Nuclear

Standard

TITLE
MONITORING OF NUCLEAR AND HAZARDOUS SUBSTANCES IN EFFLUENTS

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PURPOSE

This Standard establishes minimum requirements for the monitoring of *nuclear* and *hazardous substances* in *airborne* and *waterborne effluents* from Ontario Power Generation, Nuclear (OPGN) facilities operating under *normal* and *abnormal operating conditions*. This document takes authority from OPG-PROG-0005, Environment Health and Safety Managed Systems.

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EXCEPTIONS

Monitoring of emissions resulting from *emergency incidents* at OPGN facilities is governed by emergency procedures (refer to N-PROG-RA-0001, Consolidated Nuclear Emergency Plan).

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1.0 DIRECTION

1.1 General Requirements

This standard provides requirements to establish an appropriate surveillance and monitoring program for *nuclear* and *hazardous substances* in *airborne* and *waterborne effluents* from OPGN facilities in accordance with the following Canadian Standards Association (CSA) standards:

- N288.5-22, Effluent and Emissions Monitoring Programs at Nuclear Facilities;
- N288.0-22, Environmental Management of Nuclear Facilities: Common Requirements of the CSA N288 Series of Standards.

Specific program elements interfacing with the CSA N288.5 are incorporated from the following standards:

- N288.8-17, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities.

OPGN facilities are also required to comply with any applicable statutes, regulations, licences, or permits that govern the operation of the facility including, but not limited to the following:

(a) Section 4 of Radiation Protection Regulations: The licensee shall ascertain the quantity and concentration of any *nuclear substance* released resulting from the licensed activity by direct measurement. However, if the required time and resources outweigh the usefulness of direct measurement, *estimation* of quantity and concentration may be used.

(b) Section 12 (1)(f) of General Nuclear Safety and Control Regulations: The licensee shall take all reasonable precautions to control the release of radioactive *nuclear substances* or *hazardous substances* within the licensed nuclear facility and into the *environment* as a result of the licensed activity.

(c) Section 3 of Class I Nuclear Facilities Regulations: An application for a Class I nuclear facility licence shall contain the proposed effluent monitoring program.

(d) Environmental Compliance Approvals.

Associated documents are referenced in Appendix A, Authority and Document Hierarchy for the Effluent Monitoring Program.

1.1.1 Objectives of Effluent Monitoring Program

Each nuclear facility shall consider applicability of the following objectives:

(a) Demonstrate compliance with authorized release limits and any other regulatory requirements (e.g., action levels) concerning the release of *nuclear* and *hazardous substances* from the source.

(b) Demonstrate adherence to internal objectives and targets set on release amounts, for purposes of effluent control.

(c) Confirm the adequacy of controls on releases from the source.

(d) Provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring.

(e) Provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the *nuclear* and *hazardous substances* of concern released from facility.

(f) Confirm predictions in the environmental impact statement made through the environmental review process.

(g) Provide assurance to the public on the effectiveness of effluent and emissions control.

(h) Provide data which, when combined with the results of environmental monitoring and modelling, can be used to test or refine the models used in the Environmental Risk Assessment (ERA) or dose assessments.

(i) Address any other objective identified by the nuclear facility or licensed activity (e.g., demonstrating due diligence, meeting a stakeholder commitment, or other business reasons).

(Refer to Clauses 5.1 and 5.2 of CSA N288.5-22.)

1.1.2 Criteria for Establishing an Effluent Monitoring Program

Each facility shall measure or, where measuring is not feasible, estimate the concentration or other appropriate characteristics of a *nuclear or hazardous substance* in *airborne and waterborne effluents*, or a physical or biological characteristic of an effluent or emission, if any of the following applies:

(a) Effluent monitoring of that substance or characteristic is required to demonstrate compliance with any statute, regulation, licence, or permit that governs the nuclear facility.

(b) The results of the ERA indicate potential concern with a substance released or an effluent characteristic.

(c) There is an operational need to identify an unplanned or uncontrolled release (reasonably foreseeable upset event) of a *nuclear or hazardous substance* into the environment.

(d) It supports a public radiation dose assessment (or an assessment of potential public exposure to *hazardous substances*).

(Refer to Clause 4.1 of CSA N288.5-22.)

1.1.3 Design of an Effluent Monitoring Program

(a) When it is determined that an effluent monitoring program is required, the program shall be designed and operated in accordance with the requirements of this standard. The scope and complexity of the program shall be sufficient to address the concerns about

the release of nuclear/hazardous substances that determined the need for an effluent and emissions monitoring program. (Refer to Clause 4.2 of CSA N288.5-22.)

(b) The effluent monitoring program shall be designed to address the applicable objectives of Section 1.1.1 with respect to the effluent streams and *nuclear or hazardous substances*, or other appropriate characteristic(s), or effect(s) that met the criteria for establishing the effluent monitoring program. (Refer to Clause 4.4.1.1, Monitoring program objectives of CSA N288.0-22.)

(c) The resulting effluent monitoring program shall be appropriate to the following:

(1) Effluent and emissions released from the nuclear facility or licensed activity.

(2) Nuclear/hazardous substances contained in the effluents and emissions.

(3) Objectives of the monitoring program.

(Refer to Clause 6.1of CSA N288.5-22.)

(d) The effluent monitoring program shall be developed using a systematic, informed planning process. The systematic planning process shall:

(1) Define the objectives of the effluent monitoring program.

(2) Identify the information required to meet the defined objectives.

(3) Define the spatial boundaries of the monitoring program, if applicable.

(4) Determine how the data collected should be used to achieve the defined objectives.

(5) Specify performance or acceptance criteria. [See bullet (g) below]

(6) Develop the detailed design of the effluent monitoring program that will be implemented to obtain the required data.

(Refer to Clause 4.4.2.2.1 of CSA N288.0-22 and to Clause 6.2 of CSA N288.5-22 for information details.)

(e) The specific objectives of Section 1.1.1 to each facility shall be defined and documented. (Refer to Clause 4.4.2.2.2 of CSA N288.0-22.)

(f) The parameters of the monitoring that are to be performed in order to meet the objectives of the program shall be identified. The information provided should include:

(1) What is to be monitored:

a) Effluents and emissions to be monitored and their physical or biological characteristics (e.g., temperature, flow, toxicity);

b) Hazardous substances to be monitored and appropriate characteristics (e.g., concentration, loadings) of each hazardous substance to be measured in each effluent and emission; and

c) Nuclear substances to be monitored and appropriate characteristics (e.g., activity concentration, loading) of each nuclear substance to be measured in each effluent and emission;

(2) Release and monitoring location of each effluent and emission to be monitored, whether these are point source or non-point source;

(3) Information on monitoring frequency; and

(4) Maximum anticipated concentration of *nuclear* and *hazardous substances* and physical or biological characteristics or other appropriate characteristic of the effluent, at each monitored point of release under normal operating conditions (which includes reasonably foreseeable operational upset events).

(Refer to Clause 6.2 of CSA N288.5-22. See CSA N288.0-22, Clause 4.4.2.2 for details on how an effluent and emissions monitoring program is to be developed using a systematic planning process.)

(g) The designer shall determine how the data collected, considering the associated uncertainty, will be used to achieve the defined objectives, including consideration of

(1) Specific questions to be resolved (hypotheses to be tested), methods of sampling (e.g., monitoring strategy), and planned statistical analyses of the data (e.g., trend analysis, gradient analysis).

(2) The metrics to be used for decision-making purposes (e.g., to determine the occurrence or severity of an effect).

(3) Pertinent evaluation criteria (e.g., a compliance level or other environmental protection criteria); and

(4) Pertinent decision threshold and detection limit.

(Refer to Clause 4.4.2.2.5 of CSA N288.0-22.)

The performance or acceptance criteria shall be specified. The data that are collected shall be adequate for the intended purpose. (Refer to Clause 4.4.2.2.6 of CSA N288.0-22.)

1.1.4 Quality Assurance and Quality Control

(a) All aspects of the effluent monitoring program shall have appropriate *Quality Assurance* (QA) and *Quality Control* (QC). This QA program can be an existing one. If it has been determined that existing QA documentation is appropriate, it may be cited and applied without document duplication. (Refer to Clause 7.1.1 of CSA N288.0-22.)

(b) A QA program shall be established to verify that the effluent monitoring program is adequate and accurate and/or to identify any deficiencies requiring corrective actions. The QA program applies to work done both by contract personnel and employees. (Refer to Clause 7.1.2.1 of CSA N288.0-22.)

(c) A calibration schedule shall be specified for measuring equipment. (Refer to Clauses 10.2.1 CSA N288.5-22.) The frequency of calibration of the measuring equipment should be based on reproducibility of measurements and control charts of the monitoring system to ensure that the measurements made are within the specified tolerances for accuracy. (Refer to clause 7.3.1.3 of CSA N288.0-22.)

(d) Continuous measurement systems offer an alternative approach to sampling and analysis for some parameters. Continuous measurement systems involve an on-line analyzer, measuring, or recording data at regular intervals. (Refer to Clause 7.5.2.1.4 N288.5-22.)

(e) The laboratory QA/QC program shall, where technologically feasible, incorporate the following activities:

(1) determination of precision, which should be determined by analysis of replicate samples;

(2) determination of accuracy, which should be determined by reference standards; Note: Examples of the use of reference standards are a) blind analysis of samples containing known concentrations of nuclear or hazardous substances; or b) reading known exposures for TLDs.

(3) use of laboratory blanks, which should be analyzed to detect and measure contamination and to provide information on the adequacy of background subtraction; and

(4) the use of laboratory and field QC samples, where at least 10% of the total samples analyzed are used for the activities of Items 1) to 3).

Note: 1) Laboratory QC samples include blanks, replicates, reference materials, control samples, and spikes. 2) For example, where standard reference material is not available (despite efforts made) for certain media, determination of accuracy is not technologically feasible. 3) In certain circumstances, repeated measurement of an individual sample may be sufficient (e.g., if there is no sample preparation).

(Refer to Clause 7.3.3.3 of CSA N288.0-22.)

(f) Routine performance testing of the sample collection system should be performed to demonstrate that samples are representative and collection efficiencies satisfy effluent and emissions monitoring requirements. For airborne monitoring systems, performance may be demonstrated using tracer gases, aerosols, and vapours as challenge agents. For waterborne monitoring systems, performance may be demonstrated by comparison with a reference (parallel) sampling system. Sample collection system performance testing should be conducted,

(1) during system commissioning;

(2) after significant changes have been made to the system (e.g., change in component);

(3) in accordance with the schedule recommended by the manufacturer; or

(4) at least every ten years.

(Refer to Clause 10.2.2 of CSA N288.5-22.)

(g) Changes to the effluent monitoring program which could significantly impact the accuracy of the effluent monitoring results should be reviewed by Nuclear Environment Programs and other relevant stakeholders, to assure the quality of the reporting data. This review may examine calculation technique, parameter selections, monitoring equipment, data estimations, and any other pertinent contributor to error.

1.1.5 Uncertainty Determination

(a) A statement of uncertainties inherent in the monitoring results shall be determined to provide confidence in the accuracy of reported emissions in *airborne* and *waterborne effluents*. (Refer to Clause 8.2.2 (c) of CSA N288.0-22.)

(b) The uncertainty associated with each measured or calculated value should be estimated. The uncertainty should take into account both sampling and measurement errors. Sampling errors cannot always be quantified but they shall be kept to a minimum by design of the monitoring program. Uncertainty estimates should be quantitative, if practical, or may be qualitative. (Refer to Clause 6.3.1 and 6.3.2 of CSA N288.0-22.)

(c) The number of significant figures quoted in an effluent monitoring result should not imply a degree of accuracy greater than that warranted by the sources of uncertainty. The least significant figure in the uncertainty should correspond to the least significant figure in the results, which can vary depending on the test method used (e.g., 3.7 +/- 0.7 Bq/kg). More significant figures should be carried for calculation steps than what is reported in the final stage. (Refer to Clause 6.3.5 of CSA N288.0-22.)

1.1.6 Sampling and Laboratory Analysis

(a) Sampling and analytical procedures shall be selected to provide data that are suitable for the intended purpose of the monitoring program. For example, sampling methods should provide a representative sample, and analysis methods should be sufficiently accurate, precise, and sensitive considering program objectives and expected analyte concentrations. Procedures shall be written or referenced for the following activities (as applicable):

(1) field sampling methods, including sample handling, identification, packaging, shipping, storage, preservation, and security requirements (such as chain of custody);

(2) laboratory analytical methods and their associated uncertainty, including analytical equipment, sample handling, identification, preparation, and processing;

(3) field measurement methods, including equipment operation, and recording of results;

(4) verification of equipment performance, including: i) calibration and maintenance of field and laboratory equipment; and ii) traceability of measurements, samples, and use of reference material); and

(5) data management, including: i) protection of the security and integrity of data entry, capture, storage, transmission and processing, and retention of all original data and calculations; ii) data validation and criteria for recognizing data outliers/abnormalities; and iii) documentation and verification of the adequacy of all computer software and programs before initial use and after each program modification.

(Refer to Clauses 5.1 of CSA N288.0-22 and 8.1 of CSA N288.5-22.)

(b) Sampling and analytical procedures shall be selected to provide data that are suitable for the intended purpose of the monitoring program. (Refer to 5.2 of CSA N288.0-22.)

(c) A system for uniquely identifying the samples shall be established to avoid confusion regarding the identity of the sample. (Refer to Clause C.2.4 of CSA N288.0-22.)

(d) A system shall be established to document and record custody of the samples and to transport them under appropriate conditions to the laboratory. (Refer to Clause C.2.5 of CSA N288.0-22.)

(e) Samples used for compliance purposes shall be analyzed at accredited laboratories or laboratories with documented comprehensive QA and QC programs. The facility should consider routine assessment of the laboratory through an accredited organization. (Refer to Clause C.3.2 of CSA N288.0-22.)

(f) The detection limit of the method used to measure the concentration of a *nuclear* and *hazardous substance* in an effluent should be less than the authorized release limit or action level identified for that *nuclear* and/or *hazardous substance*. Where the detection limit is greater than the authorized release limit or action level, the user shall give the rationale as to why this is acceptable in the circumstance or provide an alternative approach. (Refer to Clause C.3.3 of CSA N288.0-22.)

(g) A “less than” or non-detect level shall be defined and its derivation should be documented. (Refer to Clause C.3.4 of CSA N288.0-22.)

(h) A sample should be as nearly identical in content and consistency as possible to the media sampled. The sample integrity shall be maintained during storage, transportation, and analysis. (Refer to Clause C.1.1 of CSA N288.0-22)

(i) Where a single grab sample cannot be considered representative over a spatial area and/or timeframe that is relevant to program objectives, the sampling strategy shall consider the use of multiple samples, collected at different locations and/or times. Multiple samples may be combined to provide a more representative composite sample, or they may be separately analyzed, and the results combined to provide an estimate of the concentration distribution within the sampling domain. (Refer to Clause C.1.2 of CSA N288.0-22.)

(j) Sample volumes, container materials and preservatives should be appropriate to:

(1) provide sufficient volume to enable the laboratory to perform all planned analyses, achieve the program DQOs such as detection limits, and repeat the analyses if necessary; and

(2) prevent adsorption of analytes on container walls or other chemical alteration of the sample prior to analysis.

(Refer to Clause C.2.3 of CSA N288.0-22.)

(k) Some samples require preservation to ensure the stability of contaminants of concern during transportation and storage (see CSA N288.0, Table C.1). Samples requiring preservation should be preserved immediately upon collection, either at the time of collection of each grab sample or at the end of the collection period for samples collected with an automatic sampler. For some contaminants such as cyanide and phenolics, sample containers used in an automatic sampler shall be pre-charged with the appropriate preservative. (Refer to Clause 8.2.4.1of CSA N288.5-22)

(l) For air samples, measures shall be taken to minimize losses of aerosols, condensable vapours, and reactive gases in the sampling train. These measures may include:

(1) Locating the sample collection media close to the sample extraction nozzle.

(2) Constructing the components of the sampling train between the sample extraction nozzle and the sample collection media from materials that do not react with the contaminants anticipated to be in the airborne effluent.

(3) Avoiding flow obstructions (e.g., bends or abrupt changes in the diameter in the transport lines) between the sample extraction nozzle and the sample collection media.

(4) Preventing large or abrupt temperature changes in the transport lines between the sample extraction nozzle and the sample collection media by insulating or heat tracing the transport lines.

(Refer to Clause 8.3.1.1 of CSA N288.5-22.)

1.1.7 Interpretation of Data

(a) The data analysis and interpretation requirements shall be determined from the monitoring program objectives and shall be documented. This should include examination of data from actual samples and QC samples for consistency. Additionally, the applicability of the statistical analysis methods that might be used for interpretation of the data should be determined. (Refer to Clause 6.1.1 of CSA N288.0-22.)

(b) The result of a measurement for any contaminant, physical stressor, or effect shall be compared to the evaluation criteria for that measurement. Where the measured values are used to calculate a quantity for which there are evaluation criteria, the calculated value should be compared to the evaluation criteria. Any required conversion factors shall be documented. (Refer to Clause 6.1.2 of CSA N288.0-22)

(c) The methods for reporting and subsequent use of measurements that are less than the non-detect level shall be defined and documented. (Refer to Clause C.3.4 of CSA N288.0-22.)

(d) Facilities Environment personnel shall:

(1) Routinely review the emission data to identify adverse trends.

(2) Where applicable, assess the need for updating internal investigation levels (IIL), and the site emission effective dose for monitored airborne and waterborne radionuclides. This assessment may be done using N-FORM-03480-00001, *Checklist to Determine if IIL Should be Reviewed.* The assessment task should be performed, as a minimum:

(i) Following any change to the facility, system, or process that might significantly alter emissions, or

(ii) Annually.

(3) Develop corrective actions, if necessary, to address the adverse trends.

1.1.8 Documentation

(a) Appropriate documentation to support the effluent monitoring program such as PLAN documents, manuals, emissions reporting methods, and records retention requirements are required to demonstrate overall integrity of the monitoring program.

(b) The detailed design of the effluent monitoring program shall be documented. For each group of measurements, the program documents shall specify the details and the rationale for the selection of:

(1) The monitoring objectives.

(2) The *nuclear* and *hazardous substances* or physical characteristic to be monitored and assessed in relation to those objectives.

(3) The method or metric that shall be used to assess that *nuclear* and *hazardous substances* or physical characteristic.

(4) The measurements to be taken or estimates to be made on the effluent stream

(5) The choice of monitoring strategy.

(6) The sampling locations where these effluent streams and *nuclear* and *hazardous substances* shall be measured or sampled for subsequent analysis.

(7) The sampling frequency for each group of *nuclear* and *hazardous substances*.

(8) The time-frame over which the measurements shall be conducted (whether the monitoring is to be performed as part of a supplementary study or if it is to be incorporated into the routine effluent monitoring program of the facility).

(9) The analysis that shall be performed and the detection limits for that analysis.

(10) The acceptance criteria (which may include limits on QC measurements and sample availability) and performance criteria (which may include critical effect size and acceptable Type I and Type II error rates) that shall be met for the data to serve their intended purpose.

(11) The interpretation and reporting requirements for the collected data.

(Refer to Clause 13.2 of CSA N288.5-22.)

(c) The program documents shall identify the existence of:

(1) Staff qualification and training requirements;

(2) Sampling and analysis methods;

(3) QA and QC programs; and

(4) Audit and review programs.

(Refer to Clause 10.2 of CSA N288.0-22.)

(d) A map or flowsheet showing the locations of all monitoring or sampling points shall be included in the facility's effluent monitoring program documents. (Refer to Clause 13.3 of CSA N288.5-22.)

1.1.9 Monitoring Records

(a) Records shall be readable, complete, identifiable, traceable to related items and work, retrievable, preserved, and retained as specified. (Clause 7.5.1 of CSA N288.0-22.)

(b) At a minimum, where applicable, any monitoring records that are directly related to the program shall include:

(1) program and design documents together with summaries of any information essential to the design of the program that is not included in the program documents;

(2) records of sample location, collection date, and the results of the analysis; and

(3) results of the interpretation of the data together with summaries of any information essential to the interpretation of the data.

(Refer to Clause 7.5.2 of CSA N288.0-22.)

(c) The period of retention for any monitoring records directly related to the program addressed shall span the life cycle of the facility. (Refer to Clause 7.5.3 of CSA N288.0-22.)

1.1.10 Reporting

Each nuclear facility shall prepare and submit to the appropriate regulator(s) any reports as required by the statutes, regulations, licences, and permits that govern the operation of the facility. A system shall be in place to ensure that reporting requirements governing the operation of the nuclear facility are met. (Refer to Clause 8.2.1 of CSA N288.0-22.)

The report(s) shall include:

(a) The results of the program addressed, including as applicable,

(1) measurements of the monitored hazardous and/or nuclear substances, physical stressors, and physical and biological parameters, including their statistical analyses (e.g., assessments of changes through time or space) and associated uncertainty;

(2) radiation doses calculated as doses to receptors where this is required;

(3) comparison of the results to any limit, level, or benchmark;

(4) results of effects monitoring;

(5) the characteristics of the effluents or emissions;

(6) the results of any toxicity testing (if required);

(7) an assessment of the program results in accordance with the program objectives;

(8) documentation and justification of any deviations from field sampling, and analytical and data management procedures; and

(9) data analysis and interpretations;

(b) a summary and assessment of the field and laboratory QA/QC results, including any non-conformances;

(c) a statement of uncertainties inherent in the monitoring results and any dose estimates derived from those results;

(d) a summary of the audit and review results and subsequent corrective actions;

(e) a summary of any proposed modifications to the program addressed; and

(f) documentation, assessment, and review of any supplementary studies that have been initiated, completed, or both.

(Refer to Clause 8.2.2 of CSA N288.0-22)

1.1.10.1 Reporting Requirements

As required in REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants (hereafter referred to as REGDOC-3.1.1), PN and DN stations shall report to the CNSC using event reports for situations or events of higher safety significance and that may require short-term action by the CNSC and shall submit routine scheduled reports on various topics that are

required for longer-term compliance monitoring. Under REGDOC-3.1.1, "reporting" means scheduled reports, event reports, notifications, and the submission of specific records.

Table A.1 of REGDOC-3.1.1 provides a list of the situations and events for which an event report is required, including the timeline for each event report. Applicable sections include, but are not limited to, Table A.1, No.21, “Reaching an action level for the purposes of environmental or radiation protection”, and No. 22, “Nuclear and hazardous substance release”, under “Specific reporting provisions”.

The scheduled reports in REGDOC-3.1.1 for environment are:

(a) Quarterly report on safety performance indicators (refer to Section 3.1 of REGDOC-3.1.1);

(b) Annual report on environmental protection (refer to Section 3.5 of REGDOC-3.1.1); and

(c) Site environmental risk assessment (refer to Section 4.3 of REGDOC-3.1.1).

The reporting requirements of Nuclear Sustainability Services, Western (NSS-W), Nuclear Sustainability Services, Pickering (NSS-P) and Nuclear Sustainability Services, Darlington (NSS-P) are provided in the site’s operating licence.

Non-compliance of requirements described in this Standard requires prompt action to be taken by responsible person(s) to return system to acceptable operating conditions. Non-compliance events shall be documented in accordance with N-PROG-RA-0003, Performance Improvement.

1.1.11 Decommissioning of Existing Monitors/Samplers

Decommissioning of existing monitors/samplers shall be reviewed by Environment Programs – Nuclear, and approved by NSS Manager, Performance Engineering, and PN and DN Section Manager, Environment in accordance with N-PROG-MP-0001, Engineering Change Control.

1.1.12 Program Review

(a) NSS Manager, Performance Engineering, and PN and DN Section Manager, Environment shall review the need for, and adequacy of, the facility’s effluent monitoring program in accordance with N-PROC-RA-0097, Self-Assessment and Benchmarking, as follows:

(1) prior to applying for a licence to begin a new stage in the lifecycle of the facility or licensed activity.

(2) following the proclamation or amendment of any pertinent statute, regulation, licence, or permit that governs the facility.

(3) following any change in the commitments made to a regulatory agency, other stakeholder, or Indigenous community;

(4) following any modification of the physical plant or any change in the nuclear facility or licensed activity or the site ecology or surrounding land uses that has the potential to substantially alter the nature of what is covered under the program;

(5) following any change in the receiving environment that that has the potential to significantly change the potential risk to pathways/receptors as a result of the nuclear facility or licensed activity

(6) following a significant revision to the Conceptual Site Model;

(7) following any update or revision of the ERA for the facility;

(8) if otherwise required by the Authority Having Jurisdiction;

(9) if new scientific advances require change to the approach of a program; and

(10) not more than five years after the last review of the need for, and adequacy of, an effluent monitoring program.

(Refer to Clause 8.4.2 of CSA N288.0-22.)

(b) A periodic review of the need for, and adequacy of, an effluent monitoring program shall include:

(1) an evaluation of whether the program is still required as per criteria set out in CSA N288.0-22 Clauses 4.1 and 4.2, and N288.5-22 (i.e., monitoring required by the Authority Having Jurisdiction or based on an Environmental Risk Assessment);

(2) an evaluation of the data that has been collected by the program;

(3) any reassessment of the environmental risks; and.

(4) an assessment of whether the objectives of the effluent monitoring program have been achieved.

(Refer to Clause 8.4.3 of CSA N288.0-22)

(c) The outcome of the review shall indicate whether there is still a need for the program and if so, whether the current program adequately meets the objectives of the program. Any program changes required to ensure the objectives are being met shall be made accordingly. (Refer to Clause 8.4.4 of CSA N288.0-22.)

1.1.13 Program Audit

To confirm that the program is carried out in compliance with its procedures and elements, an audit of the core elements of the program shall be completed a) once every five years; or b) more frequently if operational conditions change.

Note: Audits of ALs from CSA N288.8 are included in the audits for CSA N288.5. (Refer to Clause 8.5.1 of CSA N288.0-22)

Environment personnel shall notify Nuclear Oversight if an audit is required due to a significant change in conditions.

1.2 Specific Requirements for Effluent Monitoring of Nuclear Substances

(a) Each nuclear facility shall have an effluent monitoring program for *nuclear substances*. The program shall include the following areas, where applicable:

- Radioactive *airborne effluents*
- Radioactive *waterborne effluents – batch discharges*
- Radioactive *waterborne effluents – continuous discharges*
- Forebay influent and CCW or Outfall streams

(b) Where applicable, the effluent monitoring program of *nuclear substances* should include monitoring of the radionuclides or radionuclide groups. These are summarized in Table 1, Monitored Nuclear Substances in Airborne and Waterborne Effluents, and are based on the results of the Derived Release Limits (DRLs).

(c) In waterborne effluents, measuring gross beta or gross gamma provides a rough estimate of the total gross beta and gamma activity which is suitable for screening purposes of the gross “beta-gamma” DRL.

Table 1. Monitored Nuclear Substances in Airborne and Waterborne Effluents

Effluent Stream	Radionuclides or Radionuclide Groups
Airborne	Tritium, elemental Tritium, Particulates, Iodine, Noble Gas, Carbon-14, and gross Alpha.
Waterborne	Tritium, Carbon-14, gross Alpha, and gross beta / gross gamma.

1.2.1 Maximum Probable Emission Rate

(a) If monitoring of an *effluent stream* is required, based on the criteria listed in Section 1.2, *Maximum Probable Emission Rate (MPER)* to DRL ratio is used to determine the type of monitoring (refer to Figure 1).

(b) *MPER* can be determined using available process knowledge including design of the system, release scenario, radionuclide(s) of concern, emission control systems, etc. The available methodologies to determine *MPER* include, but are not limited to, the following:

(1) *NER* plus emissions from the Maximum Abnormal Release Scenario (MARS). If no MARS can be postulated, 10 times of the *NER* (if measured emissions are typically greater than minimum detection level) can be used as MARS. A

calculation example is provided in Appendix B, Example of Maximum Probable Emission Rate Calculation.

(2) Maximum emission calculations using engineering calculations and radionuclide materials inventory (e.g., where there is insufficient monitoring data).

(c) If an *effluent stream* has *performance* and *control monitoring* in place, calculation of the *MPER* is not required.

(d) If significant *changes* in conditions occur on a particular *effluent stream*, then recalculation of the MPER is required.

1.2.2 Monitoring Criteria

(a) Types of monitoring include *performance monitoring* and *control monitoring*.

(b) The effluent monitoring program of *nuclear substances* follows a risk-based approach based on *MPER*. Requirement for *performance monitoring*, *control monitoring*, and emission reporting is determined based on the ratio of *MPER* to *DRL* for each radionuclide or *radionuclide group* as described below and shown in Figure 1, Monitoring and Reporting Criteria for *Nuclear Substances in* Effluent Streams.

(1) *Performance monitoring* is required if:

(i) *MPER* value exceeds 5% of weekly *DRL* for *airborne effluents* and/or 5% of monthly *DRL* for *waterborne effluents*. *Direct sampling or measurement and* reporting of the results are required.

(ii) *MPER* value is within 0.05% and 5% of weekly *DRL* for *airborne effluents* and/or within 0.05% and 5% of monthly *DRL* for *waterborne effluents*. *Direct sampling or measurement* should be undertaken. If required time and resources for *direct sampling or measurement* outweigh its usefulness, *estimation* of emissions instead of *direct sampling or measurement* may be done with approval from NSSD Manager, Performance Engineering, and PN and DN Section Manager, Environment. Reporting of the results is required.

(2) *Control monitoring* is required, in addition to *performance monitoring,* if the *MPER value exceeds 5*% of the weekly *DRL* for *airborne effluents* and 5*% of monthly DRL for waterborne effluents.*

(3) *Performance monitoring* may satisfy *control monitoring* requirements if the period for *performance monitoring* sampling and analysis is les*s* than the *period* required in the MPER calculation to exceed 5% of weekly *DRL* for *airborne effluents an*d *5% of monthly DRL* for *waterborne effluents*.

(4) For temporary discharges or when *performance monitoring* is not required (i.e., *MPER* is below 0.05% of *DRL*), emissions greater than 0.025% MPER/DRL shall be reported. If the emissions are below the minimum detectable limit, then this reporting requirement does not apply.

(5) Facility specific conditions such as ge*ographical locatio*ns or stakeholder interest may require additional monitoring beyond the *MPER* criteria.

(6) *Performance* and *control monitoring* is required, without performing the *MPER* calculation, for DN Active Liquid Waste (ALW) system and PN Radioactive Liquid Waste Management System (RLWMS).

% of MPER to DRL	
5.0 %	- Performance monitoring and control monitoring are required. - Direct sampling is required. - Reporting the results of performance monitoring is required.
0.05%	- Performance monitoring is required. - Control monitoring is not required. - Direct sampling or measurement should be used - Reporting the results of performance monitoring is required.
	- Performance monitoring is not required. - If emission is greater than 0.025% MPER/DRL, reporting is required.

Figure 1. Monitoring and Reporting Criteria for Nuclear Substances in Effluent Streams

1.2.3 Unavailability

Alternative sampling methods that can be used during periods of equipment failure or sampler unavailability should be included in the sampling procedures. Alternative methods should be capable of producing a representative sample and may be used as an interim measure until the primary sampling method is made functional. Validation of the alternative sampling method, or cross-comparison of the two methods, might be necessary to ensure consistency of the results.

Note: For example, in the event of failure of a continuous measurement system such as an on-line analyzer, sampling can be replaced by collecting composite samples, followed by laboratory analysis.

(Refer to Clause C.2.7 of CSA N288.0-22.)

(a) Unavailability is the time an *effluent stream* is not being monitored due to, for example, component impairment or failure, maintenance without backup monitoring, impairment of samples, laboratory analysis error.

(b) Unavailability shall be tracked for all performance and control monitors with *direct sampling or measurement* systems.

(c) Inaccuracy of *monitoring system* parameters such as stack flow meters is a QA issue and is not construed as unavailability.

(d) Table 2, Unavailability Limits for Airborne and Waterborne Effluents, provides unavailability limits for planned and unplanned events. Planned unavailability includes routine maintenance or inspections, and calibration sequences. Unplanned

unavailability includes unexpected monitor component failures, loss of samples or incorrect analytical results.

(e) Unavailability shall be tracked in hours per year for each radionuclide and *radionuclide group* for each *effluent stream*. The methodology for calculating unavailability is provided in Appendix C, Methodology for Unavailability Calculation.

(f) Every effort should be made to minimize unavailability such as using interim sampling and/or monitoring.

(g) Unavailability for *performance* and *control monitoring* of *waterborne effluent - batch discharges* can occur only during the *batch discharge* process. Monitoring equipment may therefore be out of service and not be considered unavailable while there are no *batch discharges*.

(h) Due to short duration, routine media change on *airborne effluent* monitors and routine sample container change out for *waterborne effluent* monitors are not considered as planned or unplanned unavailability of the equipment.

Table 2. Unavailability Limits for Airborne and Waterborne Effluents

Effluents	Performance Monitoring	Control Monitoring
Airborne Effluents	(a) Planned: 168 hours/year (b) Unplanned: (1) 84 hours/year for *Normal Emission Rate (NER)* $\geq$ 0.5% of weekly *DRL* (2) 288 hours/year for *NER* < 0.5% of weekly *DRL*	(a) Planned: 168 hours/year (b) Unplanned: (1) 84 hours/year for *NER* $\geq$ 0.5% of weekly *DRL* (2) 288 hours/year for *NER* < 0.5% of weekly *DRL*
Waterborne Effluents - Batch Streams ***(Except ALW/ RLWMS)***	(a) Planned: (1) 24 hours/year for *NER* $\geq$ 0.5% of monthly *DRL* (2) 96 hours/year for *NER* < 0.5% of monthly *DRL* (b) Unplanned: (1) 24 hours/year for *NER* $\geq$ 0.5% of monthly *DRL* (2) 96 hours/year for *NER* < 0.5% of monthly *DRL*	(a) Planned: Zero (b) Unplanned: 24 hours/year
Waterborne Effluents - Batch Streams ***(ALW and RLWMS only)***	(a) Planned: Zero (b) Unplanned: 24 hours/year	(a) Planned: 8 hours/year (b) Unplanned: 40 hours/year Note: (a) and (b) are only applicable for on-line gross gamma monitor.
Waterborne Effluents - Continuous Streams	(a) Planned: 168 hours/year (b) Unplanned: (1) 84 hours/year for *NER* $\geq$ 0.5% of monthly *DRL* (2) 288 hours/year for *NER* < 0.5% of monthly *DRL*	(a) Planned: 168 hours/year (b) Unplanned: (1) 84 hours/year for *NER* $\geq$ 0.5% of monthly *DRL* (2) 288 hours/year for *NER* < 0.5% of monthly *DRL*

Forebay and CCW or Outfall Streams	(a) Planned: 168 hours/year (b) Unplanned: 708 hours/year

1.2.4 Alarms

Alarms may be either physical devices or procedures which are required to alert appropriate staff of monitor/sampler malfunction, loss of sample/test results, or emissions exceeding in a set point or target.

1.2.5 Airborne Effluents

1.2.5.1 Sampling/Monitoring/Analysis Frequency

(a) Continuous sampling/monitoring is required for both *performance* and *control monitoring,* and samples shall be analysed weekly as a minimum.

(b) Continuous analysis/measurement is required for *control monitoring* when the time for an *MPER* event to exceed 5% of weekly *DRL* is 12 hours or less. A sample calculation is provided in Appendix D, Sample Analysis Period for Control Monitoring.

1.2.5.2 Sample Analysis

(a) For *performance monitoring*, radionuclide-specific analyses shall be performed for all streams if gross activity exceeds 5% of weekly *DRL*.

(b) Noble gas is measured in total gamma energy release rate (Ci-MeV/s) instead of gross activity.

1.2.5.3 Monitoring and Instrument Operating Range

(a) Upper and lower ranges of measurement for *performance monitoring* are set to ensure the monitoring requirements of Sections 1.1.1 to 1.1.3 are satisfied.

(b) Lower range of measurement for *control monitoring* is based on requirement that some warning is necessary before targets are exceeded. Upper range of measurement for *control monitoring* is based on requirement that control actions shall be taken before emissions reach this level and to ensure regulatory limits are not exceeded.

(c) Field and laboratory monitor/instrument operating range may be established as follows:

(1) *Performance Monitoring*

(i) Lower Limit: $$\frac{0.05\% \text{ of weekly DRL}}{\text{Mean weekly system flow rate at sampling point}}$$

(ii) Upper Limit: $$\frac{200\% \text{ of weekly DRL}}{\text{Mean weekly system flow rate at sampling point}}$$

(2) *Control Monitoring*

(i) Lower Limit: $\frac{0.5\% \text{ of weekly DRL}}{\text{Mean weekly system flow rate at sampling point}}$

(ii) Upper Limit: $\frac{50\% \text{ of weekly DRL}}{\text{Mean weekly system flow rate at sampling point}}$

1.2.5.4 Quality Assurance Elements

The following QA elements are applicable to all permanent and interim performance monitors and control monitors.

(a) A source constancy check shall be performed in accordance with the manufacturer's instructions or vendor recommendation; if no instructions exist, at least weekly.

Note: If the monitor is out of service (e.g., due to being repaired) or inaccessible (e.g., the systems is boxed-up), the test shall be performed as soon as the condition is resolved.

(b) Effluent flow rates shall be determined because they directly impact the accuracy of the emissions estimates. The flow rates should be based on a standard effluent density or adjusted for differences in effluent density. (Refer to Clause 8.3.2.1 of CSA N288.5-22.)

(c) The sample flow rate, sample volume, or sample mass shall be measured and recorded. (Refer to Clause 8.3.3.1 of CSA N288.5-22.)

(d) Sample flow and stack flow measurements shall be performed once per calendar year in accordance with N-INS-03480-10002, Performance Testing of Airborne Effluent Monitoring Systems, or an equivalent procedure from an external service provider that has been approved by Director, Environment - Nuclear.

(e) A leak in the sampling system can cause errors in the measured sample flow rate or malfunction of the sample collection system. Sampling systems shall be assessed for leaks as follows:

1) At the time of installation or commissioning

2) Following any maintenance or replacement of the sample collection media that might compromise the integrity of the sampling system, after completion of any air sampling test, and

3) At regularly scheduled intervals.

(Refer to Clause 8.3.1.2 of CSA N288.5.)

(f) System walkdown for monitoring systems shall be performed and recorded daily in accordance with the approved procedures.

Note: System walk-down from used fuel dry storage facilities is not required when there are no waste management activities for extended period of time, e.g., weekends and statutory holidays.

(g) Routine performance testing of sample collection system should be performed to demonstrate that samples are representative and collection efficiencies satisfy effluent and emissions monitoring requirements. For airborne monitoring systems, performance can be demonstrated using tracer gases, aerosols, and vapours as challenge agents.

Sample collection system performance testing should be conducted

(1) during system commissioning,

(2) after *significant changes* have been made to the system (e.g., change in major component),

(3) in accordance with the schedule recommended by the manufacturer, or

(4) at least every ten years.

(Refer to Clause 10.2.2 of CSA N288.5-22.)

(h) Field Detector Calibration shall be performed once per calendar year in accordance with the approved procedures. (Refer to Clause 10.2.1 of CSA N288.5-22.)

1.2.6 Waterborne Effluent - Batch Discharges

This section provides specific requirements for *waterborne effluent - batch discharges, which* include the following:

(a) ALW and RLWMS.

(b) Non-ALW/RLWMS *batch discharges* such as vacuum building dousing tanks, Emergency Coolant Injection tanks, and other tanks and sumps.

1.2.6.1 Sampling/Monitoring/Analysis Frequency

(a) For *performance* and *control monitoring*, representative pre-discharge sample shall be taken. For ALW and RLWMS, pre-discharge sample from each tank shall be taken after re-circulating the tank for a pre-determined period, to ensure samples are representative and by sampling at ≥ 15-minute intervals, until the radio-analyses of consecutive samples agree to the acceptable error bound, or until at least 4 pre-discharge individual samples are collected for averaging and reporting as a composite sample. Acceptable error bounds are defined as ± 20% for Tritium Oxide, and for Gross Gamma by:

Gross Gamma Concentration	Acceptable error bound
>0.002 µCi/L	± 50%
< 0.002 µCi/L	± 100%

(b) For *control monitoring,* the pre-discharge samples shall be analyzed prior to discharge. *Continuous Monitoring* of gross gamma in ALW and RLWMS is required during discharge. In the event of on-line monitor unavailability, the pre-discharge sampling may

be modified (e.g., with the use of at least 5 samples), sufficient to identify the presence of hot particles in one of the samples.

(c) For *performance monitoring* of ALW and RLWMS:

(1) Pre-discharge sample shall be analyzed for Tritium and gross beta or gross gamma.

(2) A composite of pre-discharge samples of pump-outs during the month shall be analyzed for carbon-14 and radionuclide specific beta or radionuclide specific gamma.

(d) If the result of monthly carbon-14 analysis as required by (c)(2) above equals or exceeds 0.005% of the monthly *DRL* or shows a significant upward trend, then pre-discharge screening of carbon-14 shall be implemented until carbon-14 emissions are below 0.005% of the monthly *DRL* and no observable adverse trend is noted.

(e) For ALW and RLWMS, gross alpha emissions shall be estimated and reported.

1.2.6.2 Sample Analysis

(a) For non-ALW/RLWMS *performance monitoring,* radionuclide-specific analyses shall be performed for all streams if gross activity exceeds 5% of monthly *DRL*.

(b) For ALW and RLWMS, resources required for Carbon-14 on-line discharge *control monitoring* outweigh its usefulness since recirculation of tank and pre-discharge samples provides an adequately representative Carbon-14 sample.

1.2.6.3 Effluent Treatment and Emission Control (for ALW and RLWMS only)

To ensure concentration of *nuclear substances* in ALW and RLWMS is below *DRLs* or *Action Levels*, effluent treatment such as tank hold-up, and purification (e.g., filtration and ion exchange) shall be considered.

1.2.6.4 Monitor and Instrument Operating Range

(a) Upper and lower ranges of measurement for *performance monitoring* are set to ensure the monitoring requirements of Sections 1.1 to 1.3 are satisfied.

(b) Lower range of measurement for *control monitoring* is based on requirement that some warning is necessary before targets are exceeded.

(c) Field and laboratory monitor/instrument operating range may be calculated as follows:

(1) Performance Monitoring

(i) Lower Limit: $$\frac{0.05\% \text{ of monthly DRL}}{\text{Mean monthly volume of discharge}}$$

(ii) Upper Limit: Not applicable.

(2) Control Monitoring

(i) Lower Limit: $\frac{0.5\% \text{ of monthly DRL}}{\text{Mean monthly volume of discharge}}$

(ii) Upper Limit: Not applicable.

1.2.6.5 Quality Assurance Elements

The following QA elements are applicable to ALW and RLWMS only.

(a) Representative Sampling Check shall be performed once per calendar year for *performance monitoring* systems.

The error between the routinely obtained pre-discharge sample and a *composite sample* comprised of samples collected a minimum of five times evenly across the discharge of the tank shall be less than the acceptable error bound of Section 1.2.6.1(a). If the error exceeds the prescribed error bounds, the cause shall be determined and appropriate actions shall be taken in accordance with N-PROG-RA-0003, Performance Improvement.

(b) Constancy Check shall be performed for control monitors every month in accordance with the approved procedures to ensure the appropriate physical response to a challenge source.

(c) Field Equipment Performance Verification of control monitors shall be performed once per calendar year to ensure the discharge valve will close when challenged by a radioactive source at the appropriate alarm level.

1.2.7 Waterborne Effluent - Continuous Discharges

This section provides specific requirements for *waterborne effluent - continuous discharges*, which include the following discharge streams:

- Cooling service water associated with moderator and shutdown cooling heat exchanger service water.
- Inactive sewage and inactive building sump discharges (not considered *batch discharge* streams due to absence of mechanical device to control the flow).
- Boiler blowdown.
- Other potential continuous *effluent streams*.

1.2.7.1 Sampling/Monitoring/Analysis Frequency

(a) Continuous sampling/monitoring is required for both *performance* and *control monitoring* and samples shall be analysed at least weekly.

(b) Continuous analysis/measurement is required for *control monitoring,* when the time for an *MPER* event to exceed 5% monthly *DRL* is 12 hours, or less. A sample calculation is provided in Appendix D.

1.2.7.2 Sample Analysis

For *performance monitoring,* radionuclide-specific analyses shall be performed for all streams, if gross activity exceeds 5% of monthly *DRL*

1.2.7.3 Monitoring and Instrument Operating Range

(a) Upper and lower ranges of measurement for *performance monitoring* are set to ensure the monitoring requirements of Sections 1.1 to 1.3 are satisfied.

(b) Lower range of measurement for *control monitoring* is based on requirement that some warning is necessary before targets are exceeded.

(c) Field and laboratory monitor/instrument operating range may be calculated as follows:

(1) *Performance Monitoring*

(i) Lower Limit: $$\frac{0.05\% \text{ of monthly DRL}}{\text{Mean monthly flow rate at sampling point}}$$

(ii) Upper Limit: Not applicable.

(2) *Control Monitoring*

(i) Lower Limit: $$\frac{0.5\% \text{ of monthly DRL}}{\text{Mean monthly flow rate at sampling point}}$$

(ii) Upper Limit: Not applicable.

1.2.7.4 Quality Assurance Elements

(a) Field Monitor Performance Verification shall be performed weekly for performance monitors to ensure adequate sample volume is obtained during each collection period. Corrective actions shall be initiated if sample collection volume is not within ±20% of designed sample.

(b) Constancy Check shall be performed weekly for control monitors to ensure the field equipment will respond to the appropriate challenge source. Otherwise, constancy check shall be performed before each discharge.

1.2.8 Forebay Influent and CCW or Outfall Streams

1.2.8.1 Monitoring Requirements

(a) Monitoring of Forebay influent may be performed to quantify any radionuclides coming in the nuclear facility. Concentrations of radionuclides in the Forebay influent may be used for background subtract.

(b) Monitoring of CCW or Outfall discharge shall be performed as a final check on emissions. Due to high dilution (i.e., very high flow rate) in the CCW or Outfall discharge, monitoring provides a less precise measure and therefore is not used for reporting purposes.

1.2.8.2 Sampling/Monitoring Frequency

Continuous sampling/monitoring shall be required, and samples shall be analysed weekly for tritium and gross beta or gross gamma.

1.2.8.3 Monitoring and Instrument Operating Range

Field and laboratory monitor/instrument operating range shall be calculated as follows:

(a) Lower Limit: Background concentration

(b) Upper Limit: Not applicable.

1.2.8.4 Quality Assurance Elements

Field Monitor Performance Verification shall be performed monthly to ensure adequate sample volume is obtained during each collection period. Corrective actions shall be initiated if sample collection volume is not within ±20% of designed sample.

1.3 Action Levels

Implementation of this section and subsections is planned for December 31, 2023.

1.3.1 Reporting Exceedance of AL

An *Action Level* is a specific dose of radiation or other parameter that, if reached, may indicate a potential *Loss of Control* of part of the licensee's radiation protection program, or environmental protection program, and triggers a requirement to report to the CNSC. An assessment of the event should ascertain and document if a *Loss of Control* of the environmental protection program is associated.

1.3.2 Documentation of AL Development

Based on guidance and methodology specified in CSA N288.8-17 and CNSC guidance G-228, Developing and Using Action Levels, environmental *Action Levels* are implemented by the following reports (as revised by OPG and as accepted by CNSC):

(a) NK38-REP-03482-10002, Action Levels for Environmental Releases - Darlington Nuclear

(b) P-REP-03482-00007, Action Levels for Environmental Releases - Pickering Nuclear

(c) 0125-REP-03482-00004, Action Levels for Environmental Releases – Western Waste Management Facility

Note: Developers of Action Levels shall refer to all relevant clauses of N288.8-17. Guidance in N-STD-OP-0031 highlights specific program choices made for the implementation of N288.8-17.

1.3.3 Common AL Exclusions

An Action Level may not be required for the following circumstances:

(a) for releases at a given effluent monitoring point that have been determined to have a negligible contribution to environmental risk;

Note: A negligible contribution to environmental risk might consist of a) a very low release rate, activity, or concentration of a contaminant or physical stressor, in an effluent; or b) a very low, facility-wide risk of a specific contaminant or physical stressor, as determined in the ERA as per N288.6.

(b) for releases at a given effluent monitoring point that are only measured as part of supplementary studies;

Note: Examples include confirming the predictions of environmental assessments or the effectiveness of mitigation strategies.

(c) for releases where a *Loss of Control* event is extremely unlikely;

Note: An example might be tritium air effluent from a storage tank. In this case, the effluent release rate or activity is generally predictable with little ability to change.

(d) controlled batch releases which are subject to sampling and analysis for contaminants or physical stressors prior to release; or

(e) where a contaminant or physical stressor is part of an effluent monitoring program and is estimated only (i.e., there are no direct measurements associated with the contaminant or physical stressor).

Note: From a practical perspective, there is no mechanism to quantitatively determine the exceedance of the AL for estimated contaminants or physical stressors.

(Refer to Clause 5.4.1, CSA N288.8-17.)

An AL should not be required if a regulatory instrument (e.g., such as an ECA reporting requirement) is in place for a contaminant or physical stressor (refer to Clause 5.4.2, CSA N288.8-17).

If the value of an MPER for a radionuclide / radionuclide stream pair is less than 0.1% of the DRL, it is considered to have negligible risk for evaluation of an Action Level.

1.3.4 Consolidation of Effluent Monitoring Points

In cases where a DRL is provided for a facility emission, the user may consolidate effluent monitoring points to one AL to simplify the use of the DRL. (Refer to Clause 6.4.3, CSA N288.8-17.)

For radionuclide/radionuclide group whose stream-specific releases have all been excluded, as per section 1.3.3, a station-wide AL is not warranted.

Where a single AL is derived for multiple effluent monitoring points, justification shall be provided to demonstrate how the objectives of an AL are met. (Refer to Clause 6.3.4.3, CSA N288.8-17)

1.3.5 Upper Value of Normal Operational Release

The effluent monitoring data used in the development of the ALs should be representative of the state and condition of the facility and effluent management procedures that will prevail during the time when the ALs will apply. (Refer to Clause 8.2.2, CSA N288.8-17.)

The *Upper Value of Normal Operational Release* should be defined as a percentile of the dataset. (Refer to Clause 8.4.2, CSA N288.8-17.)

To obtain the AL, a *Factor* specified by the user shall be applied to the *Upper Value of Normal Operational Release*. (Refer to Clause 8.5.2, CSA N288.8-17.)

1.3.6 Retrospective vs. Prospective Analysis

Where there is sufficient facility or process data associated with the final discharge point, the proposed AL shall be calculated based on the *Retrospective Approach.* (For summary detail, refer to Clause 8.1, CSA N288.8-17.)

Where there is a new proposed facility or insufficient facility data from an existing facility, the proposed AL shall be calculated based on following the *Prospective Approach*. (For summary detail, refer to Clause 7.1, CSA N288.8-17.)

A prospective AL shall be reviewed when it is considered that there is sufficient data to conduct a retrospective AL development and should be converted to a retrospective AL as data become available. (Refer to Clause 10.4 and 7.4.3, CSA N288.8-17).

2.0 ROLES AND ACCOUNTABILITIES

2.1 Senior Vice-President Darlington, Darlington; Senior Vice-President Pickering A, Pickering; and Vice-President Nuclear Sustainability, Nuclear Sustainability Services

2.1.1 Ensure effluent monitoring program is in place to satisfy regulatory requirements.

2.2 DN Director, Operations and Maintenance; PN Director, Operations; Director, Western Waste Operations; and Director, Eastern Waste Operations & DGR

2.2.1 Ensure operation of facility is consistent with the monitoring requirements of this Standard.

2.2.2 Ensure effluent monitoring program is implemented.

2.2.3 Ensure required calibration and QA activities are performed on plant equipment associated with emissions monitoring.

2.2.4 Ensure non-laboratory QA programs and associated activities necessary to demonstrate compliance is maintained.

2.3 Director, Station Engineering

2.3.1 Ensure system and equipment surveillance is carried out so emissions monitoring equipment operates to requirements.

2.3.2 Ensure engineering work activities are managed to maintain and improve equipment, systems, and station performance in accordance with monitoring requirements.

2.3.3 Ensure services are provided to review procedures which monitor or test parameters to be controlled.

2.3.4 Ensure necessary support is provided to ensure emissions monitoring equipment operates.

2.3.5 Ensure QA testing of *monitoring systems* are performed in accordance with this Standard.

2.4 NSSD Manager, Performance Engineering; PN Section Manager, Environment; and DN Section Manager, Environment

2.4.1 Ensure effluent monitoring program and emission performance improvement programs are defined.

2.4.2 Ensure work activities are managed to define emission management programs and requirements to ensure effluent *monitoring system* meets monitoring requirements.

2.4.3 Ensure work activities are managed to evaluate plant emissions, plant emissions management performance, and reports on performance.

2.4.4 Ensure work activities are managed to perform assessments to determine adequacy of implemented emissions management programs.

2.4.5 Ensure emissions data are managed and processed.

2.4.6 Ensure facility's specific effluent monitoring program is reviewed.

2.5 Manager, Chemistry and Environment

2.5.1 Ensure standard laboratory analytical methods that meet requirements defined by this Standard are developed and maintained.

2.5.2 Ensure emissions sampling, analysis, and monitoring are provided by chemistry laboratory services.

2.5.3 Ensure laboratory QA programs and associated activities necessary to demonstrate compliance are maintained.

2.5.4 Ensure sampling, analyses, and data collection activities suitable to meet requirements are performed.

2.6 Vice President, Environment Health and Safety

2.6.1 Ensure effluent monitoring program is consistent with corporate environmental policy and programs.

2.6.2 Ensure advisory and oversight role for effluent monitoring program are available.

2.6.3 Ensure effluent monitoring standards are defined and establish direction of the program.

2.7 Director Environment Health & Safety, Nuclear Environment

2.7.1 Ensure adequate resources are allocated for effluent monitoring program.

2.7.2 Ensures verification of sample collection performance for *airborne effluents* including sample and stack flow measurement are completed.

2.7.3 Ensure Environment Organization's inputs are provided for the CNSC's REGDOC3.1.1 Safety Performance Indicators (and Quarterly) Reports.

3.0 DEFINITIONS AND ACRONYMS

3.1 Definitions

Abnormal Operating Conditions are defined as events which are expected to occur with a frequency equal to or greater than once in ten years. These infrequent events can result in short-term emissions at higher than the *normal emission rate*.

Action Levels are measurable parameters (in this case a monitored radionuclide or *radionuclide group* release rate) which represent a possible loss of control of a part of the radiation protection program. Reaching an action level requires notification to the CNSC, investigation of the cause, corrective action as required, and a report submitted to CNSC.

Airborne Effluent is any airborne discharge that is emitted from OPGN facilities to its environs (e.g., reactor building, contaminated and non-contaminated exhaust stacks).

As Low as Reasonably Achievable (ALARA) is a term used internationally to describe an acceptable level of radioactive emissions from a nuclear power plant or the resulting *public dose* impact.

Authority having Jurisdiction (AHJ) is the organization having jurisdiction over the design, procurement, fabrication, installation, testing, operation, inspection, maintenance, and decommissioning of a nuclear facility.

Authorized Release Limit (ARL) is any limit imposed by a statute, regulation, licence, or permit on the amount or concentration of a substance that can be released from a facility or activity.

Batch Discharge refers to *effluent streams* that typically discharge in batches to the *environment*. Some examples include the RLWMS, Vacuum Building dousing tanks, Emergency Coolant Injection tanks, miscellaneous tanks, and sumps.

Composite Samples are *multiple grab samples* (or proportions of) taken at regular intervals that are combined into a single sample.

Continuous Monitoring is monitoring through on-line instrumentation, *multiple grab samples*, or intermittent sampling and compositing at such a rate that rapidly changing effluent characteristics can be measured.

Continuous Discharge or Continuous Streams refers to *effluent streams* that typically discharge continuously to the *environment*. At OPGN facilities, these include most *airborne effluent streams*.

Control Monitoring is the monitoring of an emission source to provide adequate warning (e.g., physical devices or procedures) to ensure action can be taken to prevent exceedance of regulatory and internal limits. Note: *Control monitoring* is similar to the term Process monitoring used in the CSA N288.5. The requirements of CSA N288.5 is only applicable to *Performance monitoring* (refer to Clause 1.6 of CSA N288.5).

Credible Event is an emission event determined by a knowledgeable person to be representative of a realistic (i.e. > one in 10 year frequency) worst case emission scenario.

Decommissioning refers to the permanent removal from service of an existing *monitoring system*.

Derived Release Limit (DRL) is the rate of release that would cause the representative person of the most highly exposed group to receive and be committed to a dose equal to the regulatory annual dose limit due to release of a given radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year. For each facility, these are defined in the facility-specific DRL document. In this standard, weekly and monthly fractions of the DRL are found.

Decision Threshold is the level (relative to background) below which a change cannot reliably be measured. More specifically, the decision threshold is the largest value of the measurand for which the probability of a wrong conclusion that a change is present (error of the first kind) exceeds a specified probability, α (alpha).

Detection Limit (DL) is the level (relative to background) above which an effect can confidently be measured. Note: More specifically, the detection limit is the smallest value of the measurand for which the probability of a wrong conclusion that an effect is not present (*error of the second kind*) does not exceed a specified probability, β. Other commonly used terms might be critical level, non-detect level, decision threshold, critical value, and limit of detection.

Diffuse Effluent is an effluent or discharge that is not released from a single, identifiable source.

Direct Sampling or Measurement refers to the act of collecting (for sampling) and analyzing (for measurement) a sample from an *effluent stream* instead of estimating or approximating that value. Direct sampling/measurement applies to Performance and *Control Monitoring*.

Effluent *i*s a waterborne release of a hazardous or nuclear substance to the environment. (Source: Adapted from CNSC REGDOC-3.6 and CSA N288.5-22. In CSA N288.8, this is also considered a “release.”) In this standard, *emissions* and *effluents* are used interchangeably.

Effluent Stream is an identifiable or discrete single point of discharge to the natural *environment*.

Emergency Incidents are those events that meet the criteria for On-Site and General Emergencies in N-PROG-RA-0001.

Emission is an airborne release of a hazardous or nuclear substance to the environment. An emission may include point sources, fugitive emissions or area sources. (Source: CNSC REGDOC-3.6 and CSA N288.5-22.) In this standard, *emissions* and *effluents* are used interchangeably.

Environment is understood to be the final point of discharge from plant operations (i.e., for *waterborne effluents*; forebay, condenser cooling water discharge, outfall; for airborne emissions, ventilation exhaust stacks, and roof ventilators).

Environmental Monitoring is monitoring of hazardous and/or nuclear substances and physical stressors in the environment attributable to the activity to assess a) human exposure or the potential effects on human health and safety; b) exposure to non-human biota and the

potential effect(s) on the environment; and c) the physical and biological parameters of the environment. Note: See CSA N288.4 for additional information on environmental monitoring.

Environmental Risk Assessment (ERA) is an evaluation or analysis of risks associated with contaminants and physical stressors in the environment relevant to a facility. Notes: 1) The evaluation is undertaken to meet defined objectives, which can include risk-informed recommendations for risk management of the site or facility. 2) For further guidance on the ERA process, see CSA N288.6.

Estimation as it applies to this Standard refers to the act of calculating or inferring emissions based on chemistry data, historical performance or operational parameters.

Evaluation Criteria is the level of contaminant concentration or physical stressor intensity that monitoring data can be compared against where available. Note: Examples of evaluation criteria include a) ERA predictions; b) federal or provincial guidelines; or c) stakeholder and Indigenous community commitments.

Hazardous substance is a waste or a substance other than a *nuclear substance* that is used or produced in the course of carrying on normal operations and that can pose a risk to the environment or the health and safety of persons. Source: CNSC REGDOC-3.6. Note: Hazardous substances might include deleterious substances as per the Fisheries Act and toxic substances as per the Canadian Environmental Protection Act (CEPA).

Loss of Control Event is an operational occurrence that is attributed to one or more failures within the environmental protection program and generally results in a release that exceeds that defined as part of normal operations.

Maximum Probable Emission Rate (MPER) is an estimated maximum emission of a radionuclide or *radionuclide group* from an *effluent stream* during normal plant *operating conditions,* but not nuclear emergency events. The emission typically is from a bounding abnormal, probable event (i.e., an event that is likely to happen within the lifetime of the facility, for example with a probability of 1 in 10 years). Note: An MPER might or might not indicate a *Loss of Control* and should be assessed as indicated in CSA N288.8.

Monitor and Instrument Operating Range refers to the upper and lower limits of an instrument or process between which accurate measurements can be made. The ranges are quoted in terms of emission above background with a 95% (two sigmas) probability.

Monitoring System is any device or procedure that is used to provide surveillance for the purpose of control or *performance monitoring* of an *effluent stream* (applicable to both permanent and interim systems).

Multiple Grab Samples refers to a sampling regimen in which a series of samples from an *effluent stream* are taken at regular intervals. Grab sampling shall be frequent enough to identify any significant variations in the effluent concentration.

Normal Emission Rate (NER) is the emission rate during *normal operating conditions*. The rate is taken as the mean plus one standard deviation of the most recent effluent emission data that reflects true plant operation (i.e., last three to five years of emissions data). The rate is used in calculating *MPERs* and monitoring unavailability limits.

Normal Operating Conditions includes the operation of a nuclear facility or licensed activity within the operational limits and conditions specified in the licence governing operation of the facility. Reasonably foreseeable upset events are included under *normal operation conditions*.

Nuclear Substance is:

(a) Deuterium, thorium, uranium, or an element with an atomic number greater than 92.
(b) A derivative or compound of deuterium, thorium, uranium, or of an element with an atomic number greater than 92.
(c) A radioactive nuclide.
(d) A substance that is prescribed as being capable of releasing nuclear energy or as being required for the production or use of nuclear energy.
(e) A radioactive by-product of the development, production, or use of nuclear energy.
(f) A radioactive substance or radioactive object that is used for the development or production, or in connection with the use, of nuclear energy.

Source: Adapted from the Nuclear Safety and Control Act.

Performance Monitoring is the monitoring of an emission source for the purposes of reporting emissions and is required for the *effluent streams* that potentially could emit an amount of radioactivity equivalent to a significant proportion of any Derived Release Limit. *Performance monitoring* is required to demonstrate compliance with regulatory limits, measure emissions, identify and quantify the significant radionuclides or *radionuclide groups* emitted in the effluent, and calculate the potential dose impact to a site-public critical group. Note: *Performance monitoring* is equivalent to the term Compliance monitoring used in the CSA N288.5. The requirements of CSA N288.5 is only applicable to Performance monitoring (refer to Clause 1.6 of CSA N288.5).

Prospective Approach for the development of Action Levels is used where there is little or no historical effluent monitoring data. It is an alternative approach to the *Retrospective Approach* where there is sufficient monitoring data describing anticipated operational conditions. (Refer to Clause 7, CSA N288.8-17)

Public Dose is the dose received by any member of the public attributable to the facility operations.

Quality Assurance (QA) and Quality Control (QC) programs are needed to optimize data collection design so that environmental decisions are based on data of known quality. QA activities monitor, document, and control the quality of the process on a continual basis. The QA program is intended to instill confidence in the integrity of the results of the effluent monitoring program. The QA plan for the program should focus on the program in its entirety and not only on the sample collection and sample analysis stages. Items that could be included are sampling design, vendor selection, mobilization, data management, data analysis, report preparation, and record keeping. QC activities comprise those activities that specifically monitor and control discrete laboratory and field tasks to produce the information that is required to verify and demonstrate that the predefined criteria are met. QA/QC activities aim to reduce the total error due to sampling design error and measurement error, allow for the identification of deficiencies requiring corrective action, and permit the independent verification of the accuracy of the data.

Radionuclide Group is a radionuclide or collection of radionuclides that are monitored separately in *airborne effluents* (groups could include elemental tritium, tritium oxide,

particulate, iodine, noble gases, carbon-14, and gross alpha) and *waterborne effluents* (groups include gross beta, gross gamma, tritium, carbon-14, and gross alpha).

Release is the movement of a contaminant or physical stressor beyond the physical control of a facility; it includes both air and water. Note: A release of a nuclear or hazardous substance to the environment can include the following types of releases: a) normal or accidental; b) continuous or intermittent; or c) ascertained (measured) or estimated (unmeasured).

Representative Sample is a sample with the same quality and characteristics as that of its sample location to provide an accurate measure of in-situ condition at the time of sampling. (Refer to N288.5-22.) Note: For airborne *emissions*, factors affecting sample representativeness may include probe losses, probe-stack orientation, line losses, and leakage. For waterborne *effluents*, factors affecting sample representativeness may include loss of sample flow, contamination of sample, pump failure, and line deposition or blockage.

Retrospective Approach or the development of *Action Levels* shall be used where there is sufficient facility or process monitoring data associated with the final discharge point(s) describing anticipated operational conditions for the application of the proposed AL. (Refer to Clause 8, CSA N288.8-17.)

Significant change to a facility, system, or process is a change that might significantly alter emission rate or quality from a particular effluent stream.

Type I error (error of the first kind) is a false positive (i.e., reporting a measurand as being detected when it is in fact not present). Note: The probability of a type I error is generally denoted as α.

Type II error (error of the second kind) is a false negative (i.e., reporting a measurand as not being detected when it is in fact present). Note: The probability of a type II error is generally denoted as β. (Refer to *Detection Limit* definition.)

Upper Value of Normal Operational Release is the statistical assessment to identify the upper value of normal operational release. Typically, for *Retrospective Monitoring* datasets, this is set as the 97.5^{th} percentile of the screened data. (Refer to Clause 8.4, CSA N288.8-17.)

Waterborne Effluent is any liquid discharge stream that is emitted from OPGN facilities to the environment (e.g., condenser cooling water, sewage, and process drainage).

3.2 Abbreviations and Acronyms

AHJ	Authority Having Jurisdiction
ALARA	As Low As Reasonably Achievable
ALW	Active Liquid Waste
ARL	Authorized Release Limit
CCW	Condenser Cooling Water
CEM	Continuous Emissions Monitoring
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DL (NDL)	Detection Limit (Non-Detect Level)

DN	Darlington Nuclear
DRL	Derived Release Limit
EA	Environmental Assessment
ECA	Environmental Compliance Approval
ERA	Environmental Risk Assessment
EMS	Environmental Management System
MECP	Ministry of Environment, Conservation and Parks
MPER	Maximum Probable Emission Rate
NER	Normal Emission Rate
MDL	Minimum Detectable Limit
NSSD	Nuclear Sustainability Services Division
OPGN	Ontario Power Generation, Nuclear
PN	Pickering Nuclear
QA	Quality Assurance
QC	Quality Control
RLWMS	Radioactive Liquid Waste Management System
RRC	Records Retention Code

4.0 BASES, RECORDS AND REFERENCES

4.1 Bases

CSA N288 series standard basis references, for licensing, legal, regulatory, and quality assurance requirements, are identified at the end of each relevant clause, throughout Section 1, Direction.

4.2 Records

Records which include the quantity and concentration of *nuclear* and *hazardous substances* dispersed into the environment, and an evaluation of effluent characteristics, shall be kept as permanent records.

The following records may be generated by use of this document and shall be registered in appropriate document management system in accordance with the following table.

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
CNSC quarterly and annual reports (Various titles in use)	N/A	N	Indexed in AIMS (Approved Information Management System) Document numbers in use: • NK38-CORR-00531-xxxxx (DN) • P-CORR-00531-xxxxx (PN) • 0125-CORR-00531-xxxxx (NSS-W) • 00044-CORR-00531-xxxxx (NSS-D) • 92896-CORR-00531-xxxxx (NSS-P) RRC: REG Retention: *Permanent (P)*
(Site) Effluent and Emissions Monitoring Plan	N/A	N	Indexed in AIMS (Approved Information Management System) Document Numbers: NK38-PLAN-03480-10001 (DN, NSS-D) P-PLAN-03480-00001 (PN, NSS-P) W-PLAN-03480-00001 (NSS-W) RRC: ENV Retention: *Permanent (P)*

4.3 References

4.3.1 Performance References

CSA N288.0-22, Environmental Management of Nuclear Facilities: Common Requirements of the CSA N288 Series of Standards.

CSA N288.5-22, Effluent and Emissions Monitoring Programs at Nuclear Facilities

CSA N288.8-17, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities

CSA N286-12, Management System Requirements for Nuclear Facilities

N-FORM-03480-00001, Checklist to Determine If IIL Should Be Reviewed

N-INS-03480-10002, Performance Testing of Airborne Effluent Monitoring Systems

N-MAN-03416.3-0020, Dosimetry and Radiological Environmental Measurement Services Quality Assurance Manual

N-PROC-RA-0005, Written Reporting to Regulatory Agencies

N-PROC-RA-0020, Preliminary Event Notification

N-PROC-RA-0097, Self-Assessment and Benchmarking

N-PROG-RA-0001, Consolidated Nuclear Emergency Plan

N-PROG-RA-0003, Performance Improvement

OPG-PROG-0005, Environment Health And Safety Managed Systems

W-INS-79017-00003, Radiological Effluent Performance Monitoring

WFOL-W4-314.00 2027, Western Waste Management Waste Facility Operating Licence

WFOL-W4-350.02/2018, Waste Facility Operating Licence Pickering Waste Management Facility

WFOL-W4-355.00/2023, Waste Facility Operating Licence Darlington Waste Management Facility WFOL-W4-355.00/2023

4.3.2 Developmental References

4.3.2.1 CSA

CSA-N288.4-19, Environmental Monitoring Programs at Nuclear Facilities and Uranium Mines and Mills.

CAN/CSA-Z223.1-M1977 (Reaffirmed 1999), Method for the Determination of Particulate Mass Flows Enclosed Gas Streams.

4.3.2.2 CNSC

Regulatory documents - Canadian Nuclear Safety Commission website page.

REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2, September 2020

REGDOC-2.9.2, Controlling Releases to the Environment (Currently under development)

REGDOC-3.1.1, version 2, Reporting Requirements for Nuclear Power Plants, April 2016

CNSC, G-129, Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)", 2004

CNSC, G-228, Developing and Using Action Levels

CNSC Class I Nuclear Facilities Regulations

CNSC General Nuclear Safety and Control Regulations (SOR/2000-202, NUCLEAR SAFETY AND CONTROL ACT)

CNSC Radiation Protection Regulations (SOR/2000-203, NUCLEAR SAFETY AND CONTROL ACT)

4.3.2.3 OPG

N-CORR-00531-01917, “Regulatory Interpretations – Programs Referred to in a License Application and Program Compliance”

N-INS-03480-10005, Instruction for the Calculation of Internal Investigation Levels and Normal Operating Levels for Radioactive Effluent

N-MAN-00531-0019, CNSC 024, “Program Compliance”

N-PROC-MA-0068, Engineering Requirements Supporting the Calibration Process

N-PROG-OP-0004, Chemistry

N-PROG-TR-0005, Training

N-STD-OP-0042, Controlling Radiation Exposure of the Public and the Environment to As Low as Reasonably Achievable

NK38-REF-61200-{182051}, A Proposed NGD Policy and Standard for the Monitoring of Radioactivity in Liquid Effluent, R. Maruska, July 1982.

RMEP-IR-03442-2, A Proposed Standard for the Monitoring of Radioactivity in Airborne Effluent, R. Maruska, September 1983.

W-PROG-WM-0001, Nuclear Waste Management Program

N-CORR-00531-23281, Implementation Plans and Compliance Dates for the Implementation of CSA Standard N288.8-17 Compliant Methodology and Proposed Environmental Action Levels for OPG’s Nuclear Power Plants, A. Del Pino, August 19, 2022

4.3.2.4 MECP

O. Reg. 215/95: Effluent Monitoring and Effluent Limits — Electric Power Generation Sector (Revoked 2021, for re-incorporation into site ECA’s)

4.3.2.5 Environmental Action Level (CSA N-288.8-17)

Note: The following report implementations of CSA N288.8 are “as revised” by OPG and “as accepted” by CNSC:

NK38-REP-03482-10002, Action Levels for Environmental Releases - Darlington Nuclear, Calian Engineering

P-REP-03482-00007, Action Levels for Environmental Releases - Pickering Nuclear, Calian Engineering

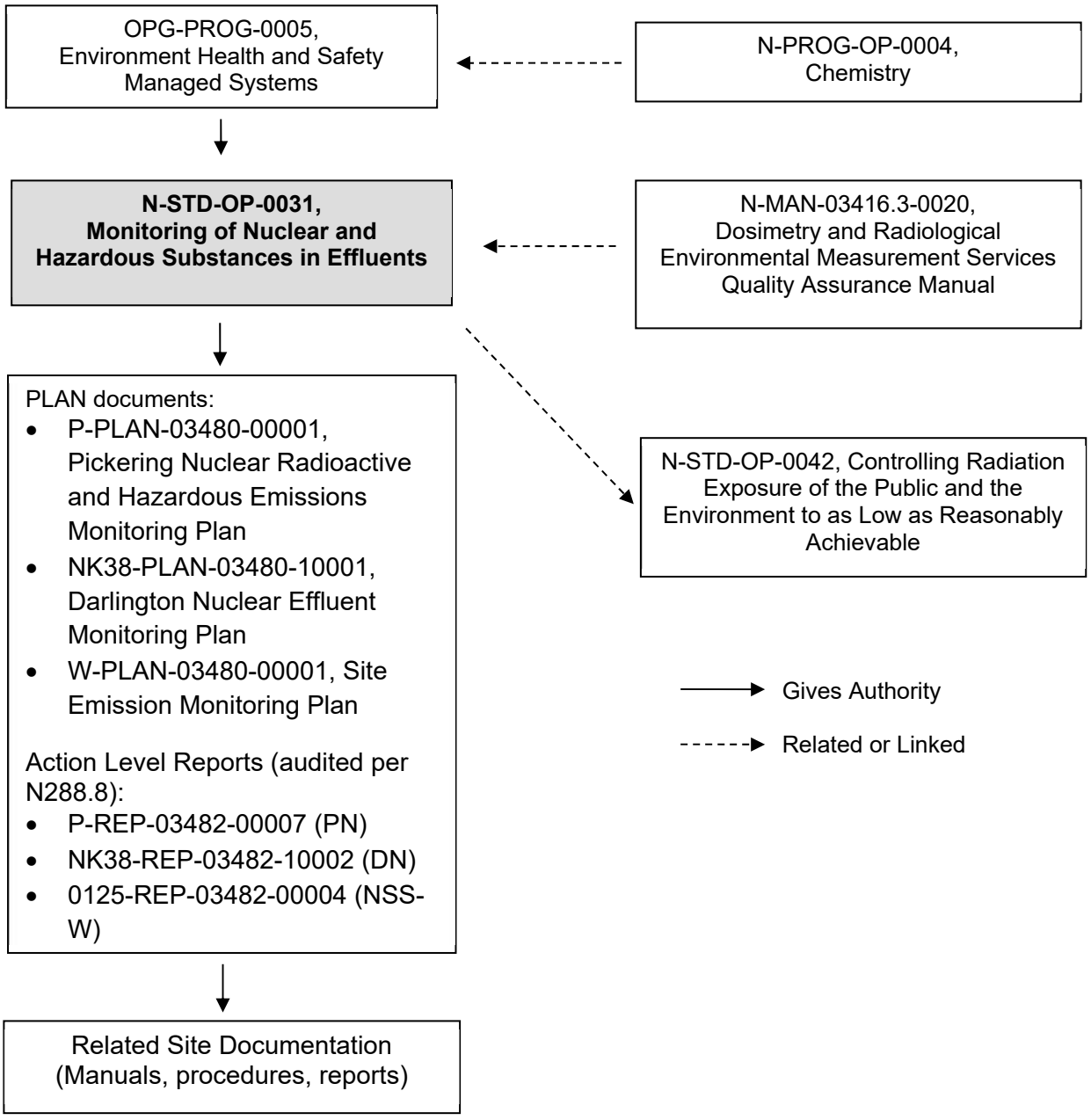
0125-REP-03482-00004, Action Levels for Environmental Releases – Western Waste Management Facility

5.0 REVISION SUMMARY

This is an **intent** revision.

- (Section 1) Former Sections 1 and 2 are now nested under new Section 1 (Direction). For cross reference, a "1." is generally added to the previous R009 section 1 or 2 number.
- (Most sections) References to N288.5-11 are revised to N288.5-22 and N288.0-22, and wording is adopted from the revised CSA standards.
- (Clause 1.1.3 a) New "shall" wording included.
- (Clause 1.1.3 b) Added program scope to include "other appropriate characteristic(s), or effect(s)," to supplement radiological and hazardous substances.
- (Clause 1.1.13) Audits of ALs from CSA N288.8 are to be included with audits for CSA N288.5. Report references to the relevant N288.8-17 documentation are added to clause 5.3.2.5 and the Appendix A program structure diagram.
- (Clause 1.1.4 g) Added to address NO-2022-006 concerns about the review and use of estimation data for reporting. This change is consistent with the CSA N286-12 Clause 4.10 to ensure that, "Required changes shall be … (c) subject to review by relevant stakeholders; (e) approved for implementation."
- (Clause 1.1.9 b and c) Records retention requirements are described more generally.
- (Clause 1.1.12 a) Program Review references are generalized to the core N288.0-22 program, and this includes items which are principally related to the Environmental Risk Assessment program.
- (Clause 1.1.13) Elements of the CSA N288.8 are to be included in the program, and this is reflected in the section 2.9 (new).
- (Clause 1.2.2 b and 1.2.2 Figure 1) Replaced 1% NER reporting threshold criterion with new 0.025% MPER/DRL criterion based on N-EVAL-03480-00001.
- (Clause 1.2.6.1 b) In the event of on-line, Liquid Effluent Monitor unavailability, the pre-discharge sampling may be modified with the use of at least 5 samples, sufficient to identify the presence of hot particles in one of the samples.
- (Section 1.3 and subsections) Added CSA N288.8 requirements for Action Levels into a new Section 1.3. These requirements reflect revised Action Level reports, and the need for audits to include N288.8 program items.
- (Section 2) Nuclear Sustainability Services Division (NSSD) replaces Nuclear Waste Management Division (NWMD)
- (Section 3.0) Updated Definitions and Acronyms list.
- (Section 4.3 and subsections) Program document references are revised.

Appendix A: Authority and Document Hierarchy for the Effluent Monitoring Program



Appendix B: Example of Maximum Probable Emission Rate Calculation

Process and rules used for calculating *MPERs* are as follows:

(i) For each potential stream and *radionuclide group*, events that potentially occur with frequency equal to or greater than once in ten years should be considered in analysis.

(ii) *MPER* value is the sum of emissions due to an event and the *NER* for the stream. *MPER* calculations should be quoted for normal monitoring period.

(iii) *MPER* shall be the largest emission rate calculated for various events postulated for given stream.

An example of *MPER* calculation is provided below:

Scenario Description Assumptions

(a) It is assumed that ten litres of tritiated moderator heavy water is spilled over a period of a few minutes.

(b) The spill is assumed to form a pool that is 0.5 cm in height. This defines the pool area. It is common practice in Hazard Assessment to assume a 1-cm pool height for spreading, unconfined pools [R-1]. This is based on a variety of liquids spilled on a variety of surfaces. The scenario being modeled involves spillage of heavy water on a sealed, smooth cement surface. Due to lower drag forces on the spreading pool, a smaller pool height is to be expected (pool spreads over a larger area). Based on this, a pool height of 0.5 cm has been assumed (50% of typical value).

(c) Tritium activity in the moderator is assumed to be 17 Ci/kg.

(d) The spill takes two hours to clean up.

(e) It is assumed that the spill occurs on a cement floor that is sealed such that no seepage into the concrete can occur. Therefore, all the liquid can be recovered.

(f) The moderator heavy water temperature is ~ 42°C

(g) Ambient temperature is assumed to be 25°C.

(h) The moderator pool, initially at 42°C will cool rapidly. It is assumed that the mean pool temperature is about 30°C over the 1-hour period. It is believed that this assumption is conservative.

(i) It is assumed that all tritium that becomes airborne and eventually emitted to outdoors through one (nearest) unmonitored pathway.

Calculation

To calculate the *MPER* (Ci/event) the following equation is used:

$$MPER = E_A + E_N = \dot{m}\Delta t + E_N$$

APPENDIX B (Continued)

Example of Maximum Probable Emission Rate Calculation

Where,

E_A = tritium emission during *abnormal event* (Ci/event), *abnormal event* occurs during week/month of interest

E_N = "normal" tritium emission during week/month of interest (Ci/week) (mean + one standard deviation)

$\dot{m}$ = tritium emission rate (Ci/s)

Δt = emission duration (s/event)

For this event, the parameters are as follow:

Δt = emission duration (s/event) = 2 hours = 7200 s/event

MPER = maximum probable tritium emission rate (Ci/event)

F'_T = tritium evaporation flux $\left(\text{Ci}/\text{m}^2\text{s}\right)$ from the pool

A_P = pool area (m^2)

The pool area for a spill of ten litres having a pool height of 0.5 cm is:

$$A_{POOL} = \frac{\text{Spill Volume}}{\text{Pool Height}} = \frac{0.01 \quad m^3}{0.005 \quad m} = 2 \quad m^2$$

Reference 2 reviews the basic mechanisms governing tritium evaporation from a spill of tritiated heavy water and develops a computer model (TRITSPIL) that has been extensively used by Ontario Power Generation. Based on a TRITSPIL run [2] using the above assumptions, the evaporation flux (F'_T) was estimated to be 1.49 $\left(\text{mCi}/\text{m}^2\text{s}\right)$.

Normal tritium mean stack emissions have been estimated as: E_N = 1.7 Ci/wk (each stack)

Therefore; MPER = [1.49 $\left(\text{mCi}/\text{m}^2\text{s}\right)$ x 2 m^2 x 7200 $^s/_{event}$] x 10^{-3} + 1.7 $^{Ci}/_{wk}$ = 23.2 $^{Ci}/_{week}$ **~ 23 $^{Ci}/_{week}$**

References

[R-1] Center for Chemical Process Safety (AIChE), Guidelines for Chemical Process Quantitative Risk Analysis, 2nd Ed., 2000

[R-2] Hanna, S., email to M. Oliverio sent March 14, 2001

Appendix C: Methodology for Unavailability Calculation

Methodology for determining unavailability is as follows:

(a) Limits on unavailability for performance monitors shall be more stringent for streams that historically have reported with greater emissions. As such, limits are stated relative to *ranges* of emissions as a fraction of *DRLs*.

(b) With exception of ALW / RLWMS, Forebay influent, and CCW or Outfall discharge, unavailability limits are set based on historical *NER* for *radionuclide group* being monitored.

(c) Unavailability shall be calculated by using one of the following equations:

If failure time is known:	Unavailability = A-F	Equation (1)
If failure time is unknown:	Unavailability = A - (B+C)/2	Equation (2)

Where

A = date and time that monitor was returned-to-service

F = date and time that monitor failed

B = date and time that monitor was previously verified in-service

C = date and time that monitor was confirmed or declared out-of-service

Appendix D: Sample Analysis Period for Control Monitoring

This Appendix is to be applied once it has been determined that *Control Monitoring* is required. The calculation in this Appendix is used to determine the analysis period required to capture the *abnormal event* described in the *MPER* calculations.

The formula used to determine the analysis period for *control monitoring* is as follows:

Analysis Period, T [hr] = *Control Monitoring* Limit / Event *MPER*

where

Control Monitoring Limit = 5% weekly (for air) or monthly (for water) *DRL*, [Ci]
Event *MPER* = $E_A + E_N$, [Ci/hr]

and

E_A = Event emission rate, [Ci/hr]

E_N = *Effluent stream*'s *NER*, [Ci/hr]

Continuous monitoring and analysis is required if T≤12 hrs

Sample Calculation:

Given:

5% weekly *DRL* = 4 Ci

E_N = 0.01 Ci/hr

E_A = 0.1 Ci/hr

Therefore:

T = 4 Ci/(0.1 + 0.01) Ci/hr

T = 36 hrs

Daily collection and analysis might be chosen to ensure that *performance monitoring* can adequately meet the *control monitoring* requirements.