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**DNNP - SITE PREPARATION LICENCE RENEWAL ACTIVITY REPORT - SEISMIC AND GEOTECHNICAL**



# DNNP - Site Preparation Licence Renewal Activity Report - Seismic And Geotechnical

**NK054-REP-01210-00106-R001 LOF**

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## Revision Summary

| Revision Number | Date | Comments |
|---|---|---|
| R001 | 2019-12-16 | Report revised with minor editorial changes and clarifications |

## 1.0 INTRODUCTION AND PURPOSE

OPG is now preparing for the application to renew the DNNP license to prepare site (PRSL) as per the licence renewal plan [R-3]. The existing license 18.00/2022 will expire in August 2022.

The original application for the DNNP's was based on CNSC Regulatory Document RD-346 "Site Evaluation for Nuclear Power Plants" which was issued in November 2008. Currently Reg Doc RD-346 has been superseded by CNSC Regulatory Document REGDOC-1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities issued in July 2018.

Initial application materials were prepared in compliance with RD-346 and all applicable codes and standards in year 2009 or earlier. Per PRSL Renewal Plan [R-3], the Site Preparation license renewal application will require updating and refreshing of information over the last decade such as:

a. a review of original application materials against REGDOC 1.1.1 requirements and guidance and addressing any gaps that are identified.

b. addressing the passage of time since the original application submission looking for any significant changes through:

   i. a review of current codes, standards and practices referenced in the Licensing Basis and those associated with REGDOC 1.1.1.

   ii. updating or reviewing selected baseline data associated with the site.

This report documents the methodology and results of the above review for seismic and geotechnical areas. Regulatory gap assessment between current REGDOC-1.1.1 and superseded RD-346 has been carried out and findings are documented in OPG Report NK054-REP-01210-00104 [R-5], Compliance Assessment of Darlington New Nuclear Project Site Preparation License Materials against REGDOC-1.1.1.

DNNP previous Site Preparation License submission documents were reviewed in [R-5] for information demonstrating compliance with the new content in REGDOC-1.1.1. Where these submission documents do not provide information that meets the intent of the current REGDOC-1.1.1 requirements, Potential Gap category to the requirement has been assigned in the report [R-5]. Identified potential gaps in report [R-5] related to DNNP Seismic and Geotechnical Aspects are further assessed in this report.

One of the other license renewal activities is to identify and address any new or updated codes and standards, since the original application, that apply to site evaluation work. The purpose of this review is to determine the degree of conformance of this previous work to the latest requirements, practices and methodologies described. As identified by the licences renewal plan [R-3], standards including CSA N289.1, CSA N289.2, CSA N289.3 and IAEA SSG-9 are identified to be reviewed under Review Topic Area of Seismic and Geotechnical.

OPG also plans to address the passage of time since the original application by revisiting or updating key baseline information that forms the basis of the site evaluation.

NK054-PLAN-01210-00004 R000, DNNP Site Preparation License Renewal Plan describes the existing licensing basis for DNNP, the scope of Site Preparation license renewal activities and the methodology to conduct those activities.

## 2.0 SCOPE OF REVIEW

Following the discussions in Section 1, the scope of this review includes:

1. Assess identified potential gaps in the compliance assessment report against REGDOC-1.1.1 [R-5] as related to DNNP Seismic and Geotechnical Aspects;
2. As identified by the licence renewal plan [R-3], review the applicable current standards including CSA N289.1, CSA N289.2, CSA N289.3 and IAEA SSG-9, capture, assess and address the gaps and impacts on the seismic and geotechnical license basis of DNNP; and
3. Review relevant Geotechnical and seismic baseline data associated with the site.

### 2.1 Review Elements

#### 2.1.1 Updated Baseline Data

##### 2.1.1.1 Review Topic Area: Seismic Aspect

The latest information and results from the 2019 PSHA under DARA 2020 project [R-7] will be utilized to characterize the seismic hazard at the DNNP. Potential changes to the seismic baseline data that may impact the licensing basis will be assessed and dispositioned in the OPG Nuclear Safety License Activity Report [R-23].

##### 2.1.1.2 Review Topic Area: Geotechnical Aspect

The Site Evaluation [R-12] was completed for the first stage (Selection Stage). The second stage (Characterization/Site Preparation Stage - Verification) is reviewed against requirements specified in IAEA Safety Guide No. NS-G-3.6. and REGDOC-1.1.1. Appendix F. The remainder of the second stage as specified by the IAEA safety guide and REGDOC-1.1.1., i.e. Characterization/Site Preparation Stage (Confirmation) is reviewed to confirm adequacy of the committed future actions for more confirmatory field, laboratory and engineering work [R-4].

#### 2.1.2 Applicable Modern Codes and Standards

##### 2.1.2.1 Review Topic Area: Seismic Aspect

The following modern codes and standards were reviewed regarding the new requirements, practices and methodologies as related to Seismic Aspect and Site Evaluation of DNNP:

**Regulatory Documents**

- REGDOC 1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities, July 2018. (vs RD-346 (2008))
- Applicable contents of REGDOC 2.5.2 (2014) [R-13] (as referred by REGDOC 1.1.1)

**Modern Codes and Standards**

- CSA N289.1-18, General Requirements for Seismic Design and Qualification of Nuclear Power Plants, May 2018. (vs CSA-N289.1-80 (R2008))
- CSA N289.2-10 (R2015), Ground Motion Determination for Seismic Qualification of Nuclear Power Plants, May 2010. (vs CAN3-N289.2-M81)
- CSA N289.3-10 (Update No. 2, 2015), Design Procedures for Seismic Qualification of Nuclear Power Plants, November 2015. (vs CAN3-N289.3-M81)

**IAEA Safety Guide**

- IAEA Specific Safety Guide No. SSG-9. Seismic Hazards in Site Evaluation for Nuclear Installations. Vienna, 2010. (vs IAEA NS-G-3.3 (2003))

### 2.1.2.2 Review Topic Area: Geotechnical Aspect

Reviewed the identified potential gaps in requirements related to Geotechnical aspect for the purpose of PRSL in the following documents:

1. Current regulatory document REGDOC-1.1.1 July 2018[1]
2. CSA N289.1-18
3. CSA N289.2-10 (Reaffirmed 2015)[2]
4. CSA N289.3-10 with update No.1 – August 2012 and Update No. 2 – November 2015[3]

For the purpose of the DNNP Evaluation of Geotechnical Aspects of the Site Preparation renewal license the following documents have been considered for review:

**Regulatory Document**

- REGDOC 1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities, July 2018.

**Modern Codes and Standards**

[1] supersedes the previous regulatory document RD-346 dated November 2008
[2] Supersedes previous edition N289.2-81
[3] Supersedes previous edition N289.3-81

- CSA N289.1-18, General Requirements for Seismic Design and Qualification of Nuclear Power Plants, May 2018.
- CSA N289.2-10, Ground Motion Determination for Seismic Qualification of Nuclear Power Plants, May 2010 (Reaffirmed 2015)
- CSA N289.3-10, Design Procedures for Seismic Qualification of Nuclear Power Plants, May 2010 with update No.1 – August 2012 and Update No. 2 – November 2015

**IAEA Safety Guide**

- IAEA Specific Safety Guide No. NS-G-3.6 Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants, Vienna, 2004.
- IAEA Safety Requirements No. NS-R-3. Site Evaluation for Nuclear Installations, Vienna, 2016.
- IAEA Specific Safety Guide No. SSG-9. Seismic Hazards in Site Evaluation for Nuclear Installations. Vienna, 2010.

### 2.1.3 Existing DNNP Commitments

The remainder of the Characterization/Site Preparation Stage (Confirmation) will require more field, laboratory and engineering work to complete. It requires the site specific determination of the soil and geotechnical characteristics of the site that are necessary for the purposes of new Reactor Facilities analysis and detailed design.

The additional Geotechnical site specific determination of the soil and geotechnical characteristics of the site that are necessary for the purposes of analysis and detailed design is being tracked as OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

The existing DNNP commitments related to seismic aspect, under deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4], have been reviewed and assessed with respect to the scope of the subject review.

## 3.0 REVIEW METHODOLOGY

The process in identifying the source materials to be included and reviewed in this report from the Seismic and Geotechnical Aspects, is based on the principle that whether such materials formed as part of the existing DNNP licence basis. Details of the methodology in determining the applicable source materials are provided in Section 4.1 of Renewal Plan NK054-PLAN-01210-00004 [R-3].

Such applicable regulatory documents, modern codes and standards, existing licensing basis documents, and other guidelines and practices that were formed as the existing licensing basis of DNNP are listed in Table 1 to Table 4 of Renewal Plan [R-3].

The review type for such source material included is determined and selected in accordance with Section 4.1.1.2 and Table 1 of Renewal Plan [R-3].

The compliance review, including identification of new or changed requirements and the corresponding assessment of existing licence basis documents against these changes, is consistent with the methodology established for compliance review of REGDOC-1.1.1 in Section 4.2.1 of Renewal Plan [R-3].

Potential gaps were identified related to Seismic and Geotechnical Aspect for the purpose of PRSL new or changed requirements or guidance in the compliance review of the REGDOC-1.1.1 [R-5]. The identified potential gaps were further reviewed in this report to determine if they impact site preparation license renewal.

The identified Potential gaps are reviewed in tandem with relevant guidelines including IAEA documents.

Potential gaps not affecting the existing conclusions of the Site Evaluation and/or Site Preparation are dispositioned and provided with appropriate justifications.

Potential gaps affecting the existing conclusions of the Site Evaluation and/or Site Preparation may require updates to existing commitments or new commitments in order to maintain the conclusions of the original application material.

## 4.0 REVIEW FINDINGS (CONFORMANCES AND POTENTIAL GAPS)

### 4.1 Review Findings Related to Updated Baseline Data

#### 4.1.1 Review Topic Area: Seismic Aspect

The latest information and results from the 2019 PSHA under DARA 2020 project [R-7] will be utilized to characterize the seismic hazard at the DNNP. Potential changes to the seismic baseline data that may impact the licensing basis are assessed and dispositioned in the OPG Nuclear Safety License Activity Report [R-23].

#### 4.1.2 Review Topic Area: Geotechnical Aspect

The Site Evaluation [R-12] carried out meets the requirements of the first stage (Selection Stage) and the second stage (Characterization/Site Preparation Stage - Verification) as specified in IAEA Safety Guide No. NS-G-3.6. and REGDOC-1.1.1. Appendix F. The remainder of the second stage as specified by the IAEA safety guide and REGDOC-1.1.1., i.e. Characterization/Site Preparation Stage (Confirmation) will require more field, laboratory and engineering work to confirm site specific soil and bedrock characteristics of the localized area of the site based on selected reactor technology, general layouts, and structural load estimates.

The above stated additional Geotechnical site specific determination of the soil and bedrock characteristics of the site that are necessary for the purposes of analysis and detailed design will be undertaken conforming to REGDOC 1.1.1 in tandem with the applicable modern codes and standards and is being tracked as OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

The following potential gaps from [R-5] were reviewed for potential applicability to geotechnical aspects:

1. Potential Gap: Evaluation against safety goals from a site perspective, REGDOC 1.1.1, clause 3.3.1 [R-5]: It is required to evaluate cliff-edge effect and multi-unit effects for internal and external events.

   Assessment/Disposition: This requirement is related to facility design and internal/external event evaluations. As such, final disposition of this item is addressed in the Nuclear Safety License Activity Report NK054-REP-01210-00108 [R-23].

2. Potential Gap: Evaluation of hazards associated with external events, REGDOC 1.1.1. clause 3.3.3 [R-5]: It is required to evaluate cliff-edge effect for external events.

   Assessment/Disposition: The requirement is related to site evaluation for frequency and severity of external natural and human induced events. As such, final disposition of this item is addressed by the Nuclear Safety License Activity Report NK054-REP-01210-00108 [R-23].

3. Potential Gap: Requirement for Geotechnical Hazards, REGDOC 1.1.1, clause 3.5.5 [R-5]: This is related to the requirement to ensure the stability of backfill material and underground excavation.

   Assessment/Disposition: The reactor foundations are typically founded on sound bedrock that is present at shallow depth. All other foundations can be founded on shallow or deep foundations, depending on the localized soil and groundwater conditions, applied loads and structural requirements.

   The requirement to ensure stability of backfill material and underground excavation was addressed by the original license application site evaluation of geotechnical aspects [R-12]. Confirmatory additional field geotechnical investigation will be undertaken once a reactor technology is selected and facility structure layout/planned structure locations are determined. The additional geotechnical investigation will be necessary to obtain adequate and precise localized soil and groundwater conditions to undertake design and construction planning activities in the confirmation stage. This is captured by commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

## 4.2 Review Findings Related to Applicable Modern Codes & Standards

### 4.2.1 Review Topic Area: Seismic Aspect

#### 4.2.1.1 Overall Description

Rigorous and systematic high level reviews of CSA N289.1-18 (May 2018), CSA N289.3-10 (Update No. 2, Nov. 2015) and IAEA SSG-9 (2010), and clause by clause

review for CSA N289.2-10 (R2015), have been performed over the new requirements or changes as applicable to Site Evaluation of DNNP.

The existing DNNP license basis documents, including [R-8], [R-9], [R-10], [R-11] and [R-12], have been considered and examined as relevant to this review.

The existing state-of-the-art code refresh review for Darlington Integrated Safety Review (ISR) and periodic code-over-code review reports for these standards listed under Section 2.1.2.1 have been considered in the subject review.

The major findings resulting from the modern standards review and the corresponding impact assessment and conclusions are summarized in the following Section 4.2.1.2. In addition, the potential gaps items identified in the compliance assessment report against REGDOC-1.1.1 [R-5] have also been included, incorporated and further assessed.

#### 4.2.1.2 Review Finding and Dispositions

**S1. Seismic Gap**

**Sources of finding:**

- REGDOC-1.1.1. Clause 3.3 General criteria for site evaluation;
- REGDOC-1.1.1. Clause 3.3.1 Evaluation against safety goals from a site perspective;
- REGDOC-1.1.1. Clause 3.3.3 Evaluation of hazards associated with external events;
- REGDOC-1.1.1. Clause C.3.5 Characterization of potential seismic hazards.

**Descriptions:** Requirements to address natural external events are expanded to include beyond design basis events, and to consider the potential for cliff-edge effects. It is also required to provide sufficient information for characterization of seismology for design extension conditions (DEC) (beyond design basis).
**Assessment/ Disposition:** The potential gaps identified can be assessed via the following three aspects:

1. Development of DEC for earthquake

   In general, engineering assessment for nuclear power plants considering the beyond design basis events, which could include severe accidents, has now becomes a common practice. Within OPG, various approaches to seismic assessments in addressing these events had been undertaken over the years.

   The DEC defined under REGDOC-2.5.2 for seismic is analogous to the review level earthquake (RLE) used in CSA N289 series standards in terms of its purpose and application in considering the beyond design basis seismic event.

   A review of the relevant license basis documents [R-8], [R-9], [R-10], [R-11] and [R-12] indicates that, although a site-specific mean uniform hazard spectrum (UHRS) with an equivalent level of probability of exceedance (as the level of DEC recommended by CSA N289.1-18) was produced, a seismic level for DEC has not been explicitly defined for DNNP as the considered beyond design basis earthquake.

Therefore, it is recommended to develop the appropriate DEC level of seismic hazard for DNNP, per requirement by REGDOC-1.1.1 incorporating latest practices and operating experience.

This gap can be addressed at a later phase and can be tracked under OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

2. Characterization of seismology of DEC for earthquake

   Seismic hazard for OPG’s nuclear facilities in Southern Ontario, specifically for characterizations of the regional and local seismic sources and ground motions, has been well investigated since 1987 [R-14].

   Subsequently, the PSHA has been continually updated and improved specifically in the years of 1990, 1994, 1997, 2009 (for DNNP), 2011, and 2019 under various projects. State-of-the-art information was utilized in geological, seismological and geophysical data, scientific knowledge and interpretations, as well as models that are suitable to develop local and regional seismotectonic models to characterize the ground motions in Eastern North America.

   It is also noted that the RLE conditions developed for Darlington Nuclear Generating Station [R-16] were based on the applicable PSHA results. These RLE conditions were used by OPG to resolution of Fukushima Action Items as required by the CNSC.

   It is concluded that there is sufficient existing information for DNNP, via use of the latest 2019 PSHA under DARA 2020 project, to characterize the seismology for the purpose of DEC development for earthquakes, and as committed under OPG commitment deliverable number D-P-9 [R-4].

3. Cliff-edge effect in analyzing seismic hazard

   There are no relevant discussions found in the DNNP license basis reports of the possible existence of cliff-edge effects or whether these were taken into consideration, specifically in the hazard level during the course of analyzing the seismic characteristics of the built environment.

   For the cliff-edge effect of earthquake at the hazard level, it is judged that the subject impact on the seismic hazard results of 2009 DNNP PSHA is negligible.

   In general, this is due to the nature of the process of a PSHA in deriving the end hazard results. Specifically, this is because the PSHA is a probabilistic integration process that considers, incorporates, and quantifies both the information and uncertainties as required and used in this process. The probability functions used in this hazard quantification process are generally in monotonic or the common nonlinear format which would usually not result in abrupt hazard changes, especially under this numerical summation process.

   This has also been confirmed by sensitivity analysis in the 2009 DNNP PSHA and the previous 1997 assessment [R-17] for varying probability levels of seismic

hazard. Especially, much lower probability levels were accounted in the 2011 seismic probabilistic risk assessment conducted for Darlington NGS [R-18]. Such studies do not indicate any cliff-edge effect in the hazard level that could impact the end hazard results rapidly due to a small change of an input parameter of the PSHA.

It is therefore concluded that, at the hazard level, the resulting impact on DNNP seismic license basis due to new requirement of considering cliff-edge effect, is negligible.

Final disposition of this item is addressed by the Nuclear Safety License Activity Report NK054-REP-01210-00108 [R-23].

### S2. Seismic Gap

**Sources of finding:**

- CSA N289.2-10 (R2015) Clause 4.3.2.2 (e) Regional geology

**Descriptions:**

Section 4.3.2.2 of CSA N289.2-10 includes new requirement on considering the paleoseismic investigation during the investigation of regional geology. Sections 3.5.6 and C.3.5 of REGDOC-1.1.1 also emphasize this requirement.

Consideration was given to paleoseismicity in some details in the DNNP PSHA [R-10] and this issue was dispositioned as “Indirect Compliant” under Clause No. 3.5.6 in the REGDOC-1.1.1 compliance assessment report [R-5].

The DNNP PSHA report has been subsequently updated in 2011 with more paleoseismological studies included and incorporated [R-19]. A project specific paleoseismological investigation study [R-20] was performed under the EA activity, and was recently incorporated in the 2019 PSHA under DARA 2020 project [R-7].

Both the 2011 and 2019 PSHA were performed specifically for DNGS and are considered applicable for DNNP.

**Assessment/ Disposition:**

This paleoseismic investigation requirement is recommended to be addressed as a baseline data update activity for seismic by utilizing the latest hazard information and results from 2019 PSHA under DARA 2020 project [R-7].

It is noted that, as one of the commitments in # D-P-9 of [R-4], confirmation of the paleoseismologic feature of the site will be made in the detail site geotechnical investigation phase of the project. Hence, a formal incorporation of these paleoseismologic information and studies, as considered in the 2011 and 2019 PSHA, into the seismic hazard licensing basis and baseline data of DNNP can be undertaken and tracked in a later phase under OPG commitment deliverables # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

### S3. Seismic Gap

**Sources of finding:**

- CSA N289.3-10 (update No. 2, 2015) Section 4.1.3 Determination of design seismic ground motion

**Descriptions:**

CSA N289.1-18 defines a design basis earthquake (DBE) with the specified probability of exceedance level. Section 4.1.3 of CSA N289.3-10 (update No. 2, 2015) specifies in details three acceptable means of defining a DBE, including a site-specific mean UHRS with a probability of exceedance of 1X10-4/yr.

However, Section 7.13.1 of REGDOC-2.5.2 defines the DBE by multiplying the mean site-specific UHRS with a probability of occurrence of 10-4/yr by a design factor, which is defined and determined in the standard ASCE 43-05 [R-21].

The methodology of ASCE 43-05's approach is to calibrate and quantify the seismic design level via the target performance goal for a specific seismic design category [R-22]. The design factor, which is frequency dependent, is defined as a parameter to adjust the site-specific UHRS to ensure the target performance goal achieved.

Although the 1X10-4/yr mean UHRS was not explicitly defined as a DBE in the seismic related licensing basis documents of DNNP, it was actually used as a DBE for comparisons with the design response spectra for the nuclear reactor design considered for DNNP [R-8].

The selected probability of DBE in DNNP satisfies the required level as specified in CSA N289.3-10 (update No. 2, 2015). CSA N289.3-10 (update No. 2, 2015) also stipulate that additional design requirements by the regulator may be specified. The regulator included such new requirement in REGDOC-2.5.2 (May, 2014). Therefore, the subject regulatory change and the resulting impact should be considered as a Gap in the existing seismic licensing basis for DNNP project.

**Assessment/ Disposition:**

The difference of values between the defined DBE as per REGDOC-2.5.2 and the 1X10-4/yr mean UHRS depends on the frequency-dependent design factor which can be determined by the standard ASCE 43-05. Determination of the design factor requires the site-specific mean UHRS at a probability of exceedance level of both 10-4/yr and 10-5/yr. Depending on the shapes of the 1X10-4/yr and 1X10-5/yr mean UHRS, the frequency dependent design factor could change both the amplitude and frequency content of the 1X10-4/yr mean UHRS.

As the 1X10-4/yr mean UHRS was used in comparing with the design response spectra for the selected nuclear reactor design of DNNP, further assessment is required to determine the resulting impact due to the subject regulatory change.

It is recommended that, the latest PHSA results, specifically mean UHRS at 1X10-4/yr and 1X10-5/yr levels developed from the 2019 PSHA, to be utilized to assess the impact as a result of the subject regulatory change.

A formal incorporation of the defined DBE as per REGDOC 2.5.2 into DNNP seismic licensing basis can be conducted and tracked in a later phase, under OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

### 4.2.2 Review Topic Area: Geotechnical Aspect

**CSA N289.1-18**, General requirements for seismic design and qualification of nuclear power plants.
Review of CSA N289.1-18 indicates no specific explicit requirements related to Geotechnical or Geological site preparation aspect of the project.

**CSA N289.2-10**, Ground motion determination for seismic qualification of nuclear power plants.
Relevant requirements of CSA N289.2-10 Part Section 4.3 Geological Investigations and Part Section 4.4 Investigations of seismically induced phenomena are included in REGDOC-1.1.1 requirements. Refer to Site Geotechnical evaluation report [R-12] and Nuclear Safety Considerations [R-6] for compliance assessment. Required detailed geotechnical field work can be undertaken and tracked at a later phase under commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

**CSA N289.3-10**, Design procedures for seismic qualification of nuclear power plants.
Section 5, Seismic analysis of foundations, Soil material properties required for Seismic analysis of foundations, Slope stability analysis, and Liquefaction potential are included in REGDOC-1.1.1 requirements. Refer to Site Geotechnical evaluation report [R-12] and Nuclear Safety Considerations [R-6] for compliance assessment. Required detailed geotechnical field work can be undertaken and tracked at a later phase under commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4].

## 5.0 INTERFACES WITH OTHER REVIEWS

### 5.1 Review Topic Area – Seismic Aspect

The following interface areas have been identified with Nuclear Safety:

- The latest information and results from the 2019 PSHA under DARA 2020 project [R-7] will be utilized to characterize the seismic hazard at the DNNP. Potential changes to the seismic hazard that may impact the licensing basis will be assessed as dispositioned in the OPG Nuclear Safety License Activity Report [R-23].

## 6.0 OVERALL ASSESSMENT AND CONCLUSIONS

### 6.1 Review Topic Area – Seismic Aspect

Based on a thorough review of the modern codes and standards listed in Section 2.1.2.1 and existing DNNP seismic license basis documents, from the seismic aspect, there is no identified new or updated requirement or findings that invalidate the site preparation suitability of the selected site as the planned Darlington New Nuclear Plant.

Detail conclusions and recommendations are summarised in the following for each gap as identified in Section 4.2.1.2.

#### 6.1.1 Seismic Gap – S1

It is recommended to develop the appropriate DEC level of seismic hazard for DNNP as required by REGDOC-1.1.1 for site evaluation incorporating latest practices and operating experience. This gap can be addressed at a later phase and will be tracked under OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4]. Commitment deliverable # D-P-9 [R-4] will be updated to include this recommendation. There is sufficient existing seismology information for DNNP to characterize the DEC for earthquakes.

It is concluded that, at the hazard level, the resulting impact on DNNP seismic license basis due to new requirement of considering cliff-edge effect, is negligible. Final disposition of this item is addressed by the Nuclear Safety License Activity Report NK054-REP-01210-00108 [R-23].

#### 6.1.2 Seismic Gap – S2

The new requirement on considering the paleoseismic investigation is recommended to be addressed under the baseline data update activity for seismic by utilizing the latest hazard information and results from 2019 PSHA under DARA 2020 project.

A formal incorporation of the paleoseismologic information and studies (as considered outside of DNNP project) into the seismic hazard licensing basis of DNNP can be undertaken and tracked in a later phase under OPG commitment deliverables # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4]. Commitment deliverable # D-P-9 [R-4] already incorporates this recommendation.

#### 6.1.3 Seismic Gap – S3

It is recommended that, the latest 2019 PHSA results to be utilized to assess the impact as a result of the regulatory change on defining the DBE for DNNP.

A formal incorporation of the defined DBE as per REGDOC 2.5.2 into DNNP seismic design basis can be conducted and tracked in a later phase, under OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in NK054-REP-01210-00078 [R-4]. Commitment deliverable # D-P-9 [R-4] will be updated to include this recommendation.

### 6.2 Review Topic Area – Geotechnical

Based on the results of assessing the soil/rock conditions present at the Darlington site for the OPG New Nuclear Reactor facilities and the planned associated non-nuclear structures, the site has been classified as “a rock and stiff soil site” [R-12]. The Darlington site is suitable for the planned OPG New Nuclear at Darlington.

The Site Evaluation [R-12] carried out meets the requirements of the first stage (Selection Stage) and the second stage (Characterization/Site Preparation Stage - Verification) as specified in REGDOC-1.1.1.

The additional Geotechnical site specific determination of the soil and bedrock characteristics of the site that are necessary for the purposes of analysis and detailed design will be undertaken and tracked in a later phase under OPG commitment deliverable # D-P-9 “Site Geotechnical and Seismic Hazard Investigation Program” in the OPG commitment report [R-4]. Commitment deliverable # D-P-9 [R-4] already incorporates these recommendations.

## 7.0 REFERENCES

[R-1] REGDOC 1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities, July 2018.

[R-2] RD-337, Design of New Nuclear Power Plants, 2008.

[R-3] NK054-PLAN-01210-00004-R000. Darlington New Nuclear Project Power Reactor Site Preparation License Renewal Plan.

[R-4] NK054-REP-01210-00078 R003, Darlington New Nuclear Project Commitments Report.

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