# Request for Confidentiality

## of Material Submitted in Relation to

## OPG's Application to Refurbish Pickering NGS units 5-8 and renew the operating licences of the Pickering NGS and WMF, CMD 26-H07

***IMPORTANT NOTE:***

The purpose of the confidentiality request process is to seek a decision from the Commission as to whether specific information being submitted for a Commission proceeding can be protected. Generally, material received as part of a matter before the Commission is made available to the public by default. The rule of confidentiality (i.e., rule 12 of the CNSC Rules of Procedure) is applied only if a request for confidentiality is submitted.

The Commission weighs any request for confidentiality against the criteria set out in rule 12 to confirm that:

- the importance of protecting the information outweighs the public interest in public hearings and disclosure of evidence; and
- the measures taken to protect confidentiality are designed to ensure that the public nature of the proceeding will be affected only to the extent necessary to adequately protect the information.

In the interest of enabling a timely decision, any request for confidentiality must be accompanied by redacted versions of all documents named in the request, and/or adequately informative summaries that can be made available to participants and the public. **Please provide the appropriate versions, as applicable.**

It is the responsibility of the requestor to provide an adequately detailed explanation as to how and why sub-rule 12(1) applies.

In the matter of:

### OPG's Application to Refurbish Pickering NGS units 5-8 and renew the operating licences of the Pickering NGS and WMF

With regard to: CNSC staff's CMD 26-H07

I, **Kapil Aggarwal**, am an authorized representative of **Ontario Power Generation Inc.** I understand that:

- documents and information ("the material") provided to the Canadian Nuclear Safety Commission ("the Commission") as part of a public proceeding will be made publicly available unless the Commission has rendered a decision to take measures to protect it; and
- regardless of any request for confidentiality or approval of same, the material may be disclosed if the Commission is required by law to disclose it (for example, after a request under the Access to Information Act).

I hereby request that the Commission take measures to protect the following information, pursuant to rule 12 of the Canadian Nuclear Safety Commission Rules of Procedure (the Rules):

**Material to be Deemed Confidential:**

The material to be deemed confidential is identified in Table 1, below.

***NOTE 2:*** *Where the request for confidentiality applies only to part of the submission, the portions to be deemed confidential must be clearly identified to distinguish them from any content that is non-sensitive.*

***NOTE 3:*** *The Commission is not responsible for any copyright infringement due to its publication on the public CNSC website of documents that have been submitted by a third party.*

| Table 1: Material to be Deemed Confidential | | | |
|---|---|---|---|
| | **Item Name** | **Portion(s) to be Deemed Confidential** | **Reason for Request** (details to be provided below) |
| 1. | Enclosure 1, 92896-REP-01320-00024 R00, "Safety Assessment for PWMF Storage Building 5 with 1410 Dry Storage Containers" of OPG Letter, *Pickering Waste Management Facility – Submission of Storage Building 5 Safety Assessment for Storage of 1,410 Dry Storage Containers*, December 4, 2025, CD# 92896-CORR-00531-01675, E-Doc# 7609483 | ☐ Entire content<br>✓ Redacted content as shown | ☐ The information is a matter of national or nuclear security<br>☐ Disclosure of the information would likely endanger the life, liberty, or security of a person or person(s)<br>The information is of a:<br>☐ financial nature,<br>☐ commercial nature,<br>✓ scientific nature,<br>✓ technical nature,<br>☐ personal nature, or<br>☐ other nature (specify),<br>and is consistently treated as confidential and the person affected has not consented to disclosure. |

**Proposed measure(s) to be taken and Detailed reason(s) for request:**

The above-noted material should be protected for the following reasons:

| Table 2: Detailed Reason(s) for Request | | |
|---|---|---|
| **Item Name** | **Measure being Requested** | **Reason(s) for Request** |
| Enclosure 1, 92896-REP-01320-00024 R00, "Safety Assessment for PWMF Storage Building 5 with 1410 Dry Storage Containers" of OPG Letter, *Pickering Waste Management Facility – Submission of Storage Building 5 Safety Assessment for Storage of 1,410 Dry Storage Containers*, December 4, 2025, CD# 92896-CORR-00531-01675, E-Doc# 7609483 | ☐ Proceeding takes part in private, to the exclusion of members of the public, other than the parties and their counsel or agent<br>☐ Part of the proceeding takes part in private, to the exclusion of members of the public, other than the parties and their counsel or agent<br>✓ Publication of information be restricted or prohibited<br>☐ Disclosure of information be prohibited or restricted to some or all of the parties and intervenors, or their counsel and agent<br>☐ Other measure to protect the information | The content of this document pertains to proprietary commercial and technical information on the operation of the Pickering Waste Management Facility.<br><br>A redacted copy of this document (attached) has been provided to CNSC staff for inlusion with the CNSC staff CMD. |

**Attestation:**

1. I attest that the above-noted material is not available through any public sources.
2. **MANDATORY:** I have included a **summary** or **redacted** version of the material that provides adequate detail to satisfy the public interest in public hearings and disclosure of evidence.
3. I understand that if this request is not approved by the Commission and/or no protection measures are taken, the information will be part of the public record as per rule 15 of the Rules.
4. I understand that upon receipt of this request, the Commission Registrar will treat the material that is subject to this request as confidential unless and until the Commission makes a ruling to deny this request.

**Attachments:**

- Redacted version of 92896-REP-01320-00024 R00, “Safety Assessment for PWMF Storage Building 5 with 1410 Dry Storage Containers”

**Authorized signature:**

Kapil Aggarwal, VP, Nuclear Sustainability Strategies & Services — April 26, 2026 (Date)

# REPORT

Unless otherwise stated, all information redacted in this document is considered prescribed information under the General Nuclear Safety and Control Regulations

# SAFETY ASSESSMENT FOR PWMF STORAGE BUILDING 5 WITH 1410 DRY STORAGE CONTAINERS

PV294/RP/0002 R01

October 20, 2025

Prepared for

Ontario Power Generation

Security Classification: Kinectrics Confidential

| ONTARIO POWER GENERATION | |
|---|---|
| Deterministic Safety Analysis Dept. | |
| Document No.: | 92896-REP-01320-00024 |
| Revision No.: | R00 |
| Accepted by: (print name) | Paul Crowley |
| Date: | 10-Nov-2025 |
| Signature: | |
| OPG Proprietary | |

| OPG Purchase Order Number: | | |
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| Kinectrics: | 300215 | ☑ |
| Worley Parsons: | 300216 | ☐ |
| Candu Energy: | 300217 | ☐ |
| Calian Ltd: | 300219 | ☐ |
| Other: | PO ______ | |

This acceptance does not relieve the contractor from responsibility for errors or omissions or from any obligations of liability under this contract.


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## Revision History

| Rev | Date | Author | Description of Revision |
|---|---|---|---|
| R00 | May 27, 2025 | A. Alves,<br>J. Peng | Initial Issue |
| R01 | October 20, 2025 | A. Alves,<br>J. Peng | Updated to Address Client's Comments |

## Certification Statement

**I, the undersigned, being a licensed professional engineer in the province of Ontario and being competent in the applicable field, have prepared or directly supervised the preparation of this document, following the procedures of the Kinectrics quality management system.**

**Kinectrics document and revision no.** PV294/RP/0002 R01

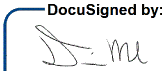
**Certified by:** Damien Moule

DS

**Registration no.** 100185374

**Stamp**


DocuSigned by:



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**Date:** October 20, 2025

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# 1.0 Introduction

At the Phase II location of the Nuclear Sustainability Services (NSS) Pickering Waste Management Facility (PWMF) there are currently 2 used fuel dry storage buildings (SB3 and SB4). There is a need for additional storage space for the used fuel arising from the operation of the Pickering Nuclear Generating Station (PNGS). Besides the construction of the Pickering Component Storage Structure (PCSS), a new storage structure (SB5) is being planned and so safety analyses and assessments are required.

# 2.0 Objectives and Scope of Work

The objectives of this project are as follows:

1. Perform a holistic safety analysis of the normal operation dose rates due to external gamma radiation for the PWMF site including the proposed new used fuel dry storage structure SB5. This analysis was performed for an SB5 layout containing 1410 Dry Storage Containers (DSCs).
2. Perform safety assessments for chronic emissions and malfunctions/accidents for 1410 DSCs stored in SB5 to confirm that the existing safety analysis [1] [2] [3] [4] [5] adequately covers DSC storage in SB5.

# 3.0 Safety Assessment Methodology

The methodology to be used for each piece of the safety assessment for SB5 are outlined in the sub-sections below. The methodology used is informed by and consistent with OPG's Guideline for Safety Assessment [6]. It also meets the requirements of REGDOC 2.4.4 [7].

## 3.1 Normal Operations Safety Assessment

### 3.1.1 Public Dose from Chronic Emissions

The emissions from the PWMF during normal operations and the doses to public were calculated recently [1] [2]. In this work, the emissions from the expanded PWMF were evaluated based on the latest emission data for PWMF. The impact of the operation of SB5 was assessed to determine if the previous analyses sufficiently bound the radiological impact of chronic emissions on public health resulting from the expanded PWMF.

### 3.1.2 Public and Worker Dose from External Gamma Radiation

A normal operations public and worker dose rate analysis was performed using MCNP for the PWMF Phase II site, which is shown in Figure 1. The analysis included DSC storage buildings SB3, SB4, and SB5 along with the PCSS. The analysis methodology followed the reference nuclear waste shielding analysis methodology for heavily shielded containers [8]. Additional details of the analysis are provided in the subsections below.

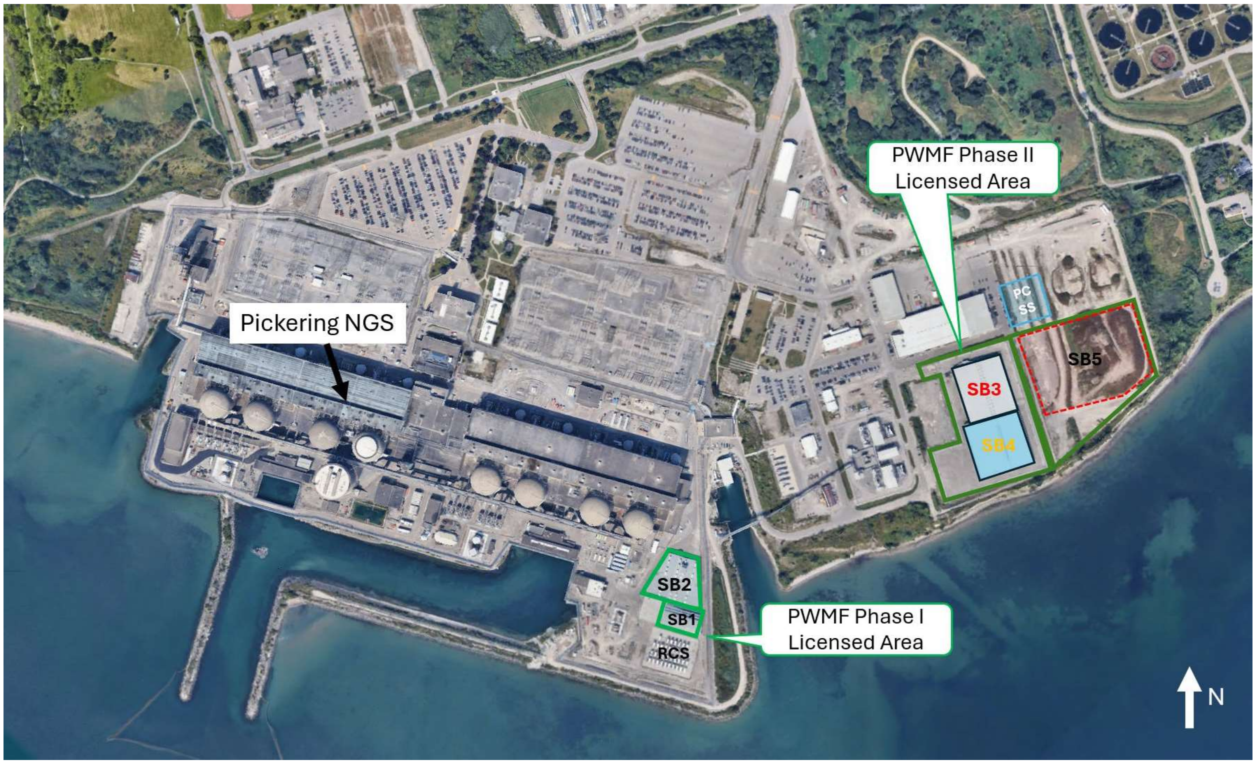



**Figure 1: Aerial View of the PWMF Site**

#### 3.1.2.1 Geometry

The geometry from the previous PWMF MCNP model, developed for the dose rate analysis of the PCSS [1] was used as the starting basis for this analysis, which includes SB3, SB4, SB5, and the PCSS with latest the layout. This PCSS layout assumes a full building, with 64 Retube Waste Containers - End Fitting (RWC-EFs), 76 Retube Waste Containers – Pressure Tubes (RWC-PTs), and 48 Steam Generators (SGs) – the RWCs are decayed by 1.7 years and SGs assumed a final placement year in 2031 with 4.2 to 4.5 years decay between unit shutdown and 2031.

The SB5 layout was modified based on the updated layout shown in Figure 2. Besides the DSC layout which are discussed below, the main changes introduced to the MCNP model geometry are the E-W distance between SB4 and SB5, which increased to 36 m, and the overall dimensions of SB5, which are about 156 m E-W by 93 m N-S. Additionally, the fences around the east side of SB5 were adjusted. The overall changes and distances between SB5 and the fences are shown in Figure 3. The MCNP model with 1410 DSCs in SB5 is shown in Figure 4.

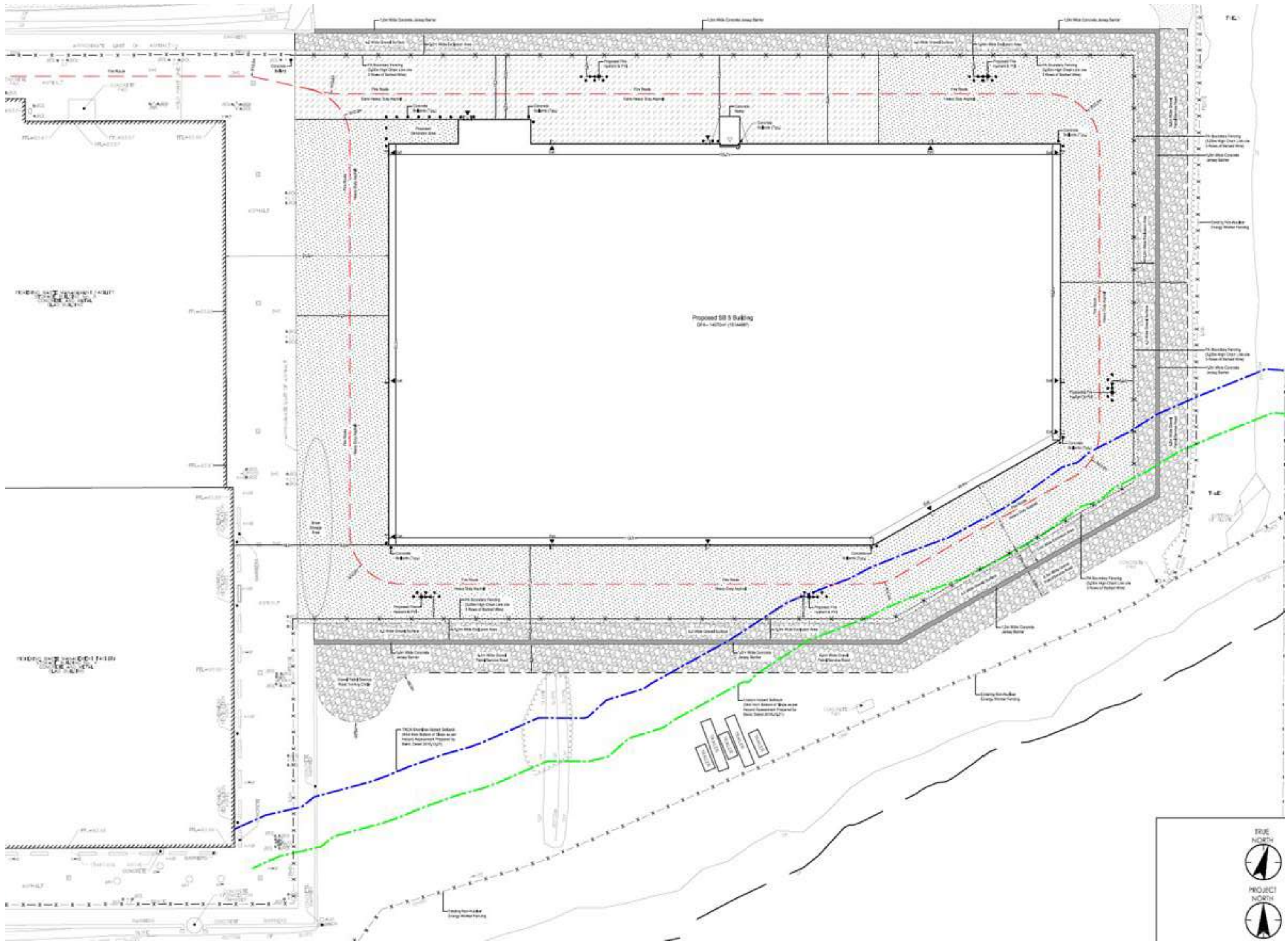



**Figure 2: PWMF SB5 Updated Drawing [9]**

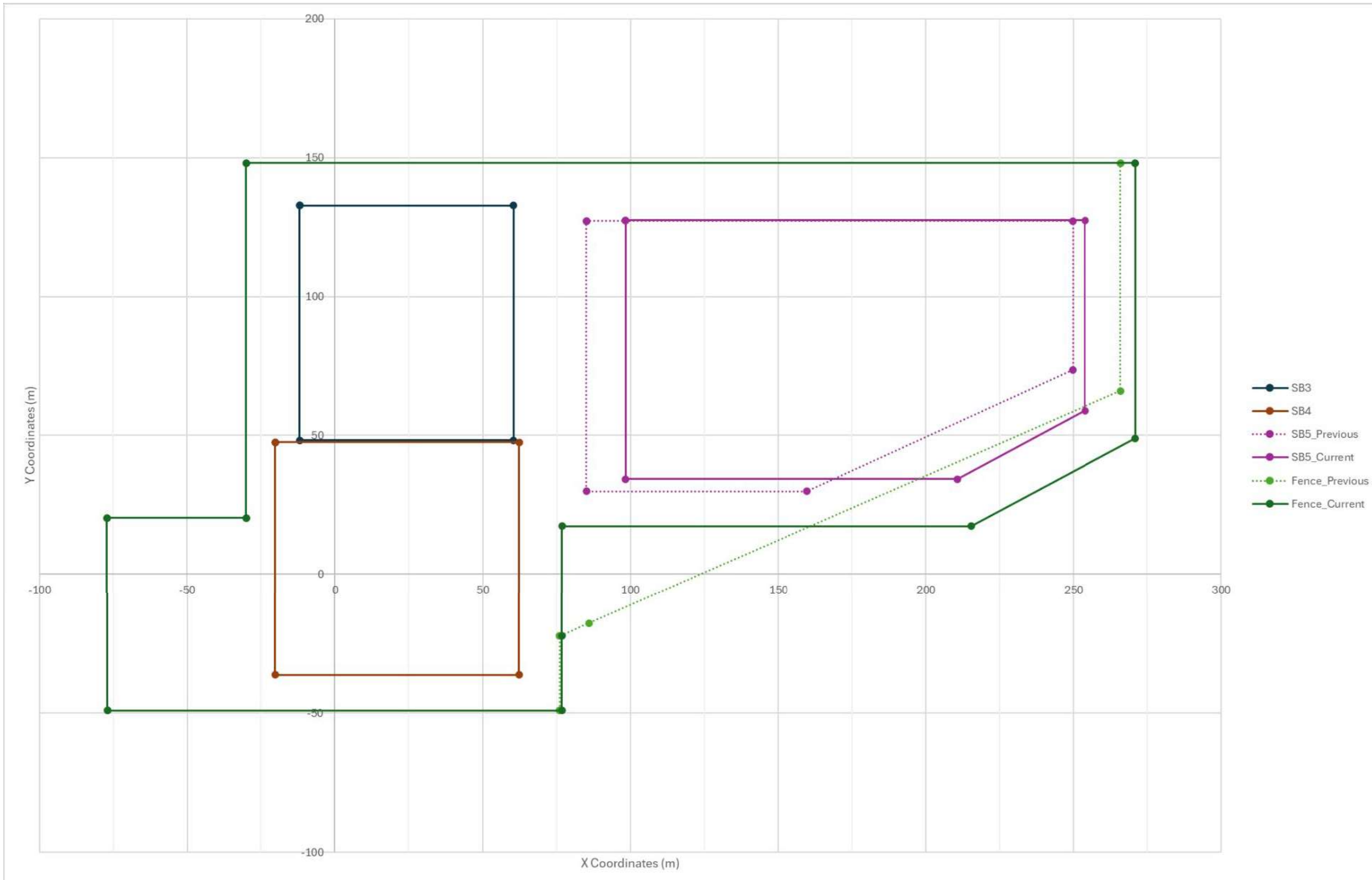



**Figure 3: PWMF SB3-SB5 and Fence Updated Layout**

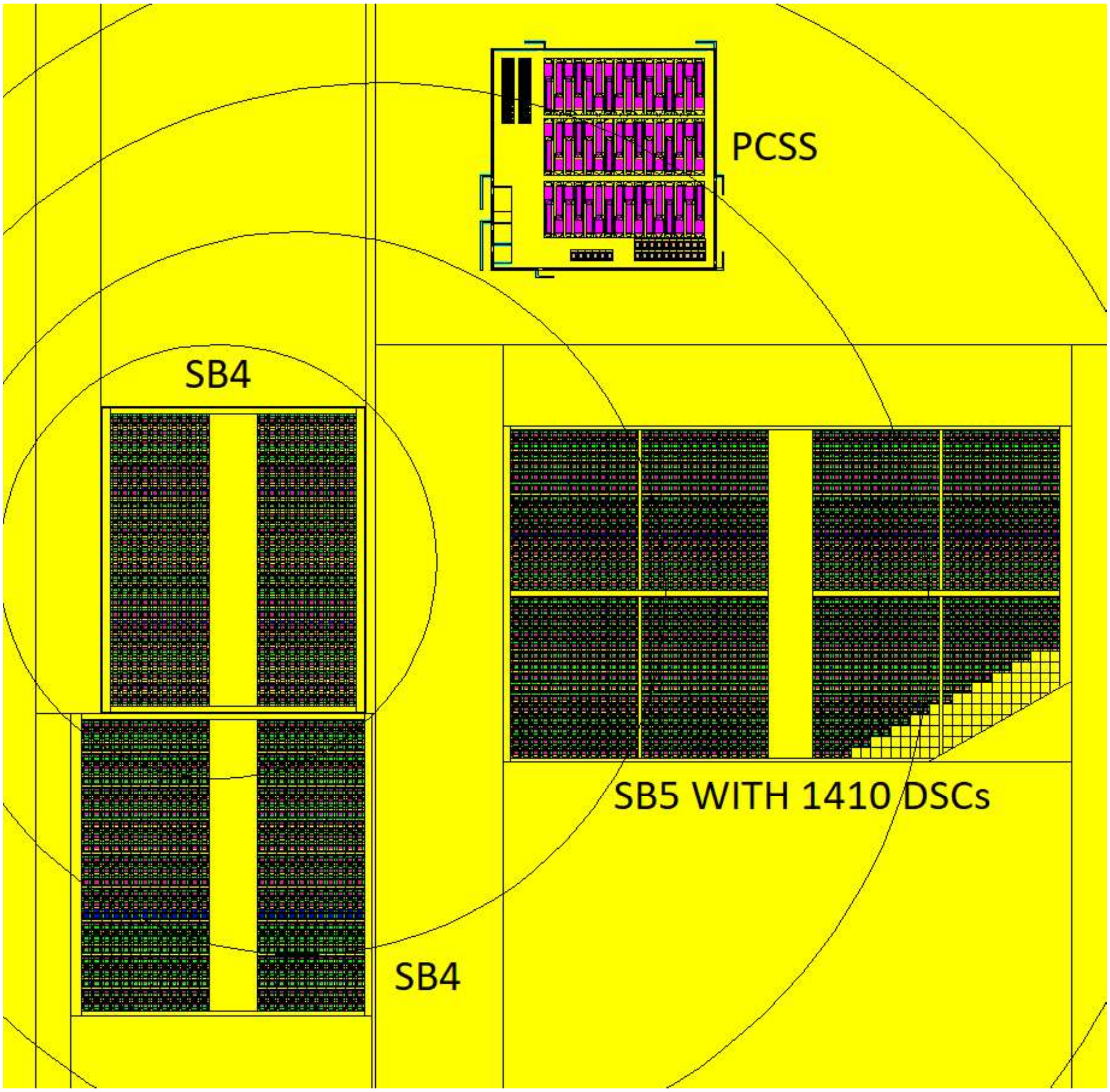


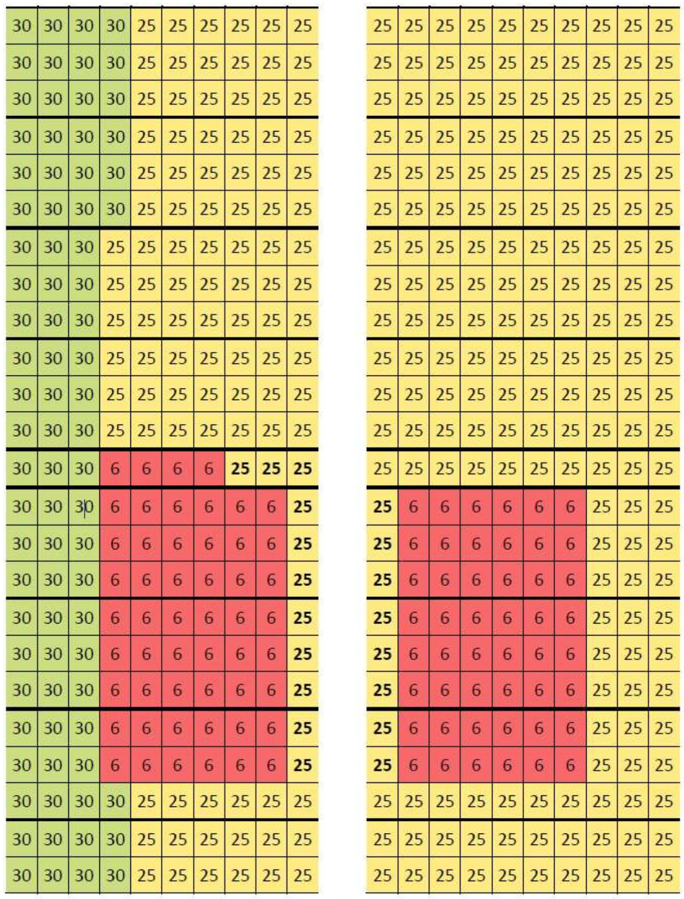

**Figure 4: MCNP Model Including SB3/SB4/SB5 and PCSS – SB5 with 1410 DSCs**

### 3.1.2.2 DSC Layout and Ages

For SB3, the layout from Reference [4] was used, shown in Figure 5. This layout contains 100 6-year-old fuel DSCs, 299 25-year-old DSCs, and 81 30-year-old DSCs. The layout for SB4 was unchanged from Reference [3]. A DSC layout for SB5 with 1410 DSCs was assumed in this analysis, shown in Figure 7. Table 1 summarizes the number of DSCs per fuel age considered in this analysis.

**Table 1: SB3/SB4/SB5 DSC Number per Fuel Ages**

| Fuel Age | SB3 | SB4 | SB5 |
|---|---|---|---|
| 6 | 100 | 0 | 0 |
| 10 | 0 | 252 | 304 |
| 15 | 0 | 0 | 147 |
| 20 | 0 | 0 | 160 |
| 25 | 299 | 147 | 178 |
| 30 | 81 | 73 | 185 |
| 35 | 0 | 32 | 278 |
| 40 | 0 | 120 | 158 |
| Total | 480 | 624 | 1410 |




Values shown in the figure correspond to the DSC decay time in years

**Figure 5: SB3 DSC Age Distribution Layout [4]**

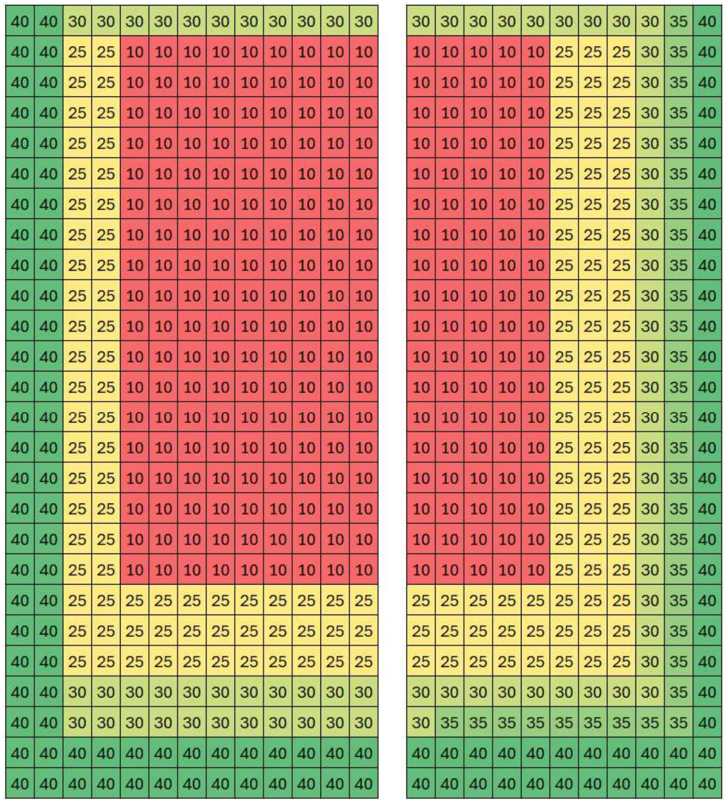


**Figure 6: SB4 DSC Age Distribution Layout [3]**

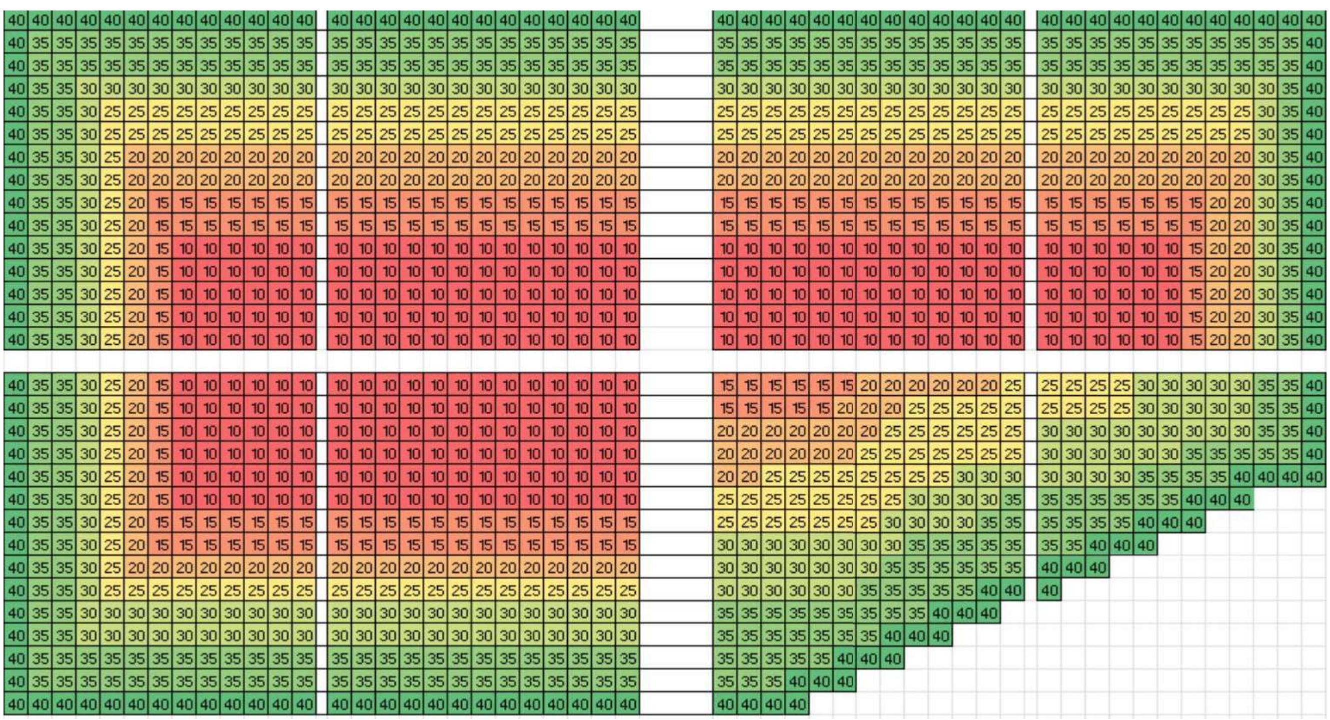


**Figure 7: Age Distribution of 1410 DSCs in SB5**

The DSC surface sources from the PCSS shielding analysis and other PWMF projects [1] [10] were used to represent the DSCs in this analysis. This surface source was developed in Reference [10] using ORIGEN-S for the reference Pickering 28-element fuel bundle with an exit burnup of [redacted] and 10 years decay time.

The DSC source spectrum was grouped into six energy bands, shown in Table 2. This grouping was initially done to ensure that the results for all energy bands of the spectra have good convergence, since the intensities of each energy band significantly vary. The use of the same surface source files assumes that the fine-group photon spectrum in each of energy band is identical across different decay times. The impact of applying the reference fuel spectra to all fuel burnup/decay age combinations has been investigated and shows that the difference in the group average energies is negligible and has no impact on the calculated dose rates [3]. Therefore, the use of the reference surface source files for other decay times is justified.

**Table 2: Energy Bands for the DSCs Surface Source**

| Energy Group | Photon Energy Band (MeV) |
|---|---|
| 00 | $0.30 \leq E < 0.65$ |
| 01 | $0.65 \leq E < 1.00$ |
| 02 | $1.00 \leq E < 1.25$ |
| 03 | $1.25 \leq E < 1.50$ |
| 04 | $1.50 \leq E < 2.00$ |
| 05 | $2.00 \leq E < 3.00$ |

#### 3.1.2.3 Materials and Cross-Sections

The materials and shielding properties were left unchanged from previous calculations of dose rates for the PCSS. Appendix D of Reference [1] includes the detailed list of materials used in the MCNP model.

The cross-section libraries that were used are those installed on the Kinectrics technical computing platform for use with MCNP. They rely primarily on the ENDF/B-VI R8 and ENDF/BVII.1 data libraries [11]. Consistent with the previous MCNP model of the PWMF site, the cross-section library used in this work was the MCLIB04 photon library, based on ENDF/B-VI cross sections.

#### 3.1.2.4 Dose Points and Dose Acceptance Criteria

The dose rate was calculated at [redacted] fences surrounding SB5 (at the north, east and southern locations), as well as the dose points used in the previous analysis for the PCSS [1], listed in Table 3 and shown in Figure 8.

**Table 3: Dose Points**

| Dose Point # | Description |
|---|---|
| PW10 | 1ft below TMB roof peak (height 41 ft above TMB floor) |
| PW24 | Montgomery Park Rd turnaround |
| PW26 | Bend in bike path northeast of PWMF Phase II |
| LS03 | Off shoreline |
| LS04 | Off shoreline |
| LS05 | Lake 282 m off shoreline |
| LS06 | Lake 144 m off shoreline |
| LS07 | Lake, where shoreline intersects with land site boundary |


**Figure 8: PWMF Site Dose Points**

The radiation safety requirements under normal operation of the PWMF are the following [12]:

- ≤ 0.5 µSv/h outside the RCS and Used Fuel Dry Storage (UFDS) areas, on a quarterly average basis, based on the CNSC dose limit of 1 mSv per year for a member of the public, over a maximum of 2,000 hours per year occupancy for non-NEWs (Nuclear Energy Workers).
- For a member of the public, the dose constraint is ≤ 100 µSv per year at the Pickering site boundary. This is an administrative dose target of ten percent of the CNSC dose limit of 1 mSv per year (assuming 2000 hours occupancy).
- For NEWs, the dose limit is 50 mSv in any single year and 100 mSv over 5 years.

The resulting acceptance criteria for each of the dose points considering the occupancy are outlined in Table 4.

**Table 4: Dose Acceptance Criteria**

| Dose Points | Annual Dose Acceptance Criteria | Occupancy | Hourly Dose Acceptance Criteria |
|---|---|---|---|
| PW24, PW26 | 100 µSv/yr | 2000 hr | 0.05 µSv/hr |
| LS03, LS04, LS05, LS06, LS07 | 100 µSv/yr | 1000 hr | 0.1 µSv/hr |
| PW10, mesh tallies (outside of buildings) | 1 mSv/yr | 2000 hr | 0.5 µSv/hr |

### 3.1.2.5 Neutron Dose Rates

Neutron dose rates from DSCs represent only around 4% of the gamma dose rates, as discussed in Reference [13]. Neutron dose rate contributions from RWCs containing Pressure Tubes (PT) and Calandria Tubes (CT) at the PCSS were not accounted for in this work. Therefore, neutron contributions were not assessed.

### 3.1.2.6 Dose Conversion Factors

The International Commission on Radiation Protection (ICRP) 116 Anterior-Posterior Dose Conversion Factors (DCF) [14] were used. These are internationally recognized and accepted conversion factors and are specifically identified in the OPG reference methodology for heavily shielded containers [8].

### 3.1.2.7 Additional Cases

The base case is defined by the storage buildings and PCSS layouts described above in Sections 3.1.2.1 and 3.1.2.2. Since the calculated base case dose rates exceeded the acceptance criterion of 0.5 µSv/h at points along the SB3-SB5 fence, each of the following calculations was performed as well:

a) The distances to where the dose rates equal 0.5 µSv/h were calculated. This was done using mesh tallies in MCNP that extend beyond the [redacted] fence boundaries.

b) The shielding thickness required to reduce dose rates below the 0.5 µSv/h criterion in the form of concrete at the buildings' perimeters was calculated. The required thickness of the shielding material was estimated based on attenuation curves [15], and a confirmatory run was performed in MCNP to confirm that the recommended shielding thickness is adequate to reduce dose rates at the fence to below 0.5 µSv/h at all locations along the fence.

c) The surface sources for the outermost DSCs were scaled down such that the dose rate criteria of 0.5 µSv/h at the [redacted] fence are met with no additional shielding in the building walls. The dose rate required near the surface of the outer DSCs was given such that the dose rate at the [redacted] fence is below 0.5 µSv/h.

## 3.2 Malfunctions/Accidents Safety Assessment

Hazard identification and screening for SB5 was carried out based on the analysis of the activities involved which include handling and storing DSCs in SB5, the characterization of the waste of concern (i.e., DSCs), OPEX and the OPG internal hazard [16] and external hazard [17] screening guides. Furthermore, the impact of construction of SB5 on existing DSCs being stored at SB3 and SB4 is assessed. The following general steps are performed as part of the hazard identification and screening process [6]:

- Perform hazard identification,
- Perform pre-screening of internal and external hazards, and
- Perform detailed qualitative and quantitative event screening.

If the frequency of occurrence estimated for any postulated accident scenario is less than $10^{-6}$ events per year (refer to CSA N292.0:19 [18] and REGDOC-2.4.4 [7]), it is considered incredible and is not considered for further assessment.

As required by REGDOC-2.4.4 [7], the credible events are classified into the following facility states:

- Anticipated Operational Occurrence (AOO),
- Design-Basis Accident (DBA), and
- Design Extension Conditions (DEC).

The frequency ranges of these states were as per Appendix C.2 of REGDOC-2.4.4 [7]. Bounding events from each event group are identified.

Based on the analysis of the activity of on-site transfer, the transfer of DSCs from PNGS to SB5 is similar to the transfer of DSCs to SB3 and SB4 which has been assessed before [2] [3] [4] [19]. The only difference compared with the previous assessment is the DSC handling and storage in the new Building SB5. Therefore, the malfunctions and accident associated with the DSC handling and storage in SB5 are assessed.

Based on the preliminary review of the previous work [3] [5] [19], it is expected that no new dose consequence analysis is required. This is confirmed and documented in Section 6.0.

## 3.3 Use of Software

### 3.3.2 MCNP

MCNP V6.1 was used in this analysis. MCNP V6.1 was executed on the Kinectrics technical computing platform using the following configuration:

- Operating System: Red Hat Enterprise Linux (RHEL) 7.4, 32-bit
- Hardware: Dell PowerEdge Xeon server

MCNP has been installed and qualified for use in radiation shielding applications on this technical computing platform, as documented [20]. It is a Grade 1 code based on Section 4.2 of the Kinectrics Software Qualification Procedure, AWI-4-30 [21].

MCNP is a rigorous physics analysis code that applies a Monte-Carlo method to solve particle transport problems with few significant approximations. It is used in reactor design and safety analysis applications and dose calculation applications. MCNP is qualified for static calculations using k-code or source term methods for various CANDU-related analyses. A code applicability document for MCNP has been prepared for OPG waste management facility shielding analysis [22].

# 4.0 Key Technical Assumptions

Assumption #1

The design and operation of SB5 including the DSC handling rate (number of DSCs being stored per year) will be similar to SB4.

Rationale: All three buildings (SB3, SB4 and SB5) at PWMF are used to handle and store DSCs transferred from PNGS. It is assumed that the design of SB5 and the DSC operation in the building including the DSC handling rate (number of DSCs being stored per year) will be similar to SB4[1].

Assumption #2

No neutron contributions will be assessed in the dose rate assessment for normal operations.

Rationale: Neutron dose rates from DSCs represent only around 4% of the gamma dose rates, as discussed in Reference [13].

# 5.0 Normal Operations Safety Assessment

## 5.1 Public Dose from Chronic Emissions

An analysis of the public dose from chronic emissions was recently performed for the PWMF using the IMPACT software [1]. The primary change since that assessment is the addition of the new DSC storage building (SB5). However, DSC lids and bases are sealed with a full-penetration groove weld and then the DSCs will be filled with inert helium followed by leak testing prior to storage. As such, chronic releases from DSCs in SB5 are not expected during the normal operation of SB5.

It is noted that the stack monitoring for the processing building at PWMF was decommissioned in 2023/2024 due to low emission from the processing building. For example, in the period of 2021 to 2023, the emissions of particulates were less than 1.5E+05 Bq/year, 1.3E+05 Bq/year and 1.2E+05 Bq/year, respectively [23] [24] [25]. These are bounded by the historical emission value used in the assessment [2]. Therefore, no update to the IMPACT analyses for the PWMF site is required and the maximum individual dose to the public due to chronic releases continues to be 1.88E-03 μSv per year, far less than the dose limit of 1000 μSv per year [1].

## 5.2 Public and Worker Dose from External Gamma Radiation

An MCNP run was performed for the Retube Waste Container and Steam Generator sources within the PCSS and the DSCs within SB3, SB4, and SB5. For each case combination, the total dose rate was calculated by summing the contributions from SGs, RWCs, and DSCs.

[1] The DSC handling rate is based on the assumption that SB4 was filled in one year which is very conservative. The actual handling rate could be much less than this number.

### 5.2.1 Base Case

#### 5.2.1.1 PWMF Site Points Dose Rates

As outlined in the OPG methodology for shielding analysis of thick-walled waste containers [8], the dose rates were compared against the dose acceptance criteria after adding 2σ to the best estimate to account for code uncertainty. For the base case, the dose rates at all site dose points are below the dose acceptance criteria, as shown in Table 5. As with the previous analyses of the PWMF site [1] [3], the dose rates were highest at site dose points PW10, PW24, and PW26 all located on the land near the waste storage buildings. The dose rates were lower at the lake dose points, which are further from the buildings.

**Table 5: Base Case Best Estimate + 2σ Dose Rates**

| Dose Point | Dose Rate (μSv/h, BE+2σ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **PW24** | **PW26** | **LS03** | **LS04** | **LS05** | **LS06** | **LS07** | **PW10** |
| **Acceptance Criteria** | **5.00E-02** | **5.00E-02** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **5.00E-01** |
| Base Case | 2.17E-02 | 1.90E-02 | 1.50E-05 | 2.61E-04 | 1.65E-03 | 3.89E-03 | 1.03E-02 | 2.31E-01 |

#### 5.2.1.2 Storage Buildings Fence Dose Rates

The best estimate dose rates around SB3, SB4, and SB5 were calculated around the three buildings along with extra space to cover the surrounding fence areas. The best estimate plus two sigma dose rates around the storage buildings for the base case are shown in Figure 9. The distances where the dose rates fall below the criteria along the fence sides are also shown in Figure 9. The north side of SB5 has the farthest distance beyond the fence above 0.5 μSv/h, up to 27 m, followed by the south side of SB5, up to 14 m beyond the fence. A few high dose streaks visible in Figure 9 are the result of statistical artifacts from the convergence of high-energy particles in the Monte Carlo simulation, not actual regions of elevated dose rates. This is further illustrated in Figure 10, where the artifacts align with the positions of the streaks seen in Figure 9. Figure 10 shows the relative 1σ uncertainty distribution from the MCNP mesh tally, indicating good convergence overall, with most values below 10%, except for the abovementioned streaks.

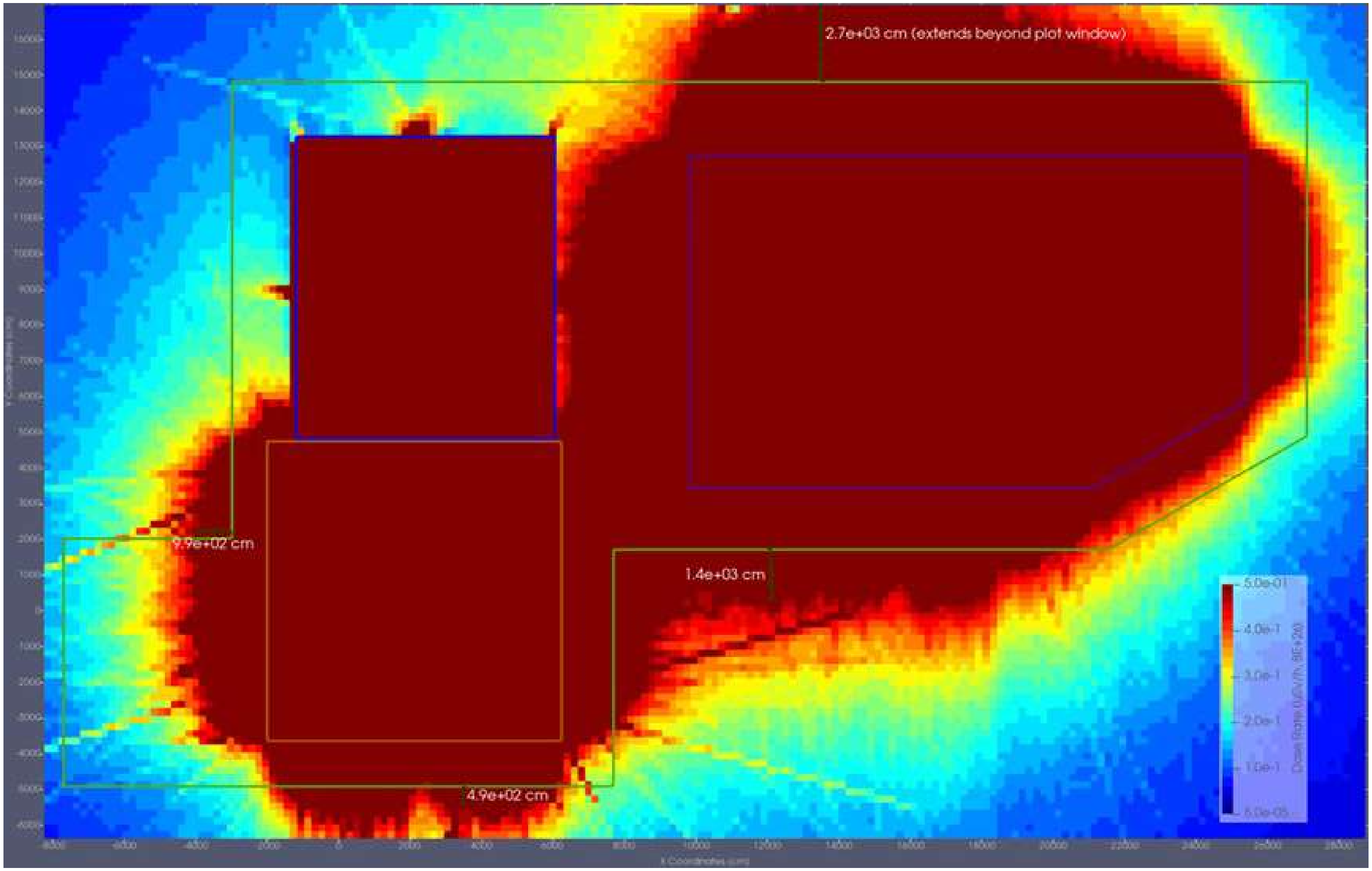



**Figure 9: Base Case with 1410 DSCs Storage Buildings Dose Rates (μSv/h, BE+2σ) – Distances from Fence Above Criteria Labeled [2]**

[2] The contour plots are representative, specific results should not be extrapolated as each voxel in the mesh tally may not have converged and the statistical uncertainties may be too high. The color scale is capped at 0.5 μSv/h; however, actual dose rates within those regions may exceed this threshold.

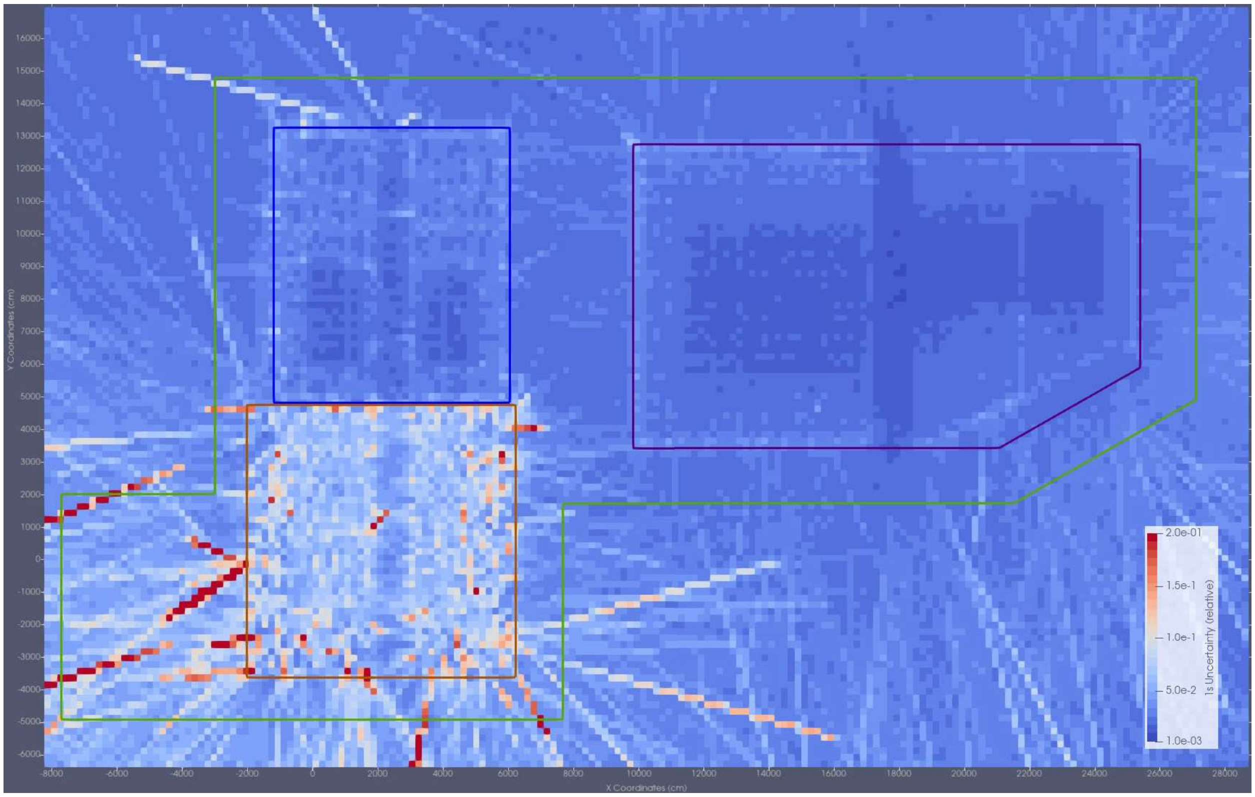



**Figure 10: Base Case with 1410 DSCs – Storage Buildings Dose Rates 1σ Relative Uncertainty**

### 5.2.1.3 Base Case – DSCs Only

To evaluate the storage building fence dose rates from the contribution of only the DSCs in SB3-SB5, a separate case was calculated without accounting for the PCSS RWCs and SGs contributions. This was also done to estimate the PCSS waste dose rate contribution by comparison with the base case. The best estimate plus two sigma dose rates around the storage buildings for the base case accounting only for the SB3, SB4, and SB5 DSCs contributions are shown in Figure 11 and Table 6. This result shows that, even without the contribution from the SGs and RWCs stored in the PCSS, segments of the fence around the storage buildings are above 0.5 μSv/h for the base case.

Figure 11 indicates that dose rates along certain fence segments around SB4 exceed the criteria. However, thermoluminescent dosimeter (TLD) survey data, as reported in Reference [26], showed that the dose rates around SB4 were less than half of the acceptance criteria. The dose rates calculated in this analysis were not scaled down to reflect this survey data, making the reported dose rates conservative.

**Table 6: Base Case Best Estimate + 2σ Dose Rates – DSCs Only**

| Dose Point | Dose Rate (μSv/h, BE+2σ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **PW24** | **PW26** | **LS03** | **LS04** | **LS05** | **LS06** | **LS07** | **PW10** |
| **Acceptance Criteria** | **5.00E-02** | **5.00E-02** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **5.00E-01** |
| Base Case | 2.17E-02 | 1.90E-02 | 1.50E-05 | 2.61E-04 | 1.65E-03 | 3.89E-03 | 1.03E-02 | 2.31E-01 |
| Base Case – DSCs Only | 1.71E-02 | 8.35E-03 | 1.36E-05 | 2.43E-04 | 1.49E-03 | 3.39E-03 | 8.78E-03 | 1.45E-01 |

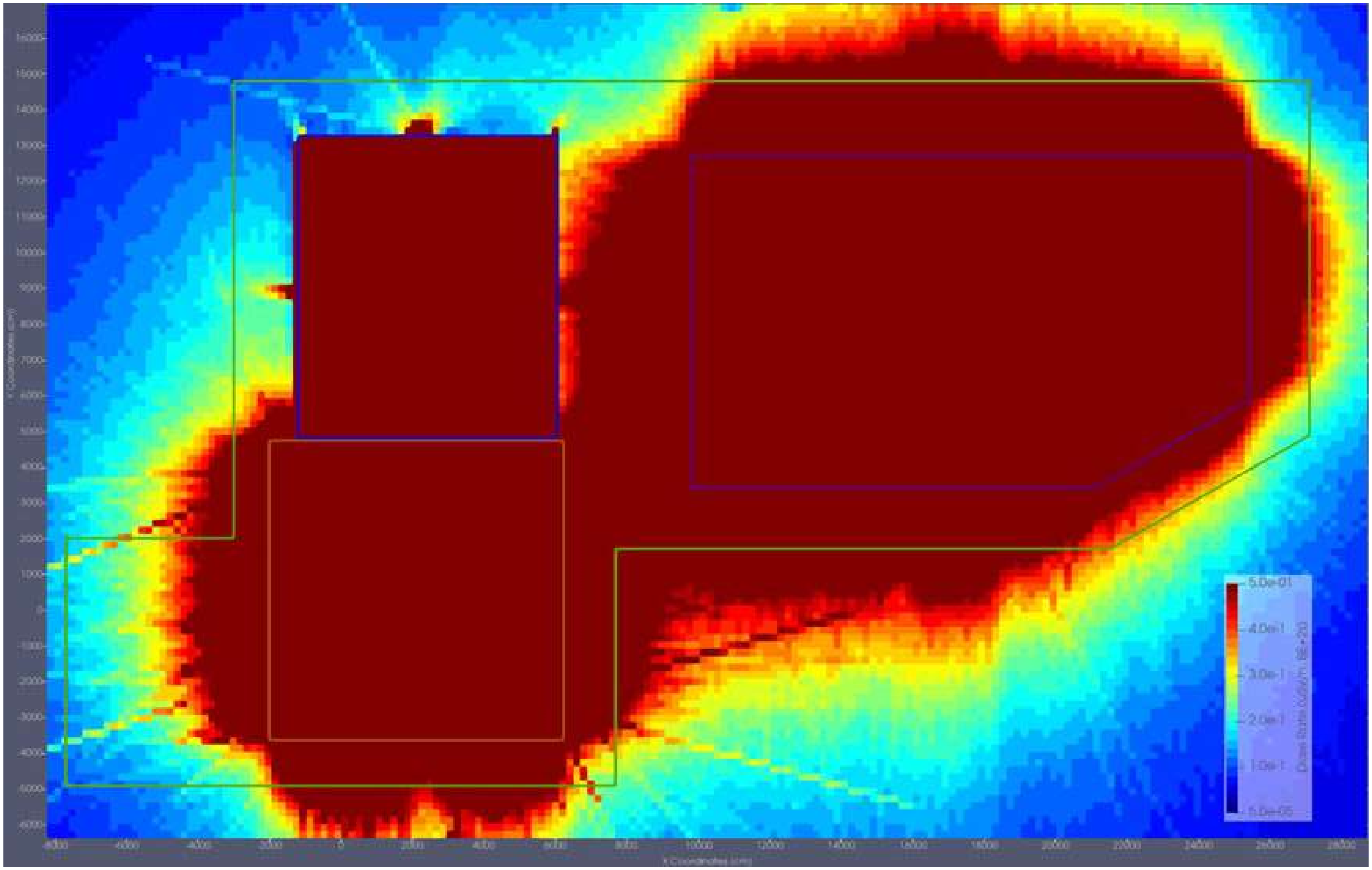


**Figure 11: Base Case with 1410 DSCs – Contributions from SB3-SB5 DSCs – Storage Buildings Dose Rates (µSv/h, BE+2σ) [3]**

[3] The contour plots are representative, specific results should not be extrapolated as each voxel in the mesh tally may not have converged and the statistical uncertainties may be too high. The color scale is capped at 0.5 µSv/h; however, actual dose rates within those regions may exceed this threshold.

### 5.2.2 Added Shielding Case

This MCNP case has the estimated concrete thickness added as shielding to confirm its effectiveness. The required thickness of the shielding material was estimated based on attenuation curves [15], and a confirmatory run was performed in MCNP to confirm that the recommended shielding thickness is adequate to reduce dose rates at the fence to below 0.5 μSv/h at all locations along the fence. While only concrete was considered as the shielding material in this analysis, alternative materials with different thicknesses but equivalent attenuation could also be used. Shielding was only added to the outside of SB5 near the fence segments surrounding SB5, as requested by OPG. The best estimate plus two sigma dose rates around the storage buildings for the added shielding case are shown in Figure 12, which labels the position and length of the walls. The shielding walls are 3 m tall, 8 cm thick on the south side of SB5,12 cm thick on the northwest side, labeled in orange in Figure 12, and 10 cm on the northeast side, labeled in green in Figure 12. With this added shielding, the dose rates at almost all fence segments surrounding SB5 are below criteria. The dose rates at all site dose points for the added shielding case are below the dose acceptance criteria, as shown in Table 7.

**Table 7: Base Case Best Estimate + 2σ Dose Rates – Added Shielding**

| Dose Point | Dose Rate (μSv/h, BE+2σ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW24 | PW26 | LS03 | LS04 | LS05 | LS06 | LS07 | PW10 |
| **Acceptance Criteria** | **5.00E-02** | **5.00E-02** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **5.00E-01** |
| Base Case | 2.17E-02 | 1.90E-02 | 1.50E-05 | 2.61E-04 | 1.65E-03 | 3.89E-03 | 1.03E-02 | 2.31E-01 |
| Added Shielding | 2.15E-02 | 1.70E-02 | 1.43E-05 | 2.31E-04 | 1.52E-03 | 3.77E-03 | 1.01E-02 | 2.27E-01 |

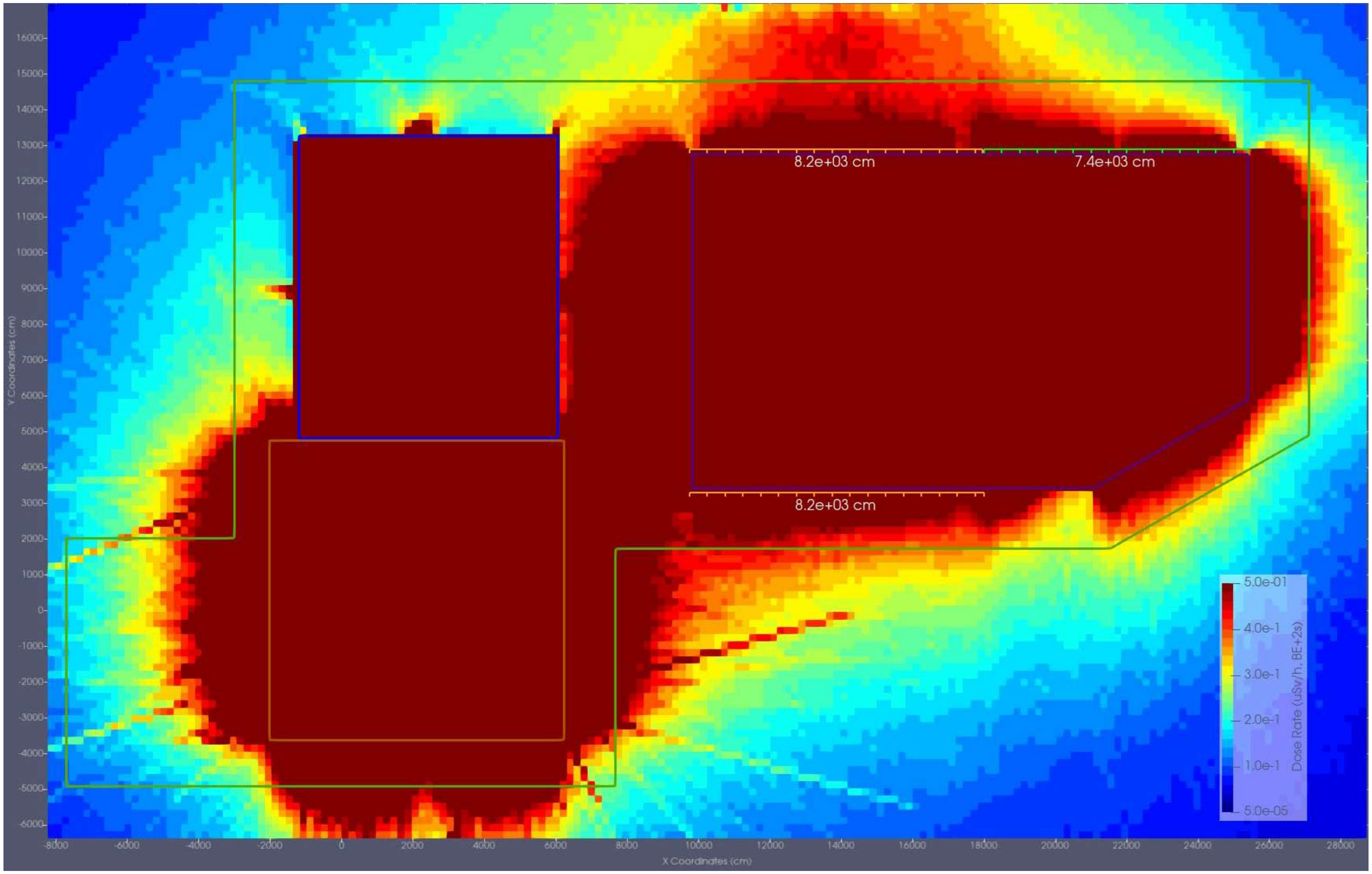



**Figure 12: Added Shielding Case with 1410 DSCs Storage Buildings Dose Rates (μSv/h, BE+2σ) – Shielding Walls Position and Length Labeled [4]**

[4] The contour plots are representative, specific results should not be extrapolated as each voxel in the mesh tally may not have converged and the statistical uncertainties may be too high. The color scale is capped at 0.5 μSv/h; however, actual dose rates within those regions may exceed this threshold.

### 5.2.3 Rescaled DSCs Case

The surface sources for the outermost DSCs were scaled down such that the dose rate criteria of 0.5 μSv/h at the [redacted] fence are met with no additional shielding in the building walls. The rescaled outer DSCs are shown in Figure 13. The SB5 MCNP calculations were rerun with the rescaling applied to these outer DSCs. The scaling factors for each energy group were rescaled down to 50% (highlighted in pink), 25% (highlighted in blue), and 15% (highlighted in purple). Then, the base case contributions from SB3, SB4, and PCSS wastes were added.

The best estimate plus two sigma dose rates with the rescaled DSCs are shown in Figure 14. With this rescaling of the DSCs, the dose rates at all fence segments surrounding SB5 are below criteria. The dose rates near the surface of the outer DSCs were taken from the mesh tally elements closest to the northernmost and southernmost DSCs. The maximum dose rates (BE+2σ) in these regions were 2.1 μSv/h for the northernmost DSCs and 1.5 μSv/h for the southernmost DSCs.

As expected, the dose rates (BE+2σ) at all site dose points for the rescaled DSCs case are lower than the base case and are below the dose acceptance criteria, as shown in Table 8.

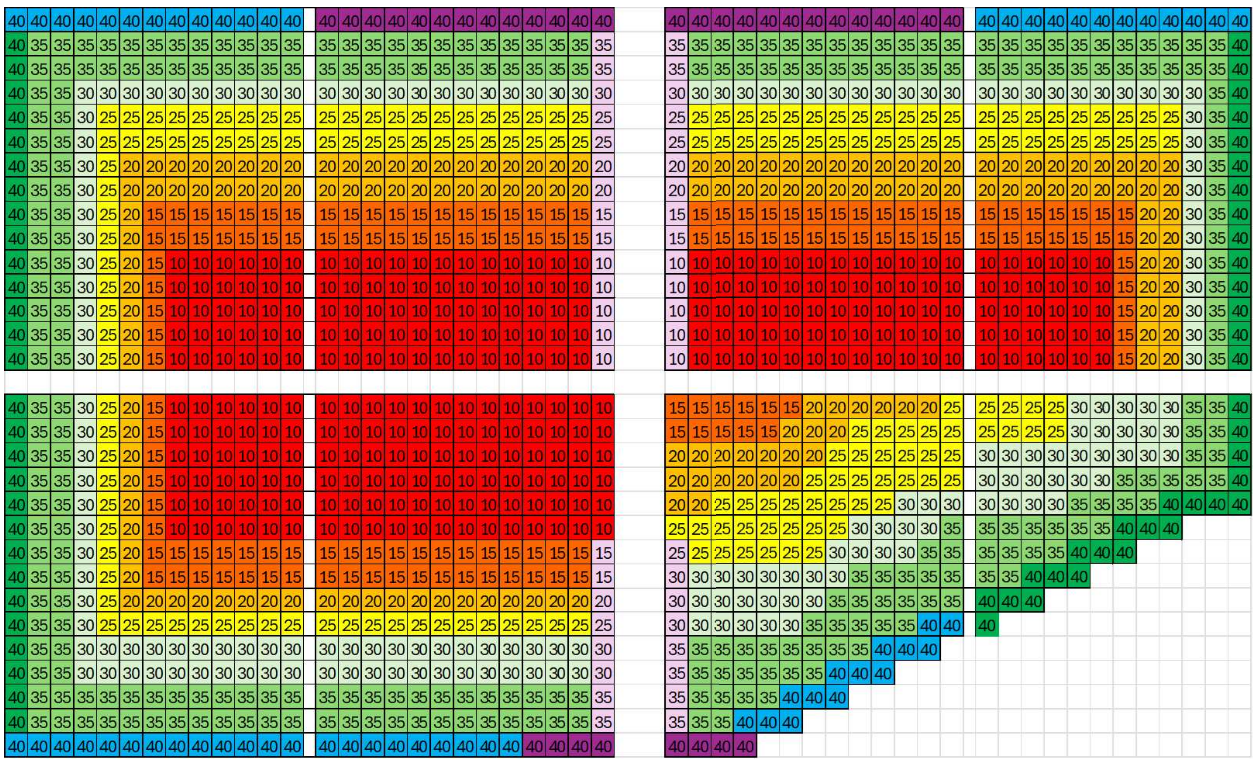


**Figure 13: Age Distribution of 1410 DSCs in SB5 – Rescaled Outer DSCs Highlighted (Scaled Down to 50% in Pink, 25% in Blue, and 15% in Purple)**

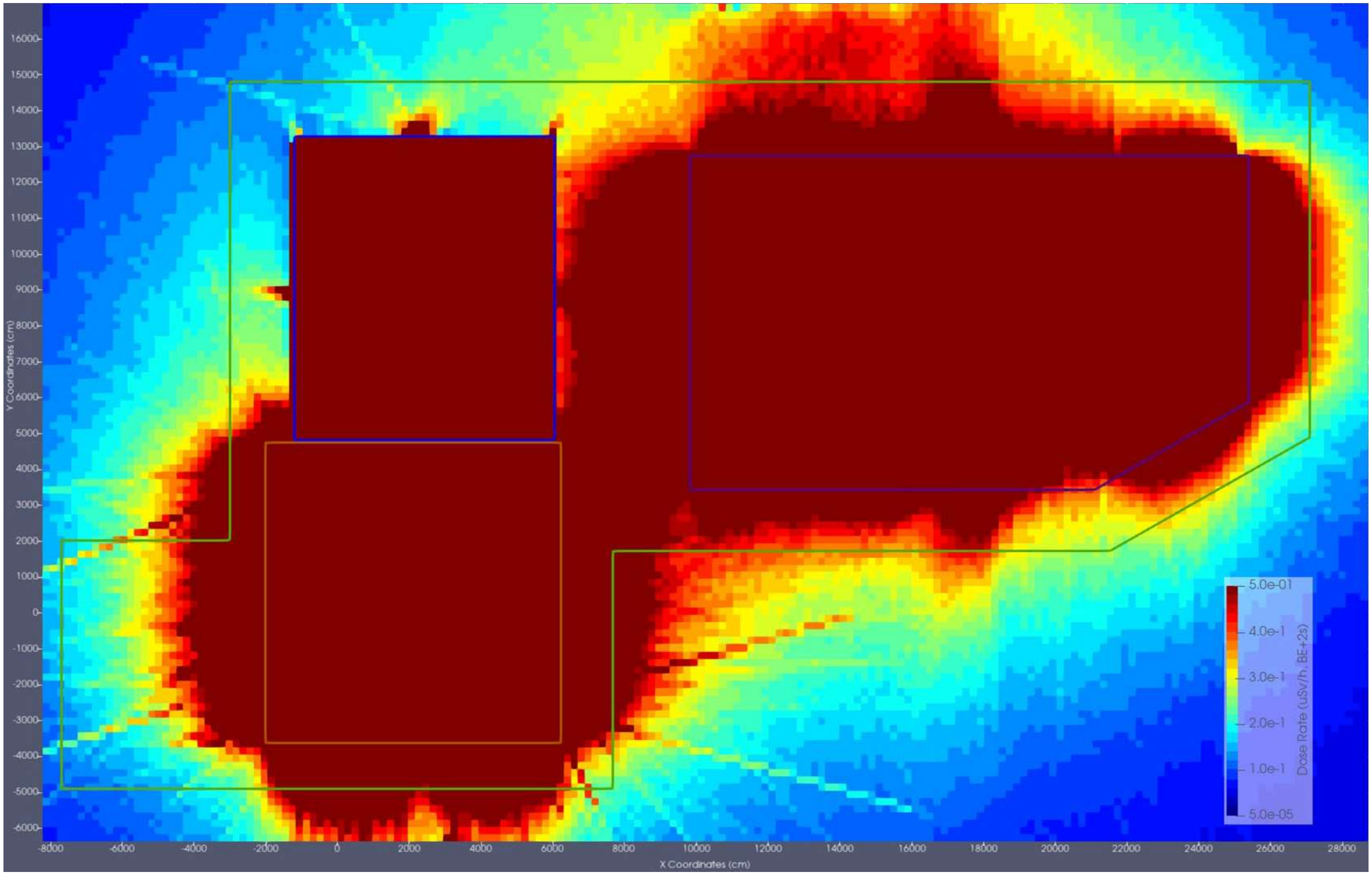



**Figure 14: Rescaled DSCs Case with 1410 DSCs Storage Buildings Dose Rates (µSv/h, BE+2σ) – Rescaled Outer DSCs[5]**

[5] The contour plots are representative, specific results should not be extrapolated as each voxel in the mesh tally may not have converged and the statistical uncertainties may be too high. The color scale is capped at 0.5 µSv/h; however, actual dose rates within those regions may exceed this threshold.

**Table 8: Base Case Best Estimate + 2σ Dose Rates – Rescaled Outer DSCs**

| Dose Point | Dose Rate (μSv/h, BE+2σ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW24 | PW26 | LS03 | LS04 | LS05 | LS06 | LS07 | PW10 |
| **Acceptance Criteria** | **5.00E-02** | **5.00E-02** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **5.00E-01** |
| Base Case | 2.26E-02 | 1.82E-02 | 1.39E-05 | 2.12E-04 | 1.45E-03 | 3.60E-03 | 1.01E-02 | 2.28E-01 |
| Rescaled DSCs Case | 2.04E-02 | 1.65E-02 | 1.35E-05 | 2.69E-04 | 1.46E-03 | 3.54E-03 | 9.59E-03 | 2.24E-01 |

To estimate the required dose rate near the DSC surface after applying the scaling factor, a single DSC MCNP input with the fuel ages 500-group photon energy spectra was used to assess the dose rates around the container. The best estimate dose rates at 30 cm from the rescaled single DSC at certain fuel ages are shown in Table 9. These values may be considered as the bounding SB5 outer DSCs surface dose rates that result in dose rates below 0.5 μSv/h at the [redacted] fence segments around SB5.

**Table 9: Dose Rates (μSv/h, BE+2σ) at 30 cm Distance from a Single DSC Surface**

| Fuel Age (Scaling) | Dose Rate at 30 cm (μSv/h, BE+2σ) | | |
|---|---|---|---|
| | Front | Side (Wide) | Top |
| 40y (100%) | 7.02E+00 | 8.70E+00 | 5.35E+00 |
| 40y (25%) | 1.75E+00 | 2.18E+00 | 1.34E+00 |
| 40y (15%) | 5.26E-01 | 6.53E-01 | 4.01E-01 |
| 35y (100%) | 8.34E+00 | 1.03E+01 | 6.32E+00 |
| 35y (50%) | 4.17E+00 | 5.15E+00 | 3.16E+00 |
| 30y (100%) | 1.00E+01 | 1.23E+01 | 7.52E+00 |
| 30y (50%) | 5.00E+00 | 6.16E+00 | 3.76E+00 |
| 25y (100%) | 1.21E+01 | 1.62E+01 | 9.44E+00 |
| 25y (50%) | 6.05E+00 | 8.12E+00 | 4.72E+00 |
| 20y (100%) | 1.51E+01 | 1.86E+01 | 1.16E+01 |
| 20y (50%) | 7.56E+00 | 9.29E+00 | 5.79E+00 |
| 15y (100%) | 1.95E+01 | 2.43E+01 | 1.52E+01 |
| 15y (50%) | 9.77E+00 | 1.21E+01 | 7.58E+00 |
| 10y (100%) | 3.03E+01 | 3.68E+01 | 2.34E+01 |
| 10y (50%) | 1.51E+01 | 1.84E+01 | 1.17E+01 |

#### 5.2.3.1 Additional Distance North Fence

There is an additional distance of about 12 m between the SB5 north fence and the south side of the road, as shown in Figure 15, where an additional barrier/fence may be installed at the 0.5 μSv/h boundary. So, the surface sources for the outermost DSCs were scaled down such that the dose rate criteria of 0.5 μSv/h considering an additional 12 m distance from the north fence were met with no additional shielding in the building walls.

The best estimate plus two sigma dose rates with the rescaled DSCs are shown in Figure 17. The dose rates near the surface of the outer DSCs were calculated closest to the northernmost and southernmost DSCs. The maximum dose rates (BE+2σ) in these regions were 2.8 μSv/h for the northernmost DSCs and 1.6 μSv/h for the southernmost DSCs.

The best estimate plus two sigma dose rates at 30 cm from the rescaled single DSC at certain fuel ages are shown in Table 10. These values may be considered as the bounding SB5 outer DSCs surface dose rates that result in dose rates below 0.5 μSv/h at the fence segments around SB5. The dose rates (BE+2σ) at all site dose points for the rescaled DSCs case are lower than the base case and are below the dose acceptance criteria, as shown in Table 11.

**Table 10: Dose Rates (μSv/h, BE+2σ) at 30 cm Distance from a Single DSC Surface**

| Fuel Age (Scaling) | Dose Rate at 30 cm (μSv/h, BE+2σ) | | |
|---|---|---|---|
| | Front | Side (Wide) | Top |
| 40y (100%) | 7.02E+00 | 8.70E+00 | 5.35E+00 |
| 40y (50%) | 3.51E+00 | 4.35E+00 | 2.67E+00 |
| 40y (25%) | 1.75E+00 | 2.18E+00 | 1.34E+00 |
| 40y (15%) | 1.05E+00 | 1.31E+00 | 8.02E-01 |
| 35y (100%) | 8.34E+00 | 1.03E+01 | 6.32E+00 |
| 35y (50%) | 4.17E+00 | 5.15E+00 | 3.16E+00 |
| 30y (100%) | 1.00E+01 | 1.23E+01 | 7.52E+00 |
| 30y (50%) | 5.00E+00 | 6.16E+00 | 3.76E+00 |
| 25y (100%) | 1.21E+01 | 1.62E+01 | 9.44E+00 |
| 25y (50%) | 6.05E+00 | 8.12E+00 | 4.72E+00 |
| 20y (100%) | 1.51E+01 | 1.86E+01 | 1.16E+01 |
| 20y (50%) | 7.56E+00 | 9.29E+00 | 5.79E+00 |
| 15y (100%) | 1.95E+01 | 2.43E+01 | 1.52E+01 |
| 15y (50%) | 9.77E+00 | 1.21E+01 | 7.58E+00 |

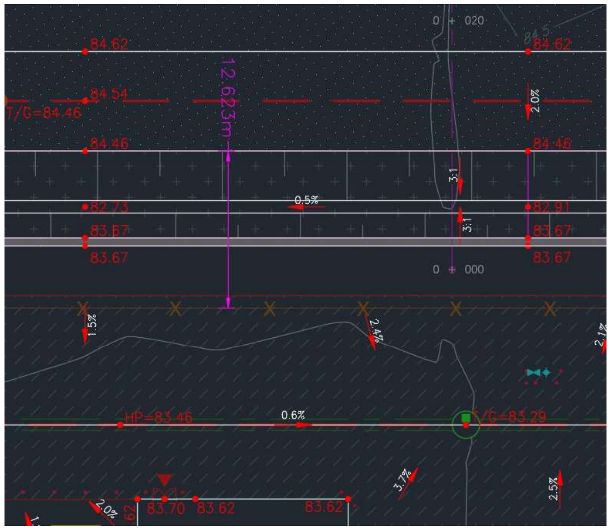



Figure 15: Additional Distance from SB5 North Fence [27]

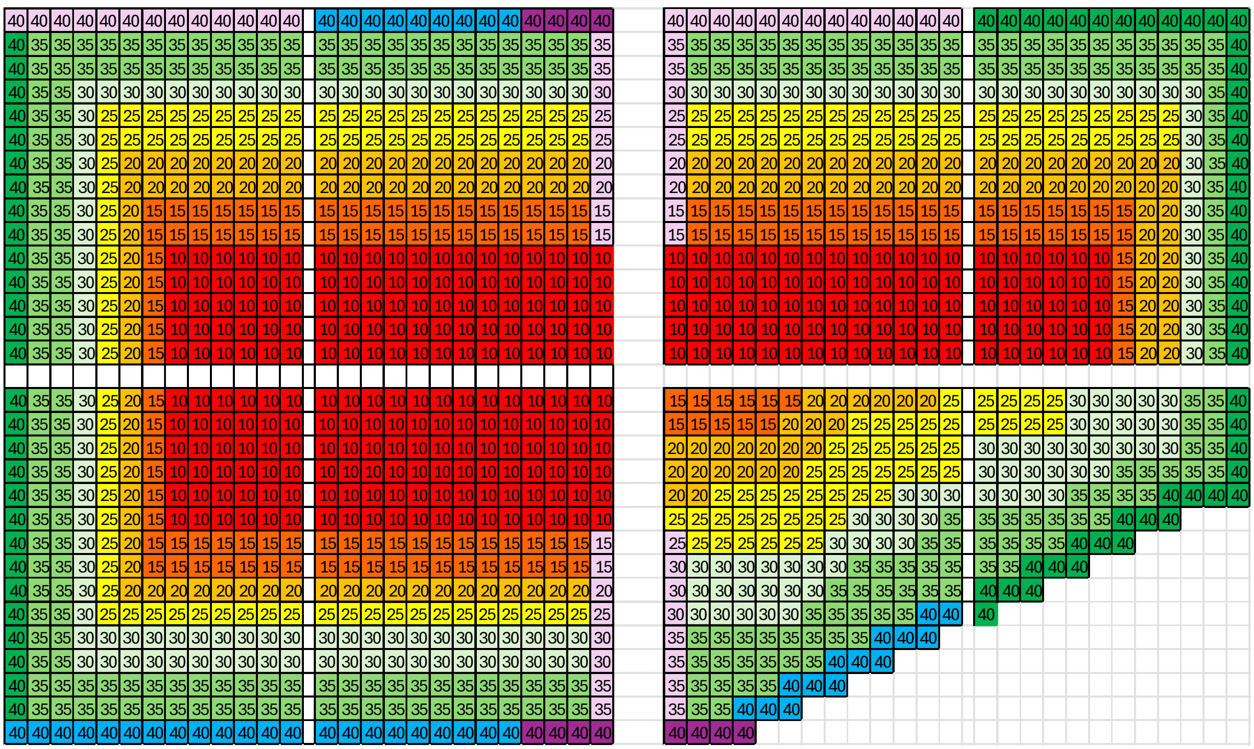


Figure 16: Age Distribution of 1410 DSCs in SB5 – Rescaled Outer DSCs Highlighted (Scaled Down to 50% in Pink, 25% in Blue, and 15% in Purple)

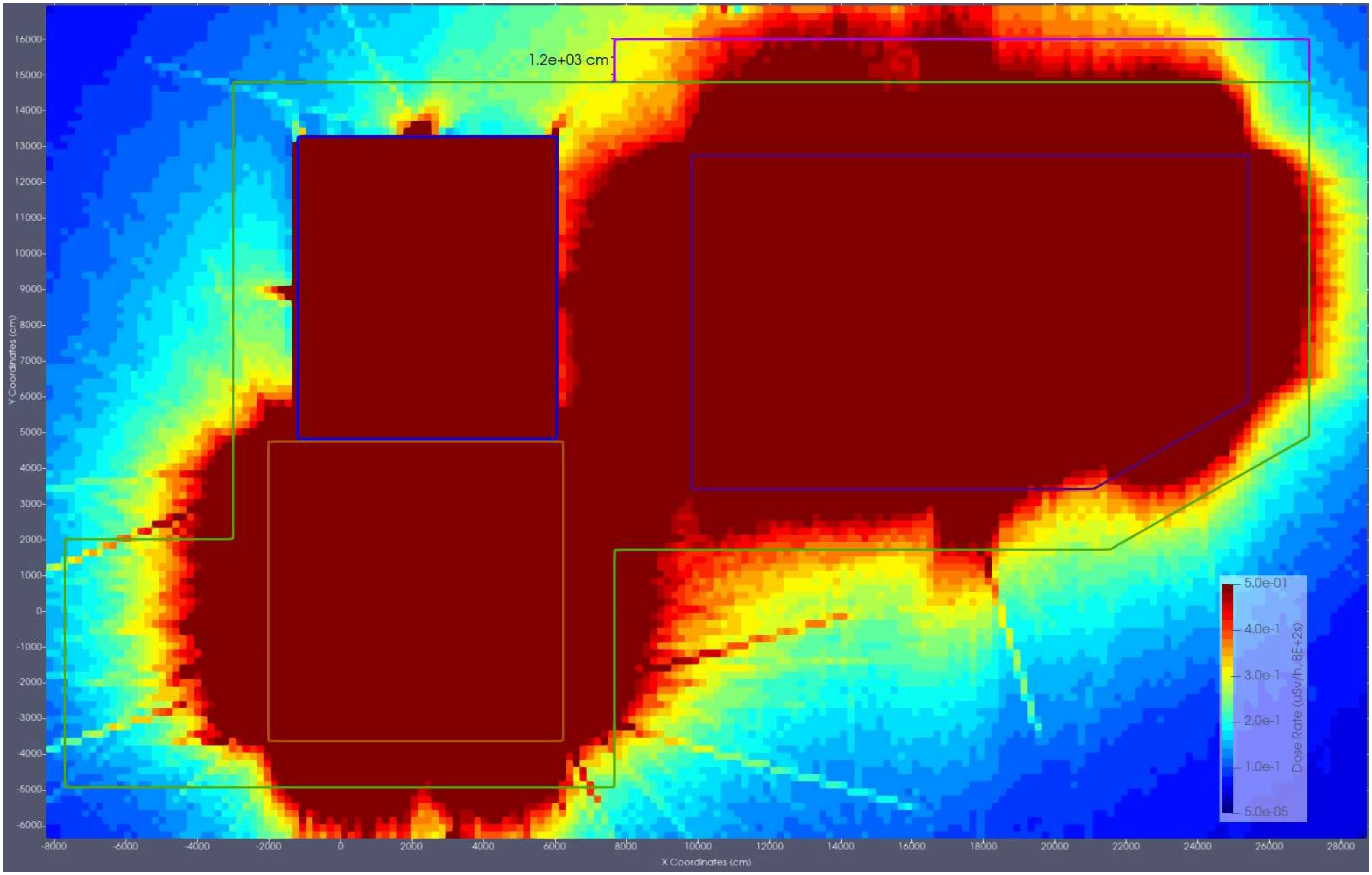



**Figure 17: Rescaled DSCs Case with 1410 DSCs Storage Buildings Dose Rates (μSv/h, BE+2σ) – Rescaled Outer DSCs – Additional Distance North Fence Highlighted in Purple [6]**

[6] The contour plots are representative, specific results should not be extrapolated as each voxel in the mesh tally may not have converged and the statistical uncertainties may be too high. The color scale is capped at 0.5 μSv/h; however, actual dose rates within those regions may exceed this threshold.

**Table 11: Base Case Best Estimate + 2σ Dose Rates – Rescaled Outer DSCs**

| Dose Point | Dose Rate (μSv/h, BE+2σ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW24 | PW26 | LS03 | LS04 | LS05 | LS06 | LS07 | PW10 |
| **Acceptance Criteria** | **5.00E-02** | **5.00E-02** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **1.00E-01** | **5.00E-01** |
| Base Case | 2.26E-02 | 1.82E-02 | 1.39E-05 | 2.12E-04 | 1.45E-03 | 3.60E-03 | 1.01E-02 | 2.28E-01 |
| Rescaled DSCs Case | 2.08E-02 | 1.78E-02 | 1.38E-05 | 2.19E-04 | 1.47E-03 | 3.56E-03 | 9.73E-03 | 2.26E-01 |

### 5.3 Total Public Dose

The maximum individual dose to members of the public can be calculated by adding together the maximum individual dose from chronic releases which is 1.88E-03 μSv per year (see Section 5.1), and the dose rate from external gamma radiation at the most conservative public dose point (PW24).

For the base case, assessed in Section 5.2.1, the dose rate from external gamma radiation (BE+2σ) calculated at PW24 was 0.0217 μSv/h (which includes the contributions from the DSCs in SB3/SB4/SB5 and the RWC-PT/CTs, RWC-EFs, and SGs in the PCSS), which equates to 43.4 μSv per year (assuming 2,000h occupancy). For the added shielding and rescaled DSCs cases, the dose rates at PW24 are 0.0215 μSv/h (43 μSv/y) and 0.0204 μSv/h (40.8 μSv/y), respectively.

The dose contribution from chronic releases is negligible compared to the dose contribution from external gamma radiation. The administrative public dose target of 100 μSv per year is not exceeded considering the dose from external gamma radiation for all cases assessed in this work.

It should be noted that the MCNP results are conservative. As discussed in Section 5.2.1.3, the MCNP analysis DSC dose rates were not scaled to reflect the recent survey data [26]. Additionally, the fuel ages assumed for the SB5 DSC layout are conservative, as the waste will have undergone further decay by the time all DSCs are transferred to the building.

## 6.0 Malfunctions/Accidents Safety Assessment

Malfunctions and accidents associated with DSC processing have been assessed previously [2]. In addition, on-site transfer of DSCs to DSC storge Buildings (e.g., SB3 and SB4) has been assessed before [2] [3] [4] [19]. The assessment results including dose consequence calculation apply to this project given the activities of DSC processing and on-site transfer are independent of activities carried out in the storage buildings. The only difference compared with the previous assessment is the DSC handling and storage in the new Building SB5. Therefore, the malfunctions and accidents associated with the DSC handling and storage in SB5 are assessed to confirm it is safe to operate. Furthermore, the impact of construction of SB5 on existing DSCs being stored at SB3 and SB4 is assessed.

The assessment followed the methodology specified in Section 3.2, taking into account the information from the existing safety assessments [2] [19]. A pre-screening of the identified hazards was undertaken to screen out those events which are known to have no impact on the Pickering site or PWMF. Hazards may be eliminated at this stage when it can easily be determined without any additional analysis, that the hazard has a negligible impact on the safety of SB5. Hazards that are screened in are then part of the detailed screening analysis. Appendix A lists the results of the hazard pre-screening assessment.

## 6.1 Malfunctions/Accidents during Handling and Storage

### 6.1.1 DSC Seal Weld Failure during Storage

Radioactive release from a DSC will only occur if both the fuel sheath and the DSC lid seal weld fail. However, used fuel having a known damaged or defective sheath will not be loaded into a DSC. Failure of the sheath is not expected to occur during the operating life of the storage facility. Furthermore, the DSC lid and base are sealed with a full-penetration groove weld. After the weld has been completed and cooled, a Phased Array Ultrasonic Testing (PAUT) system is used for the inspection of the DSC lid-to-base seal-weld. The DSC is subsequently filled with inert helium and leak tested prior to storage.

As the seal-welds are inspected and pressure tested, and there is no external force acting upon DSCs, it is concluded that multiple random weld failures are not a credible event. A check of OPEX also confirmed that no instance of random-weld failures has been reported. Therefore, this event is screened out.

### 6.1.2 DSC drop during Transfer to Storage

DSC drop could occur due to the failure of the Transporter or the DSC lift plates while the DSC is lifted by the Transporter during the transfer of a loaded DSC in SB5. Assuming that 624 DSCs are transferred to SB5 within the year, same as the rate for SB4 [19], the postulated frequency of both mechanical locking mechanisms failing simultaneously while carrying a loaded DSC within SB5 would be 6.24E-06 events per year [19], greater than he cut-off frequency of 1E-06 per year.

However, given that the Transporter is equipped with front and rear bumper emergency stops or sensors, and taking into account the low-lift height of the DSC while in the Transporter and that the loaded DSC has been seal-welded at this stage of the process, no releases are expected from this scenario. Therefore, this event is screened out.

### 6.1.3 Transporter Collision with a Dry Storage Container or Another Transporter

Operator error during Transporter operations could result in a collision with a loaded DSC on SB5 building floor or with another Transporter in SB5. The probability of a DSC drop or collision event in SB5 due to operator error would be 6.24E-01 events per year, assuming maximum of 624 DSCs are transferred to SB5 within a single year [19].

However, given the low-lift height of the DSC while in the Transporter and that the loaded DSC has already been seal welded at this stage of the process, no releases would result from this scenario. Therefore, there would be no public or occupational dose consequences. Therefore, this event is screened out.

### 6.1.4 Fire

Similar to SB3 and SB4, SB5 has been designed in accordance with the National Building Code of Canada (NBCC) [28] and the National Fire Code of Canada (NFCC) [29]. Additionally, in case of accidents involving fires, the Pickering Emergency Response Program (ERP) also applies to the PWMF Phase II site where SB5 is located within.

The credible fire scenarios could be DSC transporter fire and Transient Work Vehicle (i.e. Scissor Lift) fire in the storage area. The fire involves mainly the combustible liquids and the rubber tires. The effects of a fire could potentially increase the temperature of the DSC and the used fuel bundles inside the DSC. However, Fire Hazard Assessment (FHA) [30] concluded that given the large thermal inertia of the DSC and the limited duration of the event, the DSC exposed to the fire would not exceed their design limits during a fire event and there would be no radioactive release from the DSCs. As such, there would be no public or occupational dose consequences as a result of this event. Therefore, this event is screened out.

### 6.1.5 Earthquake

The DSC has a safety factor of 7 against overturning and 4 against sliding under the loads described for the earthquake scenario using the Pickering 'B' seismic ground response spectra and accelerations of 0.0625g horizontal and 0.05g vertical Peak Ground Acceleration (PGA) [31].

The structure of the DSC is adequately strong to ensure the integrity of the DSC in case of an earthquake with the above parameters. In addition, the DSC is required by design to withstand a storage building collapse without loss of shielding or containment [32]. Therefore, no releases would result from DSCs in storage and there would be no public or occupational dose consequences as a result of a Design Base Earthquake (DBE). Therefore, this event is screened out.

### 6.1.6 Tornados / High Wind

A DSC can resist overturning in tornado winds of up to 425 km/h [31]. This scenario considers the DSC to be subject to the full force of the horizontal wind and ignores the building structures.

It is expected that the wind associated with a Design Base Tornado (DBT) will not overturn a DSC loaded with used fuel, which has a safety factor greater than 5 against overturning due to tornado winds [31]. Therefore, it can be concluded that a seal-welded DSC will not overturn under the impact of postulated tornado missiles/severe wind load and the containment will not be breached as a result of a tornado-generated missiles.

Based on the design requirements [32], the DSCs in storage will withstand tornado generated missile impacts, strong winds and storage building structural failure or collapse without loss of shielding or containment. Therefore, there would be no releases from the seal welded DSCs in storage inside the SB5 and no dose consequences to the public or to workers. Therefore, this event is screened out.

### 6.1.7 Thunderstorms/Lightning

Thunderstorms can potentially involve lightning striking SB5. However, SB5 will be equipped with appropriate grounding provisions [28]. Additionally, according to the design requirements [32], the DSC was designed to maintain its structural integrity, appropriate shielding and containment function for severe atmospheric conditions, including lightning. This is also confirmed in a lightning strike container assessment [33].Therefore, no releases and public dose consequences are expected from this event. Therefore, this event is screened out.

### 6.1.8 Flooding

The only possibility for flooding at the PWMF site would be as a result of extreme local meteorological events. Water entry originating from a Probable Maximum Precipitation (PMP) into SB5 is possible. However, the DSCs are seal-welded and designed to tolerate water immersion at 2 MPa [32], so the temporary waters of the PMP flooding does not represent radiological safety concern. Therefore, this event is screened out.

### 6.1.9 Explosion

Explosion sources exist on PWMF Phase II. Based on the transportation route assessment for the SB3 and SB4 [34], the peak side-on overpressure at the distance of 100 m from the sources of the explosion is no more than 7 kPa. As SB5 is located at least 200 m away from these explosion sources and there are other facilities between SB5 and these sources, the impact of the explosion on SB5 can be screened out given the estimated overpressure level at SB5 will be less than 6.9 kPa, the criterion specified by the US NRC [35]. Furthermore, the maximum thermal radiation due to the propane fireball is expected to be less than 18 $kW/m^2$, less than the potential impact criteria of 35 $kW/m^2$.

### 6.1.10 Aircraft Crash

The aircraft crash frequency calculated for the total safety related container (DSCs and RWCs) storage area in the PWMF site, including SB5 and the proposed PCSS, is 6.5E-07 events per year, based on the proposed dimension of the building and taking into account the crash rate for the PWMF site (refer to Appendix B). This value is lower than the cut-off frequency of 1E-06 events per year. Therefore, this event is screened out.

## 6.2 Construction Hazards Impacting Storage of DSCs in SB3 and SB4

### 6.2.1 Dropped or Impacting Loads

During the construction of SB5, construction crane(s) will be used to lift various parts of the building materials into place. Due to crane failure or human error, swinging or dropped loads from the crane could impact the structure in the vicinity of construction area. However, SB5 is about 38 m away from SB3 and SB4, it is unlikely that structural integrity of SB3 and SB4 were to be compromised should such an event occur.

In the worst-case scenario that SB3 or SB4 were to collapse, the DSC will withstand a storage building collapse without loss of its shielding or containment [32]. Therefore, this hazard can be screened out.

### 6.2.2 Earthquake

During the construction of SB5, construction crane(s) will be used to lift various parts of the building materials into place. Scaffolding will be erected during construction activities. As a result of an earthquake, the crane might topple, scaffolding and the SB5 under construction might collapse. However, given the distance between SB3/SB4 and SB5 which is about 38 m and the peak height of SB5 is about 7.5 m [7], it is unlikely the toppled crane and collapsed structure could cause damage to the SB3 and SB4.

Even in the worst scenario, where SB3 or SB4 were to collapse over the DCSs in storage due to the toppling of a crane, collapse of scaffolding, and the failure of SB5 during an earthquake event, this hazard would be within the design basis of the DSC. The DSC is designed to withstand a storage building collapse without loss of its shielding or containment [32]. Therefore, this hazard can be screened out.

### 6.2.3 Acetylene Decomposition Explosion Missile

Acetylene could be used during the construction of SB5 for activities of cutting, welding, brazing, and heat treating at very high temperatures. There will be increased possibility for acetylene explosion missiles during the construction work.

Storage and use of acetylene should strictly follow OPG's standards for hazardous material handling. Acetylene cylinders should be stored in upright position in purpose-built containment, ensuring that they are adequately secured against falling. It is recommended that bulk acetylene to be stored in secure storage in the construction laydown area, away from SB3 and SB4. If these requirements and recommendation are followed, this hazard should not impact the structural integrity of SB3 and SB4.In the worst-case scenario that an acetylene explosion missile occurs, the event will be bounded by a tornado missile [19]. This hazard is screened out.

### 6.2.4 Soil Failures (Slope Instability and Subsidence)

SB5 will be built adjacent to SB3 and SB4. Excavation work will be performed about 38 m away from the east side of SB3 and SB4. To minimize slope instability and/or subsidence risk, all applicable codes and standards shall be followed. The Construction Plan shall ensure that adequate provisions are made for shoring the foundations of the adjacent buildings. If these requirements are followed, the construction hazards associated with soil failures are not expected to impact the structural integrity of SB3 and SB4.

In the worst-case scenario, soil failure occurs due to excavations, which could compromise the integrity of the SB3 and SB4 structure. Under this scenario, the release of radioactivity from a seal-welded DSC is not expected, given the robust design of the DSCs, which are designed to withstand storage building structural failure [32]. Therefore, this hazard is screened out.

## 6.3 Summary of Malfunctions/Accidents Associated with Construction, Handling and Storage

Based on the screening performed in Section 6.1 and Section 6.2, all identified events are screened out. The following events are screened out due to their low frequency of occurrence.

- Seal Weld Failure during Storage
- Aircraft Crash

The following events are screened out based on a qualitative assessment of their consequences:

[7] The peak height is without the height of the ridge vent.

- Dropped or Impacting Loads
- Earthquake
- Acetylene Decomposition Explosion Missile
- Soil Failures (Slope Instability and Subsidence)
- DSC drop during Transfer to Storage
- Transporter Collision with a Dry Storage Container or Another Transporter
- SB5 Fire
- Tornados / High Wind
- Thunderstorms/Lightning
- Flooding
- Explosion

The assessment results are summarized in Table 1.

**Table 1: Summary of Postulated Malfunction and Accident**

| Malfunction or Accident | Potential for occurrence (event /year) | Credible event (Y/N) -See Note 1 | Classification (see Note 3) | Potential maximum dose to public (mSv) | Potential maximum occupational dose (mSv) |
|---|---|---|---|---|---|
| **Malfunctions and Accidents during DSC Storage in SB5** | | | | | |
| DSC seal weld failure during storage | <1E-06 | N | --- | --- | --- |
| DSC drop during transfer to storage | 6.24E-06 | Y | DEC | 0 | 0 |
| Transporter collision with a DSC or another transporter | 6.24E-01 | Y | AOO | 0 | 0 |
| Fire | See Note 2 | Y | See Note 2 | 0 | 0 |
| Earthquake | See Note 2 | Y | See Note 2 | 0 | 0 |
| Tornado/high wind | 3.13E-06 | Y | DEC | 0 | 0 |
| Thunderstorms /lightning | See Note 2 | Y | See Note 2 | 0 | 0 |
| Flooding | See Note 2 | Y | See Note 2 | 0 | 0 |
| Explosion | See Note 2 | Y | See Note 2 | 0 | 0 |
| Aircraft crash | 6.5E-07 | N | --- | --- | --- |

| Malfunction or Accident | Potential for occurrence (event /year) | Credible event (Y/N) -See Note 1 | Classification (see Note 3) | Potential maximum dose to public (mSv) | Potential maximum occupational dose (mSv) |
|---|---|---|---|---|---|
| **Construction Hazards Impacting Storage of DSCs in SB3 and SB4** | | | | | |
| Dropped or Impacting Loads | See Note 2 | Y | See Note 2 | 0 | 0 |
| Earthquake | See Note 2 | Y | See Note 2 | 0 | 0 |
| Acetylene Decomposition Explosion Missile | See Note 2 | Y | See Note 2 | 0 | 0 |
| Soil Failures (Slope Instability and Subsidence) | See Note 2 | Y | See Note 2 | 0 | 0 |

Notes:

1. The term credible is used for those events with the frequency of occurrence higher than 1E-06 events per year.
2. The hazard frequency was not calculated for this scenario. The event is considered credible based on its nature or if it is bounded by a credible event. The classification of DEC was assigned to such event for conservatism.
3. As per REGDOC 2.4.4 [7], the following classification was applied:
   - AOO: an event with a likelihood of occurrence greater than $10^{-2}$ per year
   - DBA: an event with a likelihood of occurrence less than $10^{-2}$ per year and greater than $10^{-5}$ per year
   - DEC: an event with a likelihood of occurrence less than $10^{-5}$ per year and greater than $10^{-6}$ per year

# 7.0 Conclusions

This report documents the safety assessments that were performed to support the operation of SB5 on the PWMF site, including a normal operations safety assessment and malfunction/accident safety assessment.

In the normal operations safety assessment, doses to workers and the public for normal operation of the PWMF were assessed. It was concluded that doses to the public due to chronic emissions from the PWMF were significantly less than the dose acceptance criterion. With respect to dose rates around the facility, public dose acceptance criteria at the site boundary locations are met, and dose rates at the facility fence line around SB5 are met when mitigation options (e.g. additional shielding or the use of lower dose rate DSCs around the periphery) are applied.

In the malfunction/accident safety assessment, hazards were identified and screened for handling and storage of DSCs in SB5. It was concluded that no releases would result from all the events considered. Furthermore, it is confirmed that the construction of SB5 will not have an impact on DSCs stored in SB3 and SB4.

# 8.0 References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# Appendix A: Hazard Pre-screening

The pre-screening of hazards associated with DSC handling and Storage in SB5 as presented below was conducted based on the previous work [A-1], taking into account the project specific aspects, such as the location and design of SB5, the characteristics of the waste packages and relevant activities.

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| **H-EXT External Hazards – Human Induced** | | | |
| **Mobile Sources** | | | |
| H-EXT-1 | Aircraft Impact | IN | This hazard is expected to cause significant damage to SB5 and may lead to a radiological release. |
| H-EXT-2 Rail Transportation Hazards | | | |
| H-EXT-2.1 | Train Crash | OUT | The Screening Distance Value (SDV) for train derailment is estimated to be 80 m (3-rail-car length) from the crash [A-2]. The Canadian National (CN) Rail main line runs north of the PNGS, at approximately 3 km to the PWMF and the Canadian Pacific (CP) Rail mainline is located approximately 6 km north of the site [A-3] Therefore, this hazard can be screened out based on the distance from the PWMF. |
| H-EXT-2.2 | Cold Toxic Gas Release | OUT | The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site, [A-3]. Table 3-1 of Reference [A-2] shows the SDV for Cold Toxic Gases.<br>SDV for ammonia, hydrochloric acid and hydrogen fluoride releases is 0.9 km and 1.4 km, respectively. This means that these toxic materials can be screened out based on distance.<br><br>SDV for Chlorine, sulphuric acid and sulphur dioxide is 4.4 km. This hazard can be screened out based on frequency (8.81E-07) (refer to Table 3-9 of Reference [A-3]). |
| H-EXT-2.3 | Hot Toxic Gas Release | OUT | The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. Table 3-2 of Reference [A-2] shows that the maximum SDV is 2.3 km (sulphur dioxide) for hot toxic gases. Therefore, this hazard can be screened out based on the distance from the PWMF. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| H-EXT-2.4 | BLEVE – Missile Damage | OUT | The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The Boiling Liquid Expanding Vapour Explosion (BLEVE) SDV is estimated to be 1.6 km [A-2]. Therefore, the BLEVE hazard from rail derailment can be screened out based on the distance from the PWMF. |
| H-EXT-2.5 | BLEVE – Blast Wave | OUT | The blast waves associated with a BLEVE are localized and not as strong as a Vapour Cloud Explosion (VCE) [A-2]. Since this hazard is bounded by the VCE hazard, it is screened out. |
| H-EXT-2.6 | VCE | OUT | The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The VCE SDV is estimated to be 460 m [A-2].<br>Therefore, this hazard can be screened out based on the distance from the PWMF. |
| H-EXT-2.7 | Explosions of Rail Car Containing Explosive | OUT | The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The SDV is estimated to be 700 m [A-2]. Therefore, this hazard can be screened out based on the distance from the PWMF. |
| **H-EXT-3 Road Transportation Hazards** | | | |
| H-EXT-3.1 | Cold Toxic Gas Release, such as: ammonia, hydrochloric acid and hydrogen fluoride, hot toxic gases, BLEVEs, VCEs, and Explosions | OUT | As major roads/highways are slightly further away from the PWMF site than the railway, these offsite road transportation accidents can be screened out based on distance [A-2]. |
| H-EXT-3.2 | Cold Toxic Gas Release e.g., Chlorine; Sulphuric Acid, Sulphur Dioxide | OUT | Only 10% of these chemicals are transported on Highway 401 compared to the CN rail line traffic [A-2]. This hazard can be screened out based on frequency (8.81E-08), referring to Table 3-11 of Reference [A-3]. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| **H-EXT-4 Ship Accidents** | | | |
| H-EXT-4.1 | Small Vessels | OUT | Boats/small vessels are not permitted to dock on the shore near the PWMF site. The accidents associated with small vessels are not expected to have an impact on PWMF. Therefore, this hazard can be screened out. |
| H-EXT-4.2 | Large Vessels | OUT | The normal shipping lanes in Lake Ontario are 10 kilometres away from the shoreline in the vicinity of the plant [A-2]. In addition, there are no commercial wharfs around the Pickering area [A-3]. Therefore, this hazard can be screened out based on the distance from the PWMF. |
| **Fixed Sources** | | | |
| H-EXT-5 | Nearby Nuclear Event | OUT | An accident at the PNGS A, PNGS B or Darlington NGS, resulting in significant releases, would progress slowly enough to ensure notification to PWMF personnel such that the required actions could be taken.<br><br>Any anticipated dose from the PWMF as a result of a significant event at either PNGS A or PNGS B, would be bounded by the dose received from the station itself. Therefore, this hazard can be screened out. |
| **H-EXT-6 Toxic Gas Release** | | | |
| H-EXT-6.1 | Toxic Gas Release –<br>Chlorine originated from Ajax Water Treatment Plant | OUT | The Ajax Water Treatment Plant is situated near the Ajax Waterfront Park and uses chlorine cylinders for water treatment. The SDV for chlorine is 4.4 km [A-2]. The Ajax Water Treatment facility is located approximately 4.0 km from PWMF Phase II site. This hazard cannot be screened out based on distance. However, its impact on the operation (handling and storge of DSCs) inside SB5 is negligible, bounded by DSC drop during DSC transfer to storage or transporter collision with a DSC or another transporter. Therefore, this event can be screened out. |
| H-EXT-6.2 | Toxic Gas Release - Chlorine originated from the Duffin Creek Water | OUT | The Duffin Creek Water Pollution Control Plant which uses chlorine for pollution control is located in Pickering at about 1.0 km from the PWMF Phase II site (SB5). Due to its proximity, it may be able to release sufficient chlorine to impair the DSCs transporter operator. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| | Pollution Control Plant | | Since the SDV for chlorine is 4.4 km, this hazard cannot be screened out based on distance. However, the annual frequency of a chlorine leak from a fixed storage tank is 2.86E-07 (refer to Table 3-12 of Reference [A-3]), which is below the cutoff frequency of 1.0E-06, this hazard can be screened out based on frequency. |
| H-EXT-7 | BLEVE | OUT | External fixed sources of BLEVEs have been identified within a radius of 5 km of PNGS [A-3]. It was concluded that none of the sites were within the SDV, which is 1600 m for BLEVE [A-2]. Therefore, this hazard can be screened out based on distance. |
| **Other Sources** | | | |
| H-EXT-8 | Missiles from Military Activity | OUT | This is considered a malevolent act; therefore, it is out of scope per Reference [A-2]. |
| H-EXT-9 | Orbital Debris Crashes | OUT | Orbital debris can cause serious damage to DSCs. There is no SDV for this hazard type [A-2]. However, based on the annual frequency analysis, this hazard can be screened out for UFDS facilities due to low frequency [A-5][A-6]. Similarly, this hazard can be screened out for SB5 based on similar building size. |
| **N-EXT External Hazards – Natural** | | | |
| N-EXT-1 | Earthquakes | IN | The seismic risk for National Building Code of Canada (NBCC) 2005 and later is based on an earthquake with a 2500-year return period or the frequency of earthquake is 4.0E-04 events per year [A-1].<br><br>The ground motion associated with this event may exceed the design capacity of the PWMF facility. Earthquakes could also affect the DSCs if they are being transported when the earthquake occurs. This hazard has the potential to lead to radiological release, and therefore it cannot be screened out. This also applies to the building under construction. |
| **N-EXT-2 Soil Failures** | | | |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| N-EXT-2.1 | Slope Instability | IN. | The PNGS site complies with the specific clauses of the Canadian Foundation Engineering Manual and the NBCC ([A-2] and [A-3]). Therefore, this event can be screened out for the safe operation of SB5. However, the impact on SB3 and SB4 during the construction of SB5 should be examined. |
| N-EXT-2.2 | Subsidence | IN | The PNGS site is not situated in a geographical area where subsidence can occur ([A-2] and [A-3]). Therefore, this hazard can be screened out for the safe operation of SB5. However, the impact on SB3 and SB4 during the construction of SB5 should be examined. |
| N-EXT-2.3 | Swelling Clay | OUT | The foundations of PNGS are not on clay layers [A-2]. Therefore, this hazard can be screened out. |
| N-EXT-2.4 | Soil Frost | OUT | This hazard is primarily relevant to the integrity of buried piping [A-2]. This hazard is not anticipated to impact the transfer or storage of DSCs and is therefore not applicable to the present assessment. |
| **N-EXT-3 Flooding** | | | |
| N-EXT-3.1 | Flooding Due to Runoff | IN | A PMP event has the potential to cause damage to the PWMF SSCs and could result in radiological release. Therefore, flooding has been screened in. |
| N-EXT-3.2 | Flooding Due to River | OUT | Main river courses are located at a distance greater than 2 km from the western (Rouge River and the Petticoat Creek) and eastern (Duffin's Creek) boundary of the PNGS site [A-3]. Based on distance, the potential for these rivers to represent a potential flood hazard to the PWMF site is screened out.<br><br>Krosno Creek is located immediately to the west of the PNGS and is prone to flooding. Based on Flood Plain Mapping from the Toronto and Region Conservation Authority (TRCA), water surface elevations for Krosno Creek are in the range from 76.26 m (at Liverpool Road) to 77.22 m (at Sandy Beach Road). Ground elevations between the PNGS and the flood zone are approximately 3.6 m and 5.1 m, respectively, above the Regional Flood elevation at these locations (Appendix F of Reference [A-3]).<br><br>An assessment has been conducted as part of the Fukushima follow-up and it was determined that Krosno Creek would maintain at minimum approximately |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| | | | 2.7 m of freeboard from a potential spill during the flooding due to a PMP event. Based on this, the potential for flooding from this river can be screened out. |
| N-EXT-3.3 | Flooding Due to Waves | OUT | The SB5 elevation is about 83 m [A-4].<br><br>For an assumed lake level of 74.5 m (mean winter condition), wave uprushes have been estimated at 0.2 m and 1.8 m [A-3]. The maximum wave run-up height (76.3 m) is below the elevation of SB5.<br><br>For an assumed (100-year) lake level of 75.6 m (Review Level Conditions – Lake Level) and with wave uprushes of 2.20 m [A-3], the maximum wave run-up height is 77.8 m, which is below the SB5 elevation.<br><br>Therefore, this hazard can be screened out. |
| N-EXT-3.4 | Flooding Due to Seiche | OUT | Section 4.4.4 of Reference [A-3] notes that the site requires protection for water surge of up to 0.75 m, as the highest modeled water level at Darlington resulting from surge or seiche is about 0.75 m. The 100-year maximum lake level is 75.6 m [A-3], so the possible maximum level is 76.35m. However, the average shoreline near PNGS is 77 m. This hazard can be screened out. |
| N-EXT-3.5 | Flooding Due to Tsunami | OUT | A tsunami in Lake Ontario is an improbable event, with no associated flood hazard potential [A-2]. Furthermore, the Great Lakes are in a geologically stable, mid-continental region, where the probability of occurrence of earthquakes large enough to generate tsunamis is negligible [A-3]. Therefore, this hazard can be screened out. |
| N-EXT-3.6 | Flooding Due to Sudden Releases of Water from Natural or Artificial Storage | OUT | No large lakes and no man-made water retaining structures creating reservoirs are located within the drainage areas in the vicinity of the PNGS that could influence flooding [A-3]. For this reason, this hazard can be screened out. |
| N-EXT-3.7 | Flooding Due to Rapid Melting of Snow and Large Blocks of Ice | OUT | Rapid melting of snow and large blocks of ice accumulated on the buildings' rooftop and at site as the temperature rises above the freezing point (late winter/early spring) can cause flooding. However, the event is slow developing |

| Category | Hazard | Screening Status | Rationale |
| --- | --- | --- | --- |
| | | | [A-3], providing enough time for operational personnel to ensure all PWMF facility are in a safe state. Therefore, this hazard can be screened out. |
| N-EXT-3.8 | Flooding Due to Other Causes | OUT | Other causes of flooding may include underwater landslides and lake ice. Lake Ontario shorelines as a whole are not susceptible to shore slope failure or landslide [A-3]; lake ice can also be screened out as a flood hazard as ice structures are not expected to create or worsen any coastal flood hazard at Pickering [A-3]. Therefore, this hazard has been screened out. |
| **N-EXT-4 Meteorological – Extremes** | | | |
| N-EXT-4.1 | Temperature (extreme high/ extreme low) | OUT | Extreme temperatures are predictable, allowing time for operational staff to ensure all PWMF facilities are in a safe state. Therefore, this hazard can be screened out. |
| N-EXT-4.2 | Snowpack | OUT | Snowpack and subsequent 48-hour winter PMP would occur gradually, allowing time for the removal of snow for affected structures. Therefore, this hazard can be screened out. |
| N-EXT-4.3 | Freezing Rain | OUT | The impact of freezing rain is bounded by the impact of external flood, ice-storms and snowpack. Therefore, this hazard can be screened out. |
| N-EXT-4.4 | Extreme Water Temperature | OUT | Operation of the PWMF does not depend on the use of lake water. This event is screened out. |
| N-EXT-4.5 | Avalanches | OUT | The PNGS is not situated in a mountainous region with large slopes which would lead to an avalanche. This event is screened out. |
| N-EXT-4.6 | Lightning | IN | The effects of a lightning strike will increase the temperature of the affected DSCs and might result in an increased release of loose contamination from inside the DSCs. This event is screened in. |
| N-EXT-4.7 | Hurricanes | OUT | Tornadoes are more frequent in the region of concern and the impact of a tornado is considered bounding for high-winds category of hazard. Therefore, the wind speeds from tornadoes are considered a bounding hazard. |
| N-EXT-4.8 | Tornadoes | IN | As per [A-7], the tornado occurrence rate in the Pickering site is 3.13E-06 events per year. This hazard is expected to cause significant damage to the PWMF and may lead to radiological release. This hazard requires further evaluation. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| N-EXT-4.9 | Sandstorms | OUT | Sandstorms are typically associated with deserts. In the vicinity of the PWMF there are no large sand-bodies, therefore sandstorms are not a credible potential external hazard for Ontario [A-3] |
| N-EXT-4.10 | Ice Storms | OUT | SB5 conforms to NBCC requirements ([A-2][A-3]) which account for loading due to ice and snow. Therefore, this hazard can be screened out. |
| N-EXT-4.11 | Frazil Ice | OUT | Operation of the PWMF does not depend on the use of the lake water. Therefore, this hazard can be screened out. |
| N-EXT-4.12 | Low Lake Level/Drought | OUT | Operation of the PWMF does not depend on the use of the lake water. Therefore, this hazard can be screened out. |
| N-EXT-4.13 | Meteorites | OUT | Similar to the orbital debris hazard, this hazard cannot be screened out based on qualitative screening. However, based on the annual frequencies of this hazard ([A-5][A-6]), this hazard can be screened out for UFDS facilities due to low frequency. Similarly, this hazard can be screened out for SB5. |
| N-EXT-4.14 | Geomagnetic storm | OUT | Geomagnetic storm events would impact the power distribution system equipment and may cause loss of off-site power [A-3]. This hazard does not have an impact on SB5; therefore, it can be screened out. |
| **N-EXT-5 Other Hazards** | | | |
| N-EXT-5.1 | Forest Fire | OUT | There is no heavily forested area within 3 km of the site [A-6]. The SDV for this hazard is 1 km [A-2]. Therefore, this hazard can be screened out. |
| N-EXT-5.2 | Corrosion from Salt Water | OUT | This hazard is not applicable in the Great Lakes area [A-2]; therefore, this hazard can be screened out. |
| N-EXT-5.3 | Animals | OUT | This hazard does not have any impact on the PWMF site [A-6]. |
| **H-INT Internal Hazards** | | | |
| H-INT-1 | Turbine Generated Missiles | OUT | The frequency of low trajectory turbine missiles impacting nearby structures, systems and components (SSCs) has been determined to be $6 \times 10^{-6}$ events per year [A-3]. Furthermore, SB5 is located approximately 600 m northeast of Unit 8. The building is separated not only by the distance from the Unit 8 turbine but also is shielded by various buildings located between the two facilities. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| | | | Based on the low frequency of a turbine missile impacting an SSC and taking into account the location of the SB5 with reference to Unit 8 turbine, this hazard is not further assessed. |
| H-INT-2 | Other Mechanically Generated Missile Sources | OUT | As the Heat Transport pump missiles are assumed incapable of penetrating the RB wall; there is no impact to the PWMF facility. The effects of missiles from other pumps and valves are assumed bounded by turbine missiles. |
| H-INT-3 | Acetylene Decomposition Explosion Missile | IN | Acetylene could be used during the construction of SB5 for activities of cutting, welding, brazing, and heat treating at very high temperatures. There will be increased possibility for acetylene explosion missiles during the construction work. |
| H-INT-4 | Missiles Generated by a Hydrogen Explosion at the Tritium Removal Facility | OUT | This hazard is associated with the tritium removal facility at Darlington. Therefore, it is not applicable to the Pickering site. |
| H-INT-5 | Control Rod Ejection Missiles | OUT | This hazard is not applicable due to the design of a CANDU reactor [A-8]. |
| H-INT-6 | Explosions within the PWMF Facility or from nearby source | IN | No explosive materials will be stored in SB5. However, there are sources of explosive materials in the nearby area. |
| **H-INT-7 Release of Toxic, Radioactive or Corrosive Gases and Liquids from On-Site Storage** | | | |
| H-INT-7.1 | Acute Inhalation Toxicity | OUT | It is expected that no acutely toxic materials will be stored in SB5. Therefore, this hazard can be screened out. |
| H-INT-7.2 | Corrosion | OUT | It is expected that no corrosive materials will be stored in SB5. Therefore, this hazard can be screened out. |
| H-INT-7.3 | Oxidizing/Reactive Chemicals | OUT | There is no oxygen gas stored in SB5. This hazard is screened out. |
| H-INT-7.4 | Asphyxiants | OUT | There will not be any significant quantities of asphyxiating gas (argon and helium) stored in SB5. Therefore, this hazard can be screened out. |

| Category | Hazard | Screening Status | Rationale |
|---|---|---|---|
| H-INT-7.5 | Release of Stored Energy | OUT | Catastrophic failure of pressure vessels is excluded from consideration.<br>There are no other sources of significant stored energy, such as high-pressure piping, associated with SB5. |
| H-INT-8 | Collision Impacts Within SB5 | IN | Collision with other vehicles/structures within SB5 has the potential to lead to radiological release. Therefore, this hazard is screened in. |
| H-INT-9 | Collapsed Structures | OUT | This hazard is bound by earthquakes. |
| H-INT-10 | Fire – Toxic Effects Only | OUT | The effects of this hazard are bound by fire. |
| H-INT-11 | Dropped or impacting loads | IN | The dropping of DSCs during handling can lead to radioactive release. Therefore, this event is screened in. |
| H-INT-12 | Electromagnetic Interference (EMI) and Radio-Frequency Interference (RFI) | OUT | EMI and RFI can affect the proper operation of digital instrumentation, I&C systems advanced analog systems. However, DSCs will not be affected by either EMI or RFI. Therefore, this event can be screened out. |
| H-INT-13 | Seal Failure | IN | The failure of lid/seal of the DSCs could potentially result in the radiological release. Therefore, this event is screened in. |
| H-INT-14 | Fire within SB5 | IN | Fire within SB5 can lead to damage of DSCs stored and potential release of radioactivity. |
| H-INT-15 | Static Electricity | OUT | The discharge of static electricity may impact the performance of control systems and control centers. However, DSCs will not be affected by static electricity. Therefore, this event can be screened out. |
| H-INT-16 | Criticality related events | OUT | Pickering used fuel stored in DSCs cannot achieve criticality under normal conditions or under any postulated accident scenario [A-9]. Therefore, this event can be screened out. |
| H-INT-17 | High temperature surfaces | OUT | This hazard is bounded by fire. |
| H-INT-18 | Extended loss of AC power (ELAP) | OUT | An ELAP is a loss of all off-site and on-site AC power sources for an unknown period of time. It could be a significant challenge for the long-term cooling of the |

| Category | Hazard | Screening Status | Rationale |
| --- | --- | --- | --- |
| | | | reactor core and the spent fuel storage pool. Given that only DSCs will be stored within SB5 and that cooling is not specifically required for the safe storage of DSCs and any operation within SB5 could be held when an ELAP occurs, the radiological impact of an ELAP on the safe operation of SB5 is negligible. Therefore, this hazard can be screened out. |

## A.1 References


[A-1] Ontario Power Generation, "PWMF Safety Assessment Update," 92896-REP-01320-00015, November 2022.

[A-2] Ontario Power Generation, "OPG Probabilistic Safety Assessment (PSA) Guide – External Hazards Screening," N-GUID-03611-10001 Vol. 8, R006, 2024.

[A-3] Ontario Power Generation, "Hazard Screening Analysis – Pickering B," NK30-REP-03611-00008 R002, December 2021.

[A-4] Ontario Power Generation, "NSS-PWMF Used Fuel Storage Building 5 Site Plan Civil-Option 1," 705-2480050400-DWG-C0001, Rev C, Oct 2024.

[A-5] Ontario Power Generation, "Hazard Screening Analysis – Pickering Used Fuel Dry Storage," P-REP-03611-00009, R000, September 2017.

[A-6] Ontario Power Generation, "Hazards Analysis of the Existing Dry Storage Container Transport Route at Pickering Site," 92896-REP-00120-00005 R000, July 2013.

[A-7] Ontario Power Generation, "Pickering NGS "B" High Wind Probabilistic Safety Assessment," NK30-REP-03611-00020-R003, 2022.

[A-8] Ontario Power Generation, "OPG Probabilistic Safety Assessment (PSA) Guide – Internal Hazards Screening," N-GUID-03611-10001, Vol. 9, R004 2024.

[A-9] Ontario Power Generation, "Pickering Waste Management Facility Safety Assessment Update," 92896-REP-01320-00005 R002, August 2018.

# Appendix B: Aircraft Crash Frequency Calculations

This Appendix presents the aircraft crash frequency calculations for the PWMF site. The calculations were based on the Appendix B of Reference [B-1], including the calculation of the effective area of the target and multiplying that by the aircraft crash rate.

The effective target area $A_{eff}$ is calculated as

$$A_{eff} = A_f + A_s$$

where

$$A_f = (WS + R) * H * \cot\Phi + (2 *\cdot L*\cdot W*\cdot WS)/R + L*\cdot W$$
$$A_s = (WS+R) *S$$

Where

$A_f$ = effective fly-in area;
$A_s$ = effective ski area;
WS = aircraft wingspan;
R = length of the diagonal of the facility;
H = facility height;
cotΦ = mean of the cotangent of the aircraft impact angle;
L = length of facility;
W = width of facility; and
S = aircraft skid distance

The values for the aircraft wingspan, mean of the cotangent of the aircraft impact angle and aircraft skid distance were taken from Tables B-16, B-17 and B-18 from Reference [B-1], respectively. The aircraft crash rates for the PNGS site and the dimensions of facilities at the PWMF site including SB5 which are used in the frequency calculation are based on Reference [B-2].

The results of aircraft crash frequency calculations for the PWMF site where SB5 is located are presented in Table B-2.

## Table B-2: Aircraft Crash Frequency Calculations

| Parameters | Units | Category 1* | Category 2 | Category 3 | Category 4 | Category 5 | Total Crash Frequency/Facility |
|---|---|---|---|---|---|---|---|
| | | Light Aircraft | Helicopters | Small Transport | Large Transport | Military Combat | |
| Wingspan | WS, ft | 73 | 50 | 59 | 98 | 110 | |
| Skid distance | S, ft | 60 | 0 | 1440 | 1440 | 447 | |
| Impact angle cotangent | cotΦ | 8.2 | 0.58 | 10.2 | 10.2 | 10.4 | |
| Crash rate | $km^{-2}$ $yr^{-1}$ | 3.1E-06 | 3.6E-07 | 5.6E-07 | 8.2E-07 | 6.6E-08 | |
| | | | | | | | |
| **Phase I (Processing Building and Storage Buildings 1 and 2)** | | | | | | | |
| Facility Length | L, ft | | 342.0 | 342.0 | 342.0 | 342.0 | |
| Facility Width | W, ft | | 312.0 | 312.0 | 312.0 | 312.0 | |
| Diagonal of Facility | R, ft | | 462.9 | 462.9 | 462.9 | 462.9 | |
| Facility Height | H, ft | | 11.7 | 11.7 | 11.7 | 11.7 | |
| Effective fly area | Af. $ft^2$ | | 73,939.8 | 134,848.8 | 149,255.2 | 155,025.1 | |
| Effective skid area | As, $ft^2$ | | 0.0 | 751,585.1 | 807,745.1 | 256,101.6 | |
| Total Area | Aeff, $ft^2$ | | 73,939.8 | 886,434.0 | 957,000.3 | 411,126.7 | |
| | Aeff, $km^2$ | | 0.007 | 0.082 | 0.089 | 0.038 | |
| Crash Frequency | $yr^{-1}$ | | 2.5E-09 | 4.6E-08 | 7.3E-08 | 2.5E-09 | **1.2E-07** |
| | | | | | | | |
| **DSM/RCS Area** | | | | | | | |
| Facility Length | L, ft | 194.0 | 194.0 | 194.0 | 194.0 | 194.0 | |
| Facility Width | W, ft | 144.0 | 144.0 | 144.0 | 144.0 | 144.0 | |
| Diagonal of Facility | R, ft | 241.6 | 241.6 | 241.6 | 241.6 | 241.6 | |
| Facility Height | H, ft | 16.9 | 16.9 | 16.9 | 16.9 | 16.9 | |
| Effective fly area | Af. $ft^2$ | 88,297.1 | 42,349.3 | 93,257.5 | 108,981.0 | 115,004.2 | |
| Effective skid area | As, $ft^2$ | 18,876.2 | 0.0 | 432,868.3 | 489,028.3 | 157,166.5 | |

| Parameters | Units | Category 1* | Category 2 | Category 3 | Category 4 | Category 5 | Total Crash Frequency/Facility |
|---|---|---|---|---|---|---|---|
| | | **Light Aircraft** | **Helicopters** | **Small Transport** | **Large Transport** | **Military Combat** | |
| Total Area | Aeff, $ft^2$ | 107,173.3 | 42,349.3 | 526,125.8 | 598,009.3 | 272,170.8 | |
| | Aeff, $km^2$ | 0.010 | 0.004 | 0.049 | 0.056 | 0.025 | |
| Crash Frequency | $yr^{-1}$ | 3.1E-08 | 1.4E-09 | 2.7E-08 | 4.6E-08 | 1.7E-09 | **1.1E-07** |
| **Cumulative Frequency for Used Fuel Dry Storage Area (Phase I) and DSM/RCS Area** | | | | | | | **2.3E-07** |
| | | | | | | | |
| **Phase II - DSC Storage Buildings SB3 and SB4** | | | | | | | |
| Facility Length | L, ft | | 550.7 | 550.7 | 550.7 | 550.7 | |
| Facility Width | W, ft | | 270.4 | 270.4 | 270.4 | 270.4 | |
| Diagonal of Facility | R, ft | | 613.5 | 613.5 | 613.5 | 613.5 | |
| Facility Height | H, ft | | 11.7 | 11.7 | 11.7 | 11.7 | |
| Effective fly area | Af. $ft^2$ | | 139,417.0 | 218,381.0 | 237,773.2 | 245,428.7 | |
| Effective skid area | As, $ft^2$ | | 0.0 | 968,414.7 | 1,024,574.7 | 323,409.1 | |
| Total Area | Aeff, $ft^2$ | | 139,417.0 | 1,186,795.7 | 1,262,347.9 | 568,837.8 | |
| | Aeff, $km^2$ | | 0.013 | 0.110 | 0.117 | 0.053 | |
| Crash Frequency | yr-1 | | 4.7E-09 | 6.2E-08 | 9.6E-08 | 3.5E-09 | **1.7E-07** |
| | | | | | | | |
| **Phase II - DSC Storage Buildings SB5** | | | | | | | |
| Facility Length | L, ft | | 510.69 | 510.69 | 510.69 | 510.69 | |
| Facility Width | W, ft | | 305.4 | 305.4 | 305.4 | 305.4 | |
| Diagonal of Facility | R, ft | | 595.0 | 595.0 | 595.0 | 595.0 | |
| Facility Height | H, ft | | 11.7 | 11.7 | 11.7 | 11.7 | |
| Effective fly area | Af. $ft^2$ | | 144,729.3 | 221,851.4 | 242,245.7 | 250,166.5 | |
| Effective skid area | As, $ft^2$ | | 0.0 | 941,823.2 | 997,983.2 | 315,154.6 | |
| Total Area | Aeff, $ft^2$ | | 144,729.3 | 1,163,674.6 | 1,240,228.9 | 565,321.1 | |
| | Aeff, $km^2$ | | 0.01 | 0.11 | 0.12 | 0.05 | |
| Crash Frequency | $yr^{-1}$ | | 4.8E-09 | 6.1E-08 | 9.4E-08 | 3.5E-09 | **1.6E-07** |

| Parameters | Units | **Category 1*** | **Category 2** | **Category 3** | **Category 4** | **Category 5** | **Total Crash Frequency/Facility** |
|---|---|---|---|---|---|---|---|
| | | **Light Aircraft** | **Helicopters** | **Small Transport** | **Large Transport** | **Military Combat** | |
| | | | | | | | |
| **RWCs in PCSS** | | | | | | | |
| Facility Length | L, ft | 202.3 | 202.3 | 202.3 | 202.3 | 202.3 | |
| Facility Width | W, ft | 201.3 | 201.3 | 201.3 | 201.3 | 201.3 | |
| Diagonal of Facility | R, ft | 285.4 | 285.4 | 285.4 | 285.4 | 285.4 | |
| Facility Height | H, ft | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | |
| Effective fly area | Af. $ft^2$ | 24,394.5 | 8,314.7 | 27,051.3 | 30,721.5 | 32,289.2 | |
| Effective skid area | As, $ft^2$ | 21,503.6 | 0.0 | 495,926.1 | 552,086.1 | 176,740.7 | |
| Total Area | Aeff, $ft^2$ | 45,898.1 | 8,314.7 | 522,977.4 | 582,807.6 | 209,030.0 | |
| | Aeff, $km^2$ | 0.004 | 0.001 | 0.049 | 0.054 | 0.019 | |
| Crash Frequency | $yr^{-1}$ | 1.3E-08 | 2.8E-10 | 2.7E-08 | 4.4E-08 | 1.3E-09 | **8.6E-08** |
| **Cumulative Frequency for Used Fuel Dry Storage Area (Phase II including SB3, SB4 and SB5) and RWCs in PCSS** | | | | | | | **4.2E-07** |
| **Cumulative Frequency for Safety Related Container Storage Area (Phase I and Phase II)** | | | | | | | **6.5E-07** |

Note: *The impact of Category 1 aircraft on DSC related storage facilities was screened out [B-2].

## B.1 References


[B-1] US Department of Energy, "Accident Analysis for Aircraft Crash into Hazardous Facilities," DOE-STD-3014-2006, Reaffirmed May 2006.

[B-2] Kinectrics, "Aircraft Crash Risk Assessment - Pickering Waste Management Facility: Refinement and Update," Kinectrics File No.: PV294/LET/0001 R00, Oct 3, 2025.