Loss Rate (FLR) * +



* *Sub-indicator for WANO NPI*

\+ *2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)*

	2022 Value
DN	3.15
PN	4.26
Best Quartile	1.44
Median	1.54

Factors Contributing to Performance

- Rolling Average Forced Loss Rate increased at both DNGS and PNGS in 2022

- PNGS forced loss rate increased slightly with three forced outages related to Condenser, Fuel Handling, Generator and Shut Down systems, as well as one human performance on Primary Heat Transport system. In 2021, PNGS forced loss events were related to Turbine, Generator, Fuel Handling, and Liquid Zone Control systems continue to impact rolling two-year average. Unit 7 achieved Industry Best Quartile in 2021 and 2022.

- DNGS forced loss rate increased with one forced outage related to Turbine, Main Power Output and Primary Heat Transport system. 2020-2021 DNGS' forced loss events were related to Fuel Handling, Turbine/Generator & Ion Chamber systems continue to impact rolling three-year average. Unit 1 achieved Industry Best Quartile in 2020.

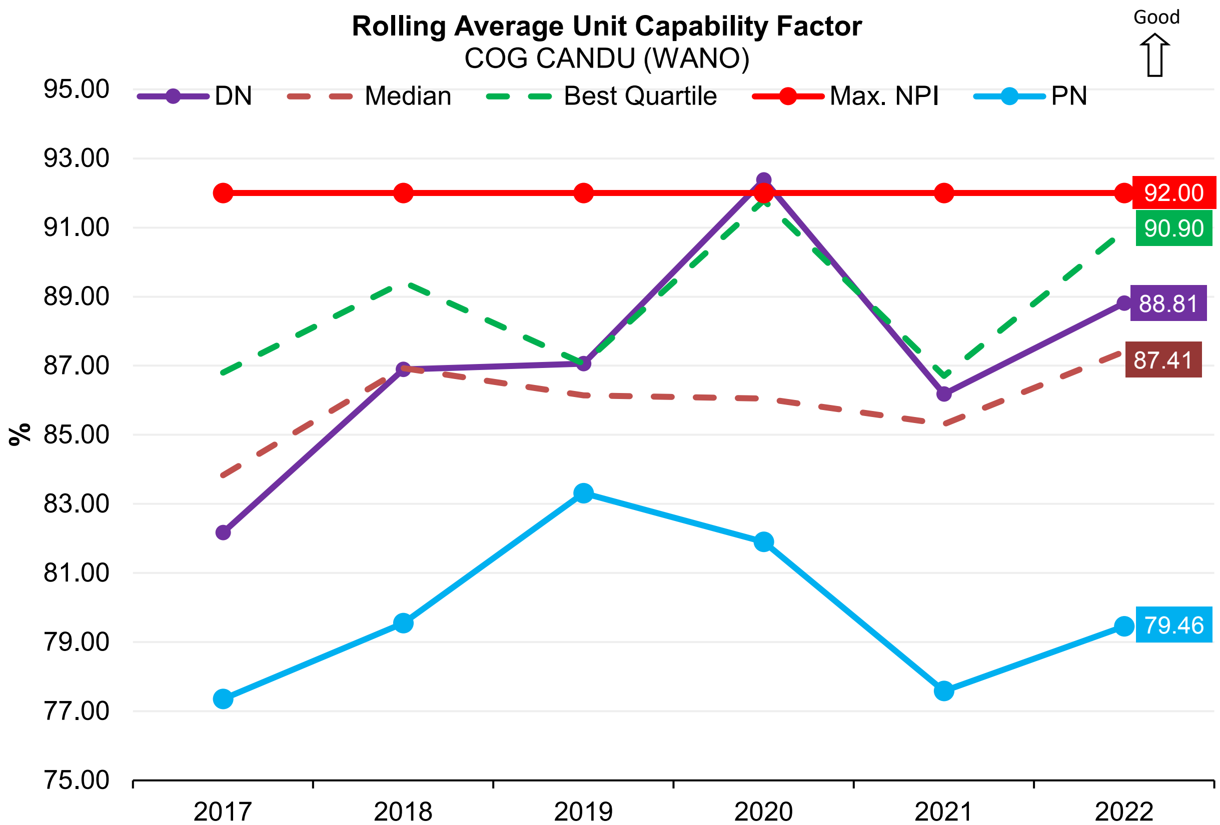
Initiatives to Improve and Sustain Favourable Performance Include:

- Focused actions, including vulnerability identification and elimination, equipment monitoring, proficiency building and project execution at both the fleet and site level have been implemented for Turbine Generator Reliability the highest fleet contributor.

- Fuel Handling contribution reduced in 2022 and remains a fleet focus area to build sustainability. Focused actions on equipment monitoring, cross-functional risk identification and resolution, proficiency building, reliability related projects and modifications implementation are in place at both the fleet and site level.

- Internal peer teams, industry benchmarking, fleet assessments against industry best practice, enhanced participation in industry working groups are in place to manage this risk going forward.

Rolling Average Unit Capability Factor (UCF) * +



* *Sub-indicator for WANO NPI*

\+ *2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)*

	2022 Value
DN	88.81
PN	79.46
Best Quartile	90.90
Median	87.41

Factors Contributing to Performance:

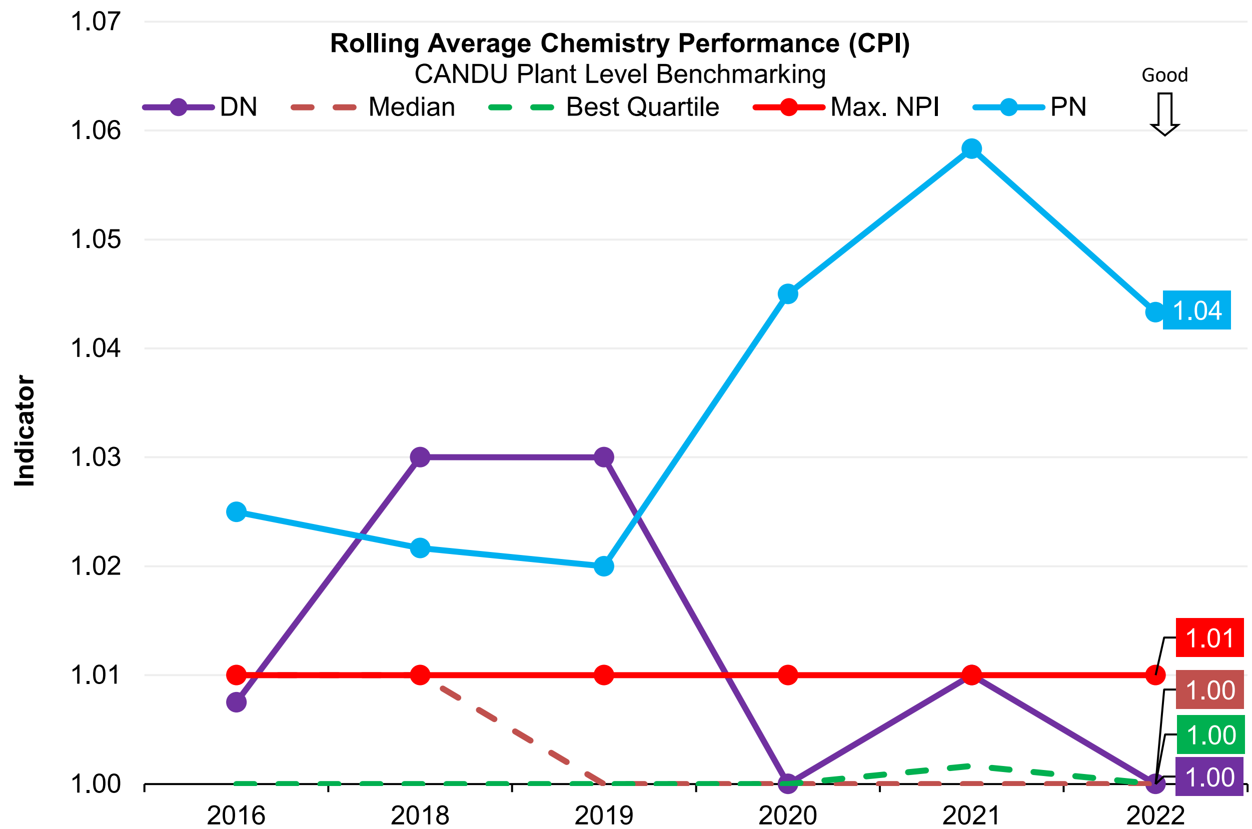
- PNGS forced loss number of events decreased through 2022, which had a positive impact on UCF partially offset by Maintenance outage execution. 2021 PNGS forced loss events and maintenance outage execution continue to impact rolling two-year average. Unit 4 and Unit 6 achieved Industry Best Quartile in 2022.

- DNGS forced loss events increased through 2022, which had an adverse impact on UCF. 2020-2021 DNGS forced loss and maintenance outage execution continue to impact rolling three-year average. Unit 1 achieved Industry Best Quartile in 2020 and 2021.

Initiatives to Improve and Sustain Favourable Performance Include:

- Focused actions, including vulnerability identification and elimination, equipment monitoring, proficiency building and project execution at both the fleet and site level have been implemented for Turbine Generator Reliability the highest fleet contributor.
- Fuel Handling contribution reduced in 2022 and remains a fleet focus area to build sustainability. Focused actions on equipment monitoring, cross-functional risk identification and resolution, proficiency building, and reliability related projects and modifications implementation are in place at both the fleet and site level.
- Internal peer teams, industry benchmarking, fleet assessments against industry best practice, enhanced participation in industry working groups are in place to manage this risk going forward.

Rolling Average Chemistry Performance Indicator (CPI) *+



* *Sub-indicator for WANO NPI*

\+ *2 Year Avg PNGS, 3 Year Avg DNGS – Unit 4 (U1 & U3 in Refurbishment. U2 in-service Q3 2020, not online for 3 years)*

	2022 Value
DN	1.00
PN	1.04
Best Quartile	1.00
Median	1.00

Factors Contributing to Performance

2022 CPI performance improved for both PNGS and DNGS from previous years. These improvements can be attributed to the initiatives taken at each station.

- PNGS – Received perfect CPI scores of 1.00 for four consecutive quarters in 2022 due to Gaps Drivers Actions Results (GDAR) implementation. The decline in performance from 2019 to 2021 can be attributed to the following:
    - Unit 5 (2019) and Unit 7 (2021) start-up boiler sulfates due to turbine maintenance activities during their respective outages.
    - Unit 4 condenser tube leak resulted in chronic elevated boiler ions for ~ 9 months (2021).
    - Unit 8 condenser tube leak resulted in elevated boiler ions for ~ 2 weeks (2021).
    - Boiler blowdown adherence issues during full power operation and outage start-ups (2021).
    - Start-up chemistry post outages (i.e., boiler blowdown adherences).

- DNGS – Received CPI scores of 1.00 and achieved maximum Nuclear Performance Index (NPI) points in 2022. The decline in performance before 2021 can be attributed to the following:
    - Increased feedwater corrosion product transport post unit start-ups.
    - Elevated boiler ions upon unit start-ups.

Initiatives to Improve and Sustain Favourable Performance Include:

Both sites have an ongoing Chemistry Outage SPOC to provide improved coordination/planning such that system chemistry control has improved during outages/start-ups.

PNGS:

- Gaps Drivers Actions Results (GDAR) implemented Q1 2022 aimed at improving practices in boiler chemistry. These include boiler blowdowns adherence during full power operation, unit start-ups and lay-up chemistry. Outcome effective because PNGS received perfect CPI scores of 1.00 for four consecutive quarters in 2022.
- Condenser tube leak Response and Strategy Guide issued in 2022 to provide guidance on how to respond to condenser tube leaks by incorporating lessons learned. Proven to be effective on U8 in April 2023 where a condenser tube leak was caught and isolated within ~ 1 week.

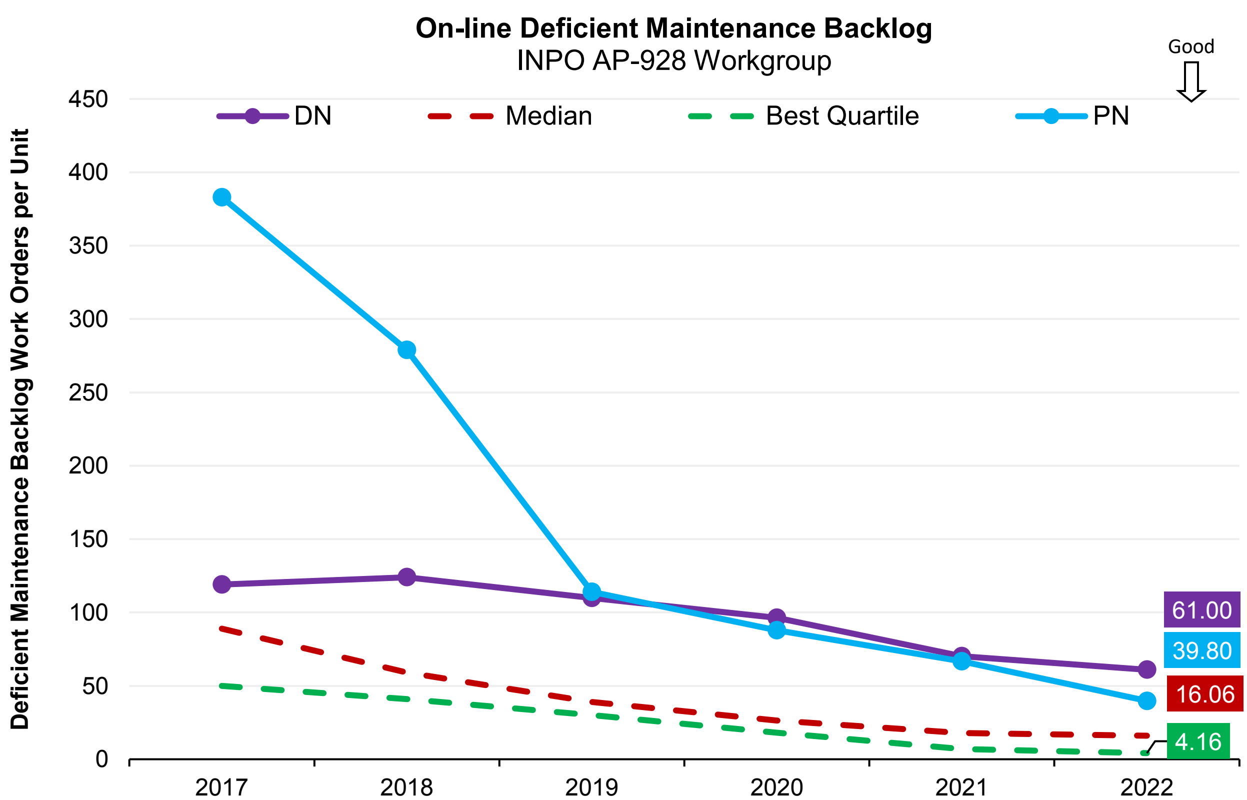
DNGS:

- Chemistry Technical:
    - Advocate utilization of condensate filtration skid upon Unit start-ups. The filtration skid is designed to remove corrosion products in the feedwater circuit.
    - Work with the Outage Work Control Team Leader to participate in Outage meetings to discuss areas to optimize boiler chemistry (i.e., minimize duration where boilers are drained, improvements in Boiler Water Lancing activities etc.).

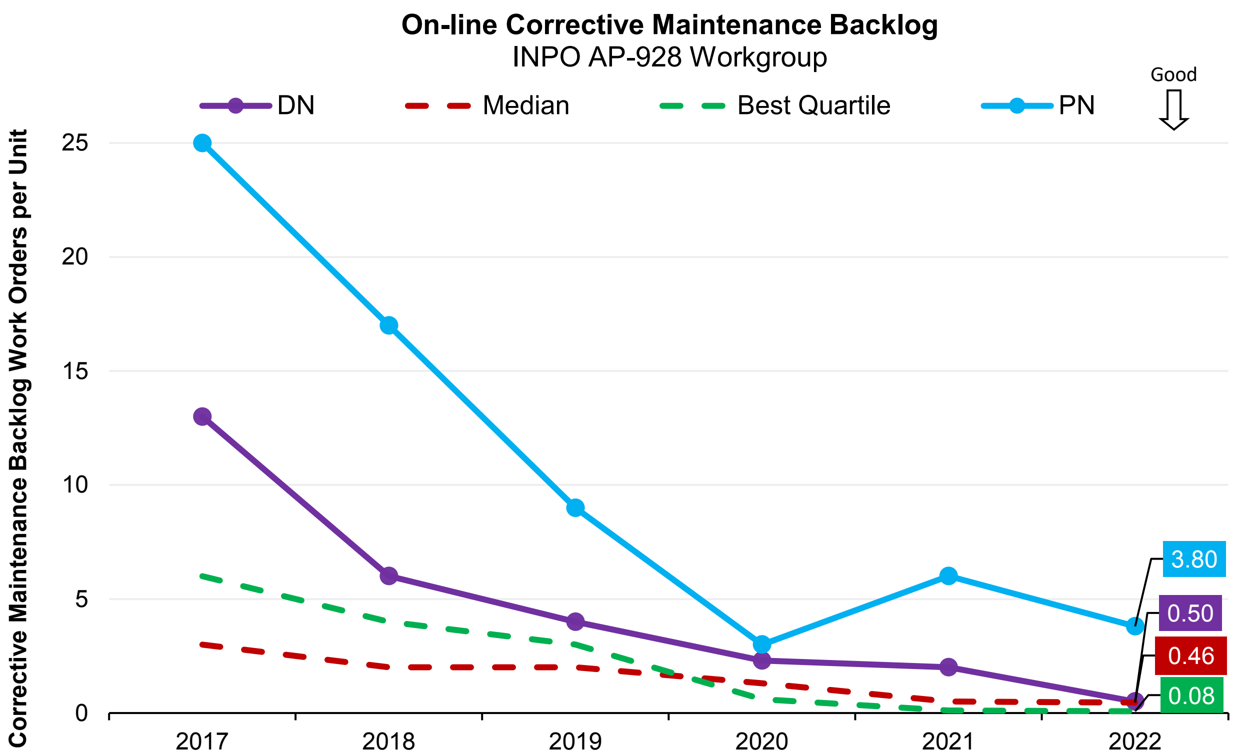
- Application of Film Forming Amines (FFA) during DNRU3. FFAs establish a protective film in the Secondary Side to prevent accelerated corrosion product transport release during power transients (i.e., Unit start-ups).

- Chemistry:
  - Revised the strategy utilizing continuous boiler blowdowns to manage secondary side chemistry control leading until Unit start-up to remove boiler ions.
  - Revising the condenser tube leak response procedure and guidance to include previous operating experience and pre-decision-making logic during leak searching activities.
  - Condenser tube inspection strategies have improved/expanded to periphery tube indications and further review is in-progress enhance the condenser tube inspection scope and frequency.

On-Line Deficient & Corrective Maintenance Backlog
On-Line Deficient & Corrective Critical Backlog



Note: Annual



Note: Annual

	2022 On-Line Deficient Maintenance Backlog	2022 On-Line Deficient Critical Backlog	2022 On-Line Corrective Maintenance Backlog	2022 On-Line Corrective Critical Backlog
DN	61.00	0.00	0.50	0.00
PN	39.80	0.80	3.80	0.00
Best Quartile	4.16	0.00	0.10	0.00
Median	16.06	0.06	0.50	0.00

Factors Contributing to Performance

- PNGS and DNGS met industry best quartile for Corrective Critical Backlog by:
    - FIN Teams continuing to work down backlog as a priority.
    - Ensuring backlog outside of FIN scope is being added to the online scheduling process.
    - FIN Coordinator role defined to review and ensure accurate WO coding.
    - Support provided via the pre-existing Backlog Readiness Team (cross-functional - Operations, Maintenance, Engineering, Work Control, Assessing, Supply Chain and Fix it Now Center of Excellence (FINCOE)).
    - Continue to work down the backlog by priorities through FIN and Work Management (WM) process.

- Not all station backlog targets were set to industry best quartile for 2022
- DNGS continues to utilize and develop the Minor Maintenance Tool.

- PNGS improved from 4th Quartile in 2021 to 1st Quartile 2022 by introducing the following:
    - Increased focus on backlog Work Orders (WO).
    - Backlog meetings were increased to 3 times a week.
    - Fix It Now (FIN) speciality crews to ensure priority is placed on the backlog.

Initiatives to Improve and Sustain Favourable Performance Include:

- Focus on Hardened Backlog due to part availability.
- Fleet Oversight on station backlog performance.
- FIN Teams continue to work down backlog as a priority.
- Ensuring backlog outside of FIN scope is being added to the online scheduling process.
- FIN governance to align with site expectations regarding Backlog priority.
- Dedicated oversight forum at DNGS for FIN Effectiveness.

Note: Factors Contributing to Performance and Initiatives to Improve and Sustain Favorable Performance are relevant to all backlogs.

Methodology and Sources of Data

The Electric Utility Cost Group (EUCG) database is the source for cost benchmarking data. Data was collected for three-year rolling averages for all financial metrics. All data submitted to and subsequently extracted from EUCG by OPG is presented in Canadian dollars.

EUCG automatically applies a purchasing power parity (PPP) factor to adjust all values across national borders. The primary function of the PPP value is to adjust for currency exchange rate fluctuations, but it also adjusts for additional cross-border factors, which may impact purchasing power of companies in different jurisdictions. As a result, cost variations between plants are limited, as much as possible, to real differences and not due to advantages of utilizing one currency over another.

The benchmarking panel utilized for value for money metrics is made up of all North American (U.S. & Canada) plants reporting to EUCG. Bruce Power is the only other CANDU technology plant reporting within that panel. The remaining plants are Boiling Water Reactors or Pressurized Water Reactors making it challenging to compare performance across plants with technology differences. As a result, beginning with 2017 results, both PNGS and DNGS TGC/MWh and TGC/Unit performance has been normalized for CANDU technology (including outage duration) and age-related impacts.

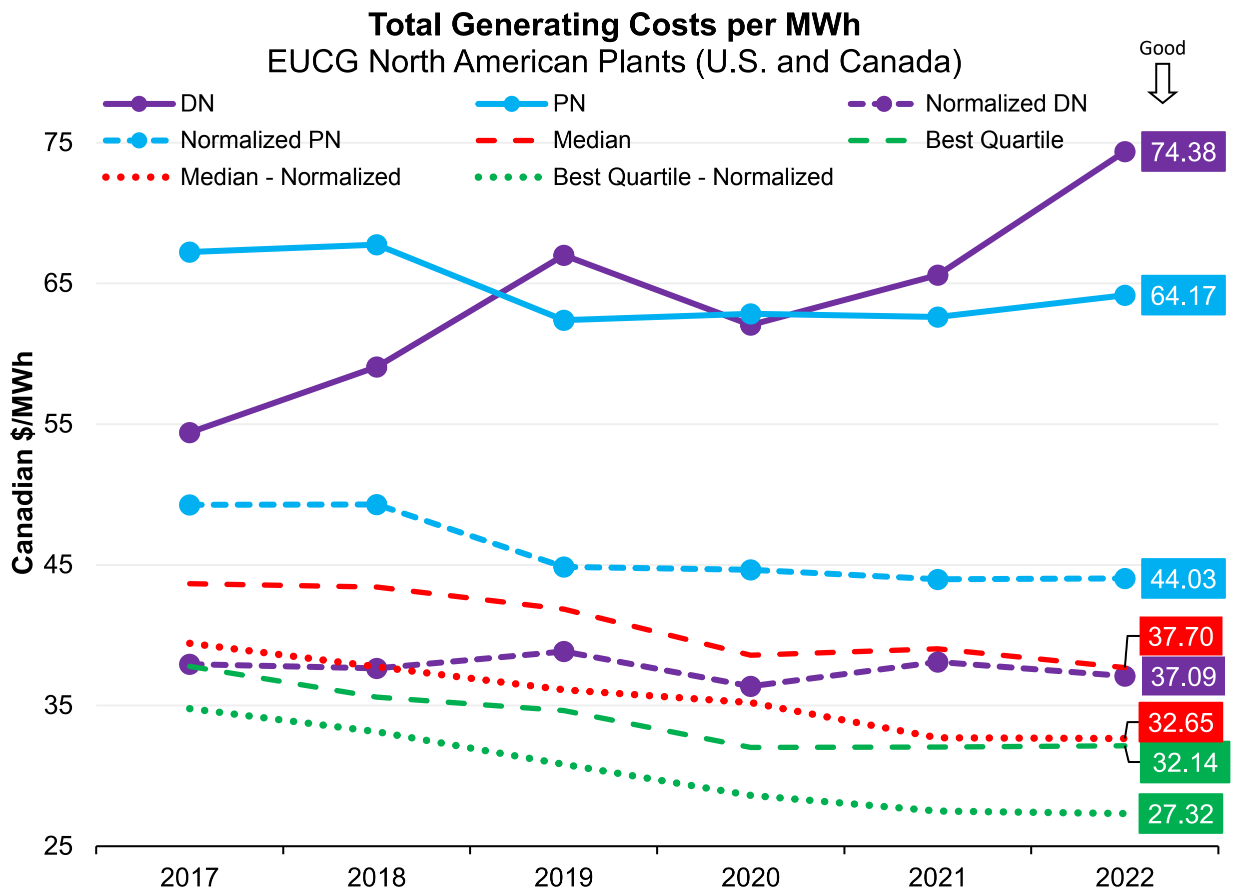
Darlington's TGC/MWh, TGC/Unit, Non-Fuel Operating Costs (NFOC)/MWh and Capital Cost/MW DER performance have also been normalized for refurbishment. The refurbishment normalization methodology allows OPG to adjust the distribution of actual operating and capital costs to reflect Darlington's number of operating units rather than a four-unit site. OPG is performing a mid-life refurbishment at Darlington, which involves bringing units offline for the replacement of certain life-limiting components. It is necessary to normalize these metrics during refurbishment to allow for comparisons to prior site performance and industry peers, given reduced generation and no corresponding decline in fixed costs.

OPG engaged ScottMadden Management Consultants (ScottMadden) to develop the normalization methodologies[3]. The combined normalization allows for a more comparable assessment of performance between peers.

Total Generating Cost per MWh is the sum of Non-Fuel Operating Cost (NFOC), Fuel Cost and Capital Cost measured on a per MWh basis for benchmarking purposes.
Given the differences between OPG's nuclear generating stations and most North American plants with respect to non-fuel operating costs, fuel and capital costs, it is difficult to compare plants using non-fuel operating cost, fuel cost or capital cost metrics separately.

[3] Two ScottMadden normalization reports provide details on the normalization methodologies: 1) *OPG Nuclear Cost Performance Benchmarking A Study of Factors Impacting TGC/MWh Performance with Normalizing Adjustments to Facilitate Closer Comparison* and 2) *OPG Nuclear Cost Performance Benchmarking Methodology to Adjust for Refurbishment and Validation of Implementation*

3-Year Total Generating Cost (TGC) per MWh



	2022 Non-Normalized Value	2022 Normalized Value
DN	74.38	37.09
PN	64.17	44.03
Best Quartile	32.14	27.32
Median	37.70	32.65

Factors Contributing to Performance

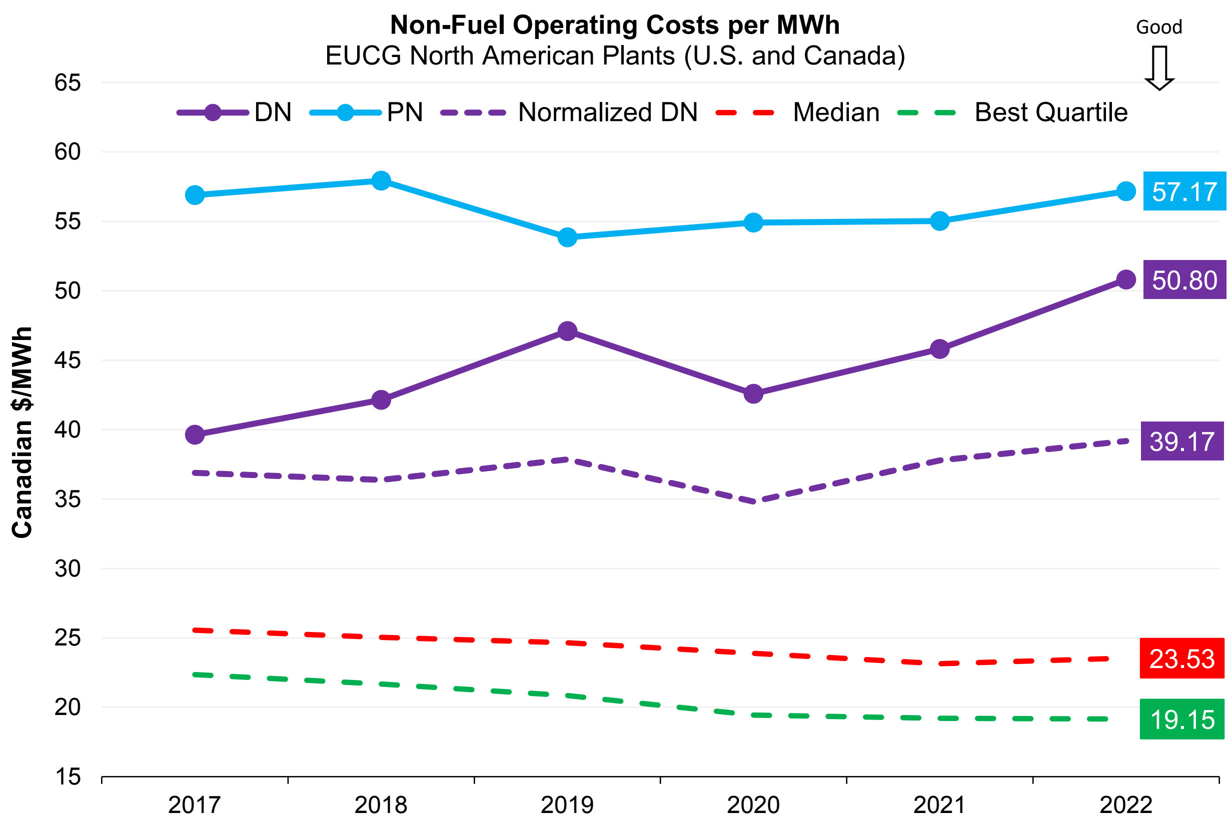
- DNGS normalized performance slightly improved in 2022 compared to 2021 due to reduced capital costs associated with Units 1 and 3 being in refurbishment outages and no planned outages in 2022 and partially offset by reduced generation from the refurbishment outages.
- DNGS non-normalized performance declined due to lower generation with Units 1 and 3 being in refurbishment outages, increased capital investment requirements for life post-refurbishment, partially offset by no planned outages in 2022.
- PNGS normalized performance were similar to 2021, reflecting continued reduction in capital investment as the station approaches shut-down in 2024/2026 (pending CNSC approval).

- PNGS non-normalized performance compared to industry reflects reduced generation due to three planned outages in 2022 partially offset by continued reduction in capital investment as station approaches shut-down in 2024/2026 (pending CNSC approval).
- PNGS units are the smallest in the peer group at 540 MW/unit compared to the peer average of 1,026 MW, a factor for which results have not been normalized.

Initiatives to Improve and Sustain Favourable Performance Include:

- Maximizing generation: See initiatives to improve and sustain favourable performance for Reliability Metrics UCF and FLR.
- Continue to utilize opportunities to reduce operating costs through strategic initiatives, excellence plans, technology deployment and resource planning.
- Employing a portfolio and asset management approach to assess, prioritize and deliver all nuclear operations projects which are developed to meet regulatory commitments (e.g., from the Canadian Nuclear Safety Commission), increase system or unit reliability, address system obsolescence, or optimize station generation.

3-Year Non-Fuel Operating Cost per MWh



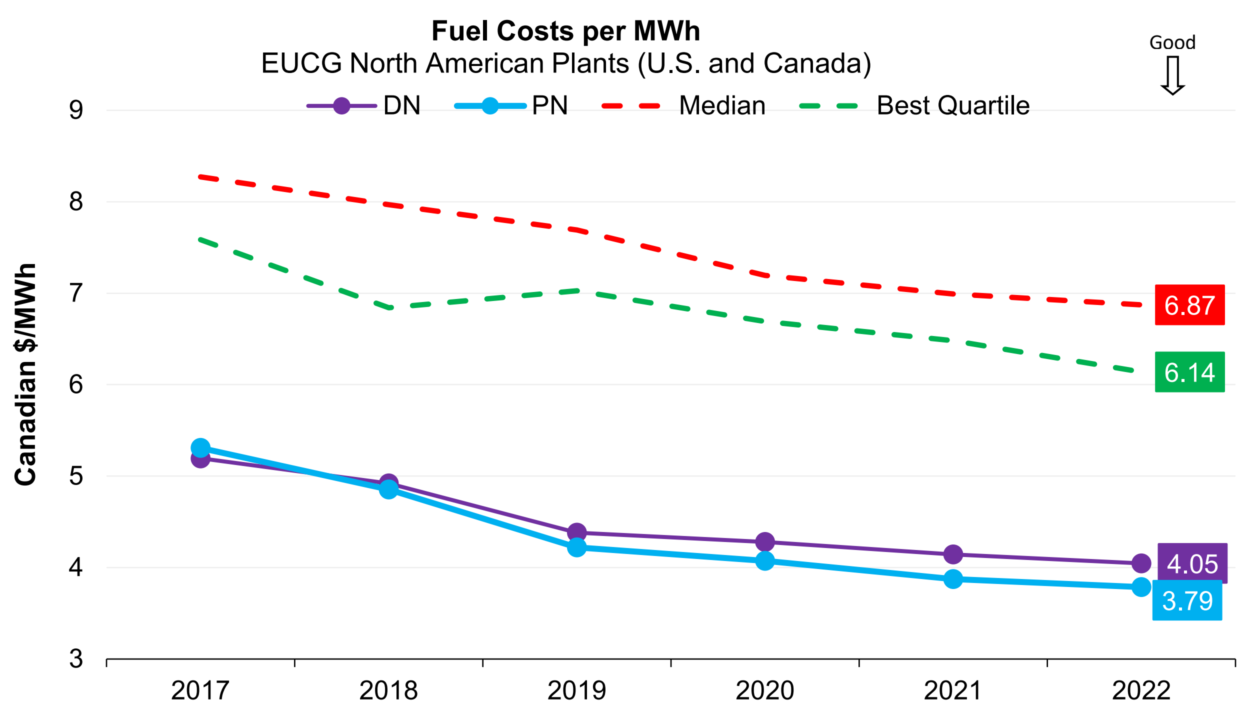
	2022 Non-Normalized Value	2022 Normalized Value
DN	50.80	39.17
PN	57.17	-
Best Quartile	19.15	19.15
Median	23.53	23.53

Factors Contributing to Performance

- DNGS normalized and non-normalized performance declined due reduced generation with both Units 1 and 3 being in refurbishment outages partially offset by no planned outages in 2022.
- PNGS non-normalized performance compared to industry reflects reduced generation due to three planned outages in 2022.
- PNGS units are the smallest in the peer group at 540 MW/unit compared to the peer average of 1,026 MW, a factor for which results have not been normalized.

Initiatives to Improve and Sustain Favourable Performance – refer to TGC/MWh.

3-Year Fuel Cost per MWh



	2022 Value
DN	4.05
PN	3.79
Best Quartile	6.14
Median	6.87

Factors Contributing to Performance

- Fuel costs are lower for OPG than most North American Pressurized Water Reactors or Boiling Water Reactors (PWR/BWR) reactors as CANDUs do not require enriched uranium like PWRs and BWRs.
  - Raw uranium is processed directly into uranium dioxide to make fuel pellets, without the additional cost and process complexity of enriching the fuel as required in light water reactors.
  - CANDU reactors are also the most efficient reactors in using uranium, requiring less uranium than PWRs and BWRs for each megawatt hour of electricity.
  - These two factors provide a significant advantage for OPG and other CANDUs in this cost category.

- Regular entry into the uranium market has allowed OPG to reduce uranium input costs year over year. Historical multi-year contracts signed between 2015 and 2021, and for which deliveries were made in 2020, 2021 and 2022, have allowed OPG to take deliveries of uranium on a both fixed price and market price basis during a period of historically low uranium spot market prices (2015-2021) not seen since 2005 and earlier.

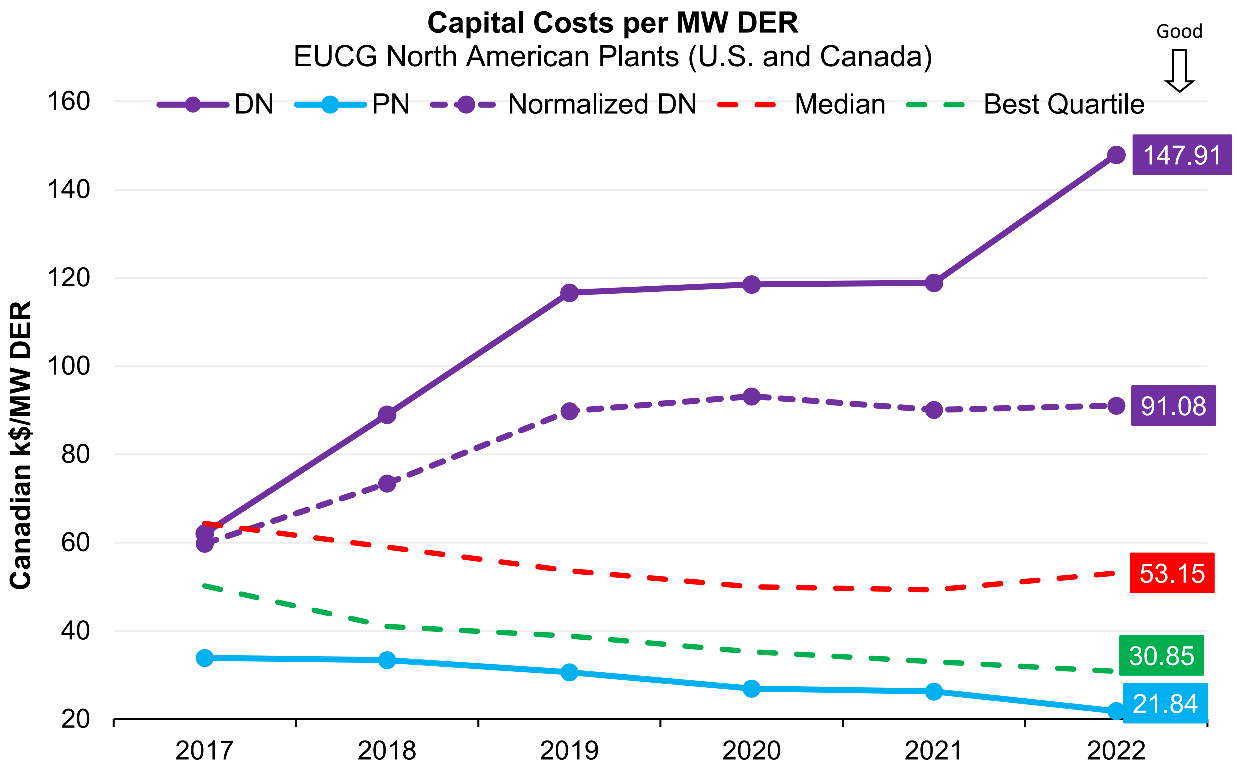
- Reduction in Fuel Costs at both DNGS and PNGS from 2021 to 2022 can be attributed to the combination of lower input uranium costs offset by general escalation in the fuel conversion and fuel fabrication costs. In 2017, the uranium spot market price reached its cyclical low point and has continued an increasing trend up to the present, and this trend is projected to continue. Over the coming years, as historical uranium contracts are completed and new contracts are entered into, the effect of the more recent increasing uranium price trend is expected to place upward pressure on the 3-year rolling average fuel cost per MWh.

Initiatives to Improve and Sustain Favourable Performance

- Recent events in 2021 and 2022 have placed upward cost pressures on nuclear fuel supply chains over the next several years, including:
  - Significant new purchasing program from a uranium investment fund
  - Increase in the general consumer price inflation level above the long-term average trend following economic stimulus programs introduced during the Covid-19 pandemic
  - Shifting perception on nuclear power due to energy.
  - Conflict in Ukraine continues to constrain the supply of uranium conversion and enrichment services; however an enrichment services supplier recently announced its intention to expand its production capacity, and there is potential for suppliers of these services to announce further increases in their production capacities under the right market conditions.

- OPG will continue to seek improvements in contract pricing for its nuclear fuel supply to sustain favourable comparative fuel costs, while also ensuring a resilient and robust nuclear fuel supply chain, given recent geopolitical and economic events.

3-Year Capital Cost per MW DER (Design Electrical Rating)



	2022 Non-Normalized Value	2022 Normalized Value
DN	147.91	91.08
PN	21.84	-
Best Quartile	30.85	30.85
Median	53.15	53.15

Factors Contributing to Performance

- PNGS is performing in the first quartile with a slight improvement in 2022 and the improvement over the trend period. This reflects reductions in spending while maintaining reliable operations in the period leading up to the end of commercial operations, which is consistent with spending trends observed at other nuclear facilities approaching their end of commercial operations.

- DNGS performance in 2022 showed a small increase on a normalized basis as compared to 2021, as the station remained in the third quartile. The large increase in the absolute DNGS Capital Cost per MW in 2022 is mainly due to the reduction in available MW as both Units 1 and 3 were in refurbishment outages. The change over the trend period reflects increased spending on life extension, performance improvements, sustaining investments, information technology and capital spares to support operations before, during and after Darlington refurbishment.

- Historically, DNGS capital expenditures were better than the industry median. Once the decision to refurbish Darlington and extend end of life was made, OPG began an extensive program to replace obsolete and/or life-expired plant equipment to support performance and reliability of Darlington's units post-refurbishment.

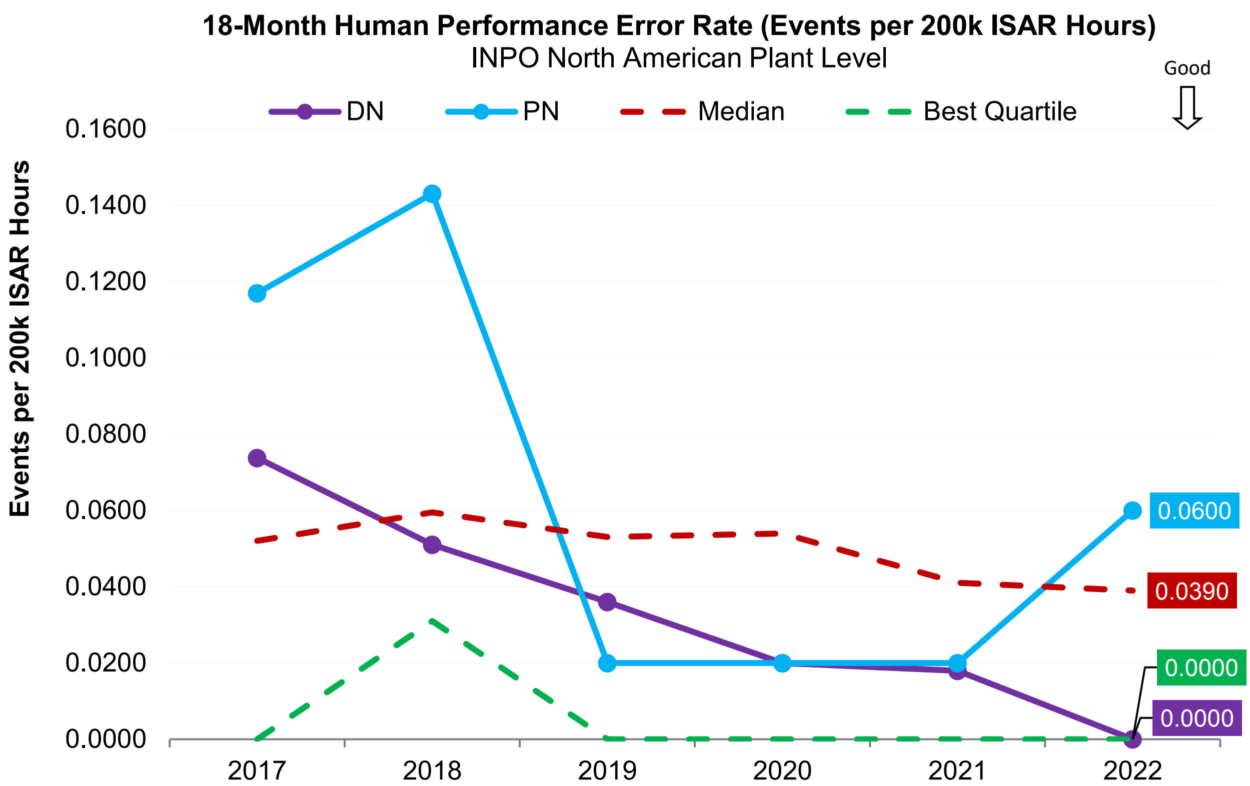
Initiatives to Improve and Sustain Favourable Performance Include:

- Employing a portfolio and asset management approach to assess, prioritize, and deliver all nuclear operations projects which are developed to meet regulatory commitments (e.g., from the Canadian Nuclear Safety Commission), increase system or unit reliability, address system obsolescence, or optimize station generation.

Methodology and Sources of Data

The Human Performance Error Rate metric is used to benchmark the performance of OPG's Nuclear fleet against other INPO utilities in the area of Human Performance.

18-Month Human Performance Error Rate



	2022 Value
DN	0.0000
PN	0.0600
Best Quartile	0.0000
Median	0.0390

Factors Contributing to Performance

- DNGS did not experience any Site Event Free Day Reset (S-EFDR)s in 2022 or in the second quarter of 2021.
- PNGS experienced two S-EFDR events in 2022. They occurred on July 19 and December 19. Event causes were identified, and corrective actions implemented to address the gaps. All actions have been completed.

Initiatives to Improve and Sustain Favourable Performance Include:

- Continuous improvement of Observation and Coaching program which is currently upgrading the associated technology as well as the implementation of the How to Observe & Coach Effectively program. These improvements include the data acquisition process (iCONNECT) and the associated Fleet and Department Dashboards.
- Oversight of First Line Managers (FLMs, FLMas, and stepped-up FLMas) to ensure effective delivery of quality pre-job brief commensurate with the risk and hazards associated with the job; and to provide independent oversight when observing work.
- Revision and enhancement of the CORE 4 to CORE 4+ including Stop When Unsure initiative as part of the Observation and Coaching improvement plan.
- Integration of Fail Safe strategies across the fleet through Pre Job Brief (PJB) and Observation & Coaching programs.
- Alignment across the fleet through various trending processes are continuing to provide increased awareness of potential emerging trends which are reviewed as part of our Validation of Trend (VOT) process.

6.0 APPENDIX

Acronyms

Acronym	Meaning
ABF	Auxiliary Boiler Feed
AC	Alternating Current
AMCA	Accumulator Control Module
BFLP	Boiler Feedline Low Pressure
BWR	Boiling Water Reactor
CANDU	CANada Deuterium Uranium (type of PHWR)
EC	Electricity Canada
CC	Corrective Critical
CM	Corrective Maintenance
CN	Corrective Non-Critical
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CPI	Chemistry Performance Index
CRE	Collective Radiation Exposure
DC	Deficient Critical
DER	Design Electrical Rating
DM	Deficient Maintenance
DN	Deficient Non-Critical
DNGS	Darlington Nuclear Generating Station
EACP	Emergency AC Power
EC	Electricity Canada
ECI	Emergency Coolant Injection
EPRI	Electric Power Research Institute
eSWP	Electronic Safe Work Plans
EUCG	Electric Utility Cost Group
FFA	Film Forming Amines
FIN	Fix It Now
FINCOE	Fix It Now Center Of Excellence
FLM	First Line Manager
FLR	Forced Loss Rate
FRI	Fuel Reliability Index
GDAR	Gaps Drivers Actions Results
HIT	High Impact Team
HPER	Human Performance Error Rate
HPSI	High Pressure Safety Injection
HPU	Hydraulic Power Unit
HTS	Heat Transport System

Acronym	Meaning
HX	Heat Exchanger
INPO	Institute of Nuclear Power Operators
ISAR	Industrial Safety Accident Rate
ISB	Integrated Station Brief
MW	Mega-Watt
MV	Motorized Valve
NFOC	Non-Fuel Operating Cost
NPI	Nuclear Performance Index
O&C	Observation & Coaching
OPEX	Operating Experience
OPG	Ontario Power Generation
PJB	Pre Job Brief
PNGS	Pickering Nuclear Generating Station
PHTS	Primary Heat Transport System
PHWR	Pressurized Heavy Water Reactor
PPP	Purchasing Power Parity
PRL	Plant Reliability List
PWR	Pressurized Water Reactor
QSP	Quality of Safety Practices
RDM	Rapid Delivery Machine
RP	Radiation Protection
RTR	Reactor Trip Rate
SDC	Shutdown Cooling
S-EFDR	Site event free day resets
SG	Standby Generators
SIF	Significant Injuries and Fatalities
SIIR	Serious Injury Incidence Rate
SPOC	Single Point of Contact
SRV	Steam Reject Valve
TGC	Total Generating Costs
TGC/MWH	Total Generating Costs per Mega-Watt Hour
TRIF	Total Recordable Injury Rate
UCF	Unit Capability Factor
VOT	Validation of Trend
WANO	World Association of Nuclear Operators
WM	Work Management
WO	Work Order

Safety and Reliability Definitions

The following definitions are summaries extracted from industry peer group databases.

Total Recordable Injury Frequency (TRIF)
Average number of fatalities, lost time injuries, medical treatment injuries and restricted work injuries per 200,000 hours worked.

Industrial Safety Accident Rate (ISAR)
Number of accidents for all utility personnel (permanently or temporarily) assigned to the station, that result in one or more days away from work (excluding the day of the accident) or one or more days of restricted work (excluding the day of the accident), or fatalities, per 200,000 man-hours worked. The selection of 200,000 man-hours worked or 1,000,000 man-hours worked for the indicator will be made by the country collecting the data, and international data will be displayed using both scales. Contractor personnel are not included for this indicator.

Collective Radiation Exposure (CRE)
Total external and internal whole body exposure determined by a dose control device (e.g., electronic personal dosimeter, dose recording device, etc.) and internal exposure calculations. All measured exposure should be reported for station personnel, contractors, and those personnel visiting the site or station on official utility business.
Visitors, for purposes of this indicator, include only those monitored visitors who are visiting the site or station on official utility business.

Airborne Tritium Emissions per Unit
Tritium emissions to air.

Fuel Reliability Index (FRI)
Inferred from fission product activities present in the reactor coolant. Due to design differences, this indicator is calculated differently for different reactor types. For PHWR's, the indicator is defined as the steady-state primary coolant iodine-131 activity (Becquerels/gram or Microcuries/gram), corrected for the tramp uranium contribution and power level, and normalized to a common purification rate.

Unplanned automatic reactor trips (SCRAMS)
Number of unplanned automatic reactor trips (reactor protection system logic actuations) that occur per 7,000 hours of critical operation. The indicator is further defined as follows:

- Unplanned means that the trip was not an anticipated part of a planned test.
- Trip means the automatic shutdown of the reactor by a rapid insertion of negative reactivity (e.g., by control rods, liquid injection shutdown system, etc.) that is caused by actuation of the reactor protection system. The trip signal may have resulted from exceeding a set point or may have been spurious.
- Automatic means that the initial signal that caused actuation of the reactor protection system logic was provided from one of the sensors' monitoring plant parameters and conditions, rather than the manual trip switches or, in certain cases described in the clarifying notes, manual turbine trip switches (or pushbuttons) provided in the main control room.

- Critical means that, during the steady-state condition of the reactor prior to the trip, the effective multiplication factor (k_{eff}) was essentially equal to one.
- The value of 7,000 hours is representative of the critical hours of operation during a year for most plants and provides an indicator value that typically approximates the actual number of scrams occurring during the year.

Safety System Performance Indicators include the following:

- Auxiliary boiler feedwater system
- Emergency AC power
- High pressure emergency coolant injection system

These systems were selected for the safety system performance indicator based on their importance in preventing reactor core damage or extended plant outage. They include the principal systems needed for maintaining reactor coolant inventory following a loss of coolant, for decay heat removal following a reactor trip or loss of main feedwater, and for providing emergency AC power following a loss of plant off-site power. (Gas cooled reactors have an additional decay heat removal system instead of the coolant inventory maintenance system).

Nuclear Performance Index (NPI) Method 4
INPO sponsored performance measure and is a weighted composite of 10 WANO Performance Indicators related to safety and production performance reliability.

Forced Loss Rate (FLR)
Ratio of all unplanned forced energy losses during a given period of time to the reference energy generation minus energy generation losses corresponding to planned outages and any unplanned outage extensions of planned outages, during the same period, expressed as a percentage.

Unplanned Energy Losses
Either unplanned forced energy losses (unplanned energy generation losses not resulting from an outage extension) or unplanned outage extension of planned outage energy losses.

Unplanned Forced Energy Loss
Energy that was not produced because of unplanned shutdowns or unplanned load reductions due to causes under plant management control when the unit is considered to be at the disposal of the grid dispatcher. Causes of forced energy losses are considered to be unplanned if they are not scheduled at least four weeks in advance. Causes considered to be under plant management control are further defined in the clarifying notes.

Unplanned Outage Extension Energy Loss
Energy that was not produced because of an extension of a planned outage beyond the original planned end date due to originally scheduled work not being completed, or because newly scheduled work was added (planned and scheduled) to the outage less than four weeks before the scheduled end of the planned outage.

Planned Outage Energy Losses
Corresponding to outages or power reductions which were planned and scheduled at least four weeks in advance (see clarifying notes for exceptions).

Reference Energy Generation
Energy that could be produced if the unit were operated continuously at full power under reference ambient conditions throughout the given period. Reference ambient conditions are environmental conditions representative of the annual mean (or typical) ambient conditions for the unit.

Unit Capability Factor (UCF)
Ratio of the available energy generation over a given time period to the reference energy generation over the same time period, expressed as a percentage. Both of these energy generation terms are determined relative to reference ambient conditions.

Available Energy Generation
Energy that could have been produced under reference ambient conditions considering only limitations within control of plant management, i.e., plant equipment and personnel performance, and work control.

Reference Energy Generation
Energy that could be produced if the unit were operated continuously at full power under reference ambient conditions.

Reference Ambient Conditions
Environmental conditions representative of the annual mean (or typical) ambient conditions for the unit.

Chemistry Performance Indicator (CPI)
CPI compares the concentration of selected impurities and corrosion products to corresponding limiting values. Each parameter is divided by its limiting value, and the sum of these ratios is normalized to 1.0. If an impurity concentration is equal to or better than the limiting value, the limiting value is used as the concentration. This prevents increased concentrations of one parameter from being masked by better performance in another. As a result, if a plant is at or below the limiting value for all parameters, its indicator value would be 1.0, the lowest chemistry indicator value attainable under the indicator definition.

The following is used to determine each unit's chemistry indicator value for PHWRs:

- *Inconel-600 or Monel tubes
  - Steam generator blowdown chloride
  - Steam generator blowdown sulfate
  - Steam generator blowdown sodium
  - Final feedwater iron
  - Final feedwater copper
  - Final feedwater dissolved oxygen

- Incoloy-800 tubes
  - Steam generator blowdown chloride
  - Steam generator blowdown sulfate
  - Steam generator blowdown sodium
  - Final feedwater iron
  - Final feedwater dissolved oxygen

Online Deficient Maintenance (DM) Backlog
Average number of active on-line maintenance work orders per operating unit classified as Deficient Critical (DC) or Deficient Non-Critical (DN) that can be worked on without requiring the unit shutdown. This metric identifies deficiencies or degradation of plant equipment components that need to be remedied, but which do not represent a loss of functionality of the component or system.

Online Corrective Maintenance (CM) Backlog
Average number of active on-line maintenance work orders per operating unit classified as Corrective Critical (CC) or Corrective Non-Critical (CN) that can be worked on without requiring the unit shutdown. This metric identifies deficiencies or degradation of components that need to be remedied and represents a loss of functionality of a major component or system.

On-line Maintenance
Performed with the main generator connected to the grid.

Value for Money Definitions

The following definition summaries are taken from the January 2022 EUCG Nuclear Committee Data Definitions and Nuclear Integrated Information Database.

Capital Costs
All costs associated with improvements and modifications made during the reporting year. These costs should include design and installation costs in addition to equipment costs. Other miscellaneous capital additions such as facilities, computer equipment, moveable equipment, and vehicles should also be included. These costs should be fully burdened with indirect costs, but exclude AFUDC (interest and depreciation), spent fuel storage costs and/or reimbursements, capital write-off expenditures, taxes (except Payroll), and COVID response costs.

Nuclear Fuel Costs
Total cost associated with a load of fuel in the reactor which is burned up in a given year. Fuel burn costs should NOT include spent fuel storage costs or fuel impairment.

Fuel impairment is the write-down of the value of the Nuclear fuel and thus reduces the amortization or fuel expense, occurs in plants either announcing shutdown or are in a pending shutdown.

Net Generation
Gross electrical output of the unit measured at the output terminals of the turbine-generator minus the normal station service loads during the hours of the reporting period, expressed in Gigawatt hours (GWh).

Design Electrical Rating (DER)
Nominal net electrical output of a unit specified by the utility and used for plant design (DER net expressed in MWe). Design Electrical Rating should be the value that the unit was certified/designed to produce when constructed. The value would change if a power uprate was completed. After a power uprate, the value should be the certified or design value resulting from the uprate.

Operating Costs (Non-Fuel Operating Costs - NFOC)
All costs associated with normal operations, maintenance, and outage periods that occur within the current EUCG data reporting year. These costs should be fully burdened and reflect the total operating costs for labour, materials & equipment, outside services and other costs, but exclude depreciation, interest, taxes (except Payroll), COVID response costs, spent fuel storage costs and/or reimbursements, capital write-off expenditures, and new plant expenditures

New Plant Expenditures
All costs for supporting new nuclear generation and licensing efforts

Total Generating Costs (TGC)
Sum of operating costs, fuel costs and capital costs

Total Generating Costs (TGC) per MWh
Sum of operating costs, fuel costs and capital costs divided by Net Generation

Total Generating Costs (TGC) per Unit
Sum of operating costs, fuel costs and capital costs divided by Number of Units at Station

Non-Fuel Operating Costs (NFOC) per MWh
Operating costs divided by Net Generation

Fuel Costs per MWh
Nuclear Fuel costs divided by Net Generation

Capital Cost per MW DER
Capital costs divided by Design Electrical Rating (DER)

Human Performance Definitions

The following definition summary is taken from the Institute of Nuclear Power Operations (INPO) database.

Human Performance Error Rate (HPER)
Represents the number of site level human performance events in an 18-month period per 200,000 Industrial Safety Accident Rate (ISAR) hours worked (including on site supplemental personnel).

Formula = {(# of S-EFDRs) / (Total ISAR Hours + Total Contractor Hours)} x 200,000 Hours
(Calculated as an 18-month rolling average)

Non-utility Personnel
Includes contractor, supplemental personnel assigned to perform work activities on site or at other buildings that directly support station operation. This includes personnel who deliver and receive equipment, deliver fuel oil, remove trash and radioactive waste, and provide building and grounds maintenance within the owner-controlled areas or facilities that support the station.

Event
An initiating action (error) by an individual or group of individuals (event resulting from an active error) or an initiating action (not an error) by an individual or group of individuals during an activity conducted as planned (event resulting from a flawed defense or latent organizational weakness). They may be related to Nuclear Safety, Radiological Safety, Industrial Safety, Facility Operations or considered to be a Regulatory Event reportable to a regulator or governing agency. OPG Nuclear's criteria for defining station event free day resets have been developed based on INPO guidelines.

Industry Peer Groups

All data provided by the peer groups (WANO, INPO, EC, and EUCG) is confidential. A redacted version of this report, which removes individual plant and unit names, is available from Nuclear Business Planning and Benchmarking should there be a requirement to publicly release this report.

Table 2: Industry Peer Groups

Safety	COG CANDUs (WANO)	All North American PWR and PHWRs (WANO)	INPO AP-928 Workgroup	INPO	EC	EUCG North American Plants (US and Canada)
Total Recordable Injury Frequency					X	
Rolling Average Industrial Safety Accident Rate*+		X				
Rolling Average Collective Radiation Exposure*+	X					
Airborne Tritium Emissions (Curies) per Unit	X					
Fuel Reliability Index*	X					
2-Year Reactor Trip Rate*	X					
3-Year Auxiliary Feedwater System Unavailability*	X					
3-Year Emergency AC Power Unavailability*	X					
3-Year High Pressure Safety Injection Unavailability*	X					
Reliability						
Rolling Average WANO NPI +	X					
Rolling Average Forced Loss Rate*+	X					
Rolling Average Unit Capability Factor*+	X					
Rolling Average Chemistry Performance Indicator*+	X					
1-Year On-line Deficient Maintenance Backlog			X			
1-Year On-line Deficient Critical Backlog			X			
1-Year On-line Corrective Maintenance Backlog			X			
1-Year On-line Corrective Critical Backlog			X			
Value for Money						
3-Year Total Generating Costs / MWh						X
3-Year Non-Fuel Operating Costs (OM&A) / MWh						X
3-Year Fuel Costs / MWh						X
3-Year Capital Costs / MW DER						X
Human Performance						
18-Month Human Performance Error Rate				X		

** Sub-indicator of WANO NPI*
+ Rolling 2 Year Average PNGS ; Rolling 3 Year Average DNGS

Safety and Reliability Peer Groups

Primary source of benchmarking data for operational performance (Safety and Reliability) indicators is the World Association of Nuclear Operators (WANO). Eleven out of the twenty benchmarking metrics have been compared to the COG CANDU (WANO) panel. Industrial Safety Accident Rate (ISAR) is compared to the All North American PWR and PHWR (WANO) panel.

All WANO performance indicators are presented at the unit and plant levels except the Industrial Safety Accident Rate (ISAR) and Emergency AC Power Unavailability which are only measured at the plant level.

Different peer groups were used for 5 specialized operating metrics which are not tracked through WANO:

- *Total Recordable Injury Frequency*: Electricity Canada panel was utilized. OPG benchmarks against EC Group 1 peers (a subset of all EC members), which incorporates organizations with more that 1.500 employees, including most provincial utilities.

- *On-line Deficient Maintenance Backlog, On-line Deficient Critical Backlog, On-line Corrective Maintenance Backlog, On-line Corrective Critical Backlog:* Institute of Nuclear Power Operations (INPO) AP-928 working group was utilized.

Value for Money Peer Group

For financial performance comparisons, data compiled by the Electric Utility Cost Group (EUCG) was utilized. EUCG is a nuclear industry operating group and the recognized source for cost benchmark information. EUCG cost indicators are presented at the plant level and compared on a net megawatt hour generated basis and on a per megawatt (MW) design electrical rating (DER) basis. The only CANDU operators reporting data to EUCG were OPG and Bruce Power which is not a sufficiently large panel to provide a basis for comparison; hence, the data sets were not limited to a CANDU specific panel. Should more CANDU operators choose to join EUCG in the future, comparisons to a CANDU specific panel will be reconsidered.

Human Performance Peer Group

For human performance comparisons, data was obtained from INPO.

Panels/Members

Table 3: WANO Panel

Operator	Plant
Ameren Missouri	Callaway
American Electric Power Co.	Cook
Arizona Public Service Co.	Palo Verde
Bruce Power	Bruce A Bruce B
Dominion Generation	Millstone North Anna Surry V.C. Summer
Duke Energy	Catawba Harris Mcguire Oconee Robinson
Entergy Nuclear	Waterford
Exelon Generation Co.	Braidwood Byron Calvert Cliffs R.E. Ginna
FirstEnergy Nuclear Operating Co.	Beaver Valley Davis-Besse
Florida Power & Light Co.	St. Lucie Turkey Point
International CANDU	Cernavoda Embalse Qinshan 3 Wolsong A Wolsong B
Luminant Generation	Comanche Peak
New Brunswick Power	Point Lepreau
NextEra Energy Resources	Point Beach Seabrook
Northern States Power Company	Prairie Island
Ontario Power Generation	Darlington Pickering
Pacific Gas & Electric Co.	Diablo Canyon
Public Service Enterprise Group Nuclear	Salem
Southern Nuclear Operating Co.	Farley Vogtle
STP Nuclear Operating Co.	South Texas
Tennessee Valley Authority	Sequoyah Watts Bar
Wolf Creek Nuclear Operating Corp.	Wolf Creek

Table 4: EUCG Panel

Operator	Plant
AmerenUE	Callaway
American Electric Power Co. Inc.	Cook
Arizona Public Service Co.	Palo Verde
Bruce Power	Bruce
Dominion Generation	Millstone North Anna Surry V.C. Summer
DTE Energy	Fermi
Duke Energy	Brunswick Catawba Harris Mcguire Oconee Robinson
Energy Northwest	Columbia
Entergy Nuclear	Arkansas Nuclear One Grand Gulf Indian Point River Bend Waterford
Constellation Energy	Braidwood Byron Calvert Cliffs Clinton Dresden Fitzpatrick Lasalle Limerick Nine Mile Peach Bottom Quad Cities R.E. Ginna
FirstEnergy Nuclear Operating Co.	Beaver Valley Davis-Besse Perry
Florida Power & Light Co.	St Lucie Turkey Point
Luminant Generation	Comanche Peak
Nebraska Public Power District	Cooper
NextEra Energy Resources	Point Beach Seabrook
Northern States Power Company	Monticello Prairie Island
Ontario Power Generation	Darlington Pickering
Pacific Gas & Co.	Diablo Canyon
Public Service Enterprise Group Nuclear	Hope Creek Salem
Southern Nuclear Operating Co.	Farley Hatch Vogtle
STP Nuclear Operating Co.	South Texas
Talen Energy	Susquehanna
Tennessee Valley Authority	Browns Ferry Sequoyah Watts Bar
Wolf Creek Nuclear Operations Corp.	Wolf Creek

Table 5: COG CANDUs

Operator	Plant
Bruce Power	Bruce A Bruce B
China (CNNP)	Qinshan 3
NASA	Embalse
Korea (KHNP)	Wolsong A Wolsong B
New Brunswick Power	Point Lepreau
OPG	Darlington Pickering
Romania	Cernavoda

Table 6: Electricity Canada Members

Companies
Altalink
ATCO Electric (Alberta Power Ltd.)
Atura Power
BC Hydro
Capital Power Corporation
ENMAX Corporation
EPCOR
Evolugen
Fortis Alberta
FortisBC
Heartland Generation
Hydro One Networks Inc.
Hydro Ottawa
Hydro-Québec
Manitoba Hydro

Companies
Maritime Electric
Medicine Hat Electric Utility
Nalcor
New Brunswick Power
Newfoundland Power
Northwest Territories Power Corporation
Nova Scotia Power Inc.
Oakville Enterprises
Ontario Power Generation
Saint John Energy
Saskatoon Light & Power
SaskPower
TC Energy
Toronto Hydro
Yukon Energy Corporation

Table 7: INPO Members for On-Line Maintenance Backlogs

Plant	
Arkansas Nuclear One (ANO)	Millstone
Beaver Valley	Monticello
Braidwood	Nine Mile Point
Browns Ferry	North Anna
Brunswick	Oconee
Byron	Oyster Creek
Callaway	Palo Verde
Calvert Cliffs	Peach Bottom
Catawba	Perry
Clinton	Pilgrim
Columbia Gen	Point Beach
Comanche Peak	Prairie Island
Cook	Quad Cities
Cooper	River Bend
Davis-Besse	Robinson
Diablo Canyon	Salem
Dresden	Seabrook
Duane Arnold	Sequoyah
Farley	South Texas
Fermi 2	St. Lucie
Fitzpatrick	Summer
Ginna	Surry
Grand Gulf	Susquehanna
Harris	Turkey Point
Hatch	Vogtle
Hope Creek	Waterford
LaSalle	Watts Bar
Limerick	Wolf Creek
McGuire	

Table 8: INPO Members for Human Performance Error Rate

Plant	
Arkansas Nuclear One (ANO)	Millstone
Beaver Valley	Monticello
Braidwood	Nine Mile Point
Browns Ferry	North Anna
Brunswick	Oconee
Byron	Oyster Creek
Callaway	Palo Verde
Calvert Cliffs	Peach Bottom
Catawba	Perry
Clinton	Pilgrim
Columbia Gen	Point Beach
Comanche Peak	Prairie Island
Cook	Quad Cities
Cooper	River Bend
Davis-Besse	Robinson
Diablo Canyon	Salem
Dresden	Seabrook
Duane Arnold	Sequoyah
Farley	South Texas
Fermi 2	St. Lucie
Fitzpatrick	Summer
Ginna	Surry
Grand Gulf	Susquehanna
Harris	Turkey Point
Hatch	Vogtle
Hope Creek	Waterford
LaSalle	Watts Bar
Limerick	Wolf Creek
McGuire	