Level 1: Preliminary Seismic Risk Screening Tool (PST) for existing buildings. Part 1: user's guide

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Level 1 – Preliminary Seismic Risk Screening Tool (PST) for Existing Buildings

Part 1: User's Guide

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LEVEL 1 – PRELIMINARY SEISMIC RISK SCREENING TOOL (PST) FOR EXISTING BUILDINGS

PART 1: USER'S GUIDE

Prepared by:

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FOREWORD TO THE LEVEL 1 – PST

The *Level 1 – Preliminary Seismic Risk Screening Tool (PST)* presents a preliminary seismic risk screening procedure for quickly identifying existing buildings with potential unacceptable seismic risk. The procedure is intended to be the first level of a multi-criteria and multi-level seismic risk management framework developed by the National Research Council Canada. The methodology adopted in the *Level 1 – PST* is based on a number of key criteria that will assist in the decision to take no action or to proceed with *Level 2 – Semi-Quantitative Seismic Risk Screening (SQST)* or *Level 3 – Seismic Evaluation Guidelines (SEG)*, namely: (1) seismicity; (2) benchmark NBC edition; (3) remaining occupancy time; and (4) consequence of failure.

The *Level 1 – PST* was developed largely based on NIST document "Standards of Seismic Safety for Existing Federally Owned and Leased Buildings", and adapted to Canadian seismicity, as well as Canadian building design practice. Major differences and additional features with respect to the NIST document are as follows:

1. The seismicity has been adapted to Canadian seismicity.
2. The benchmark NBC editions of various model building types have been adapted to the Canadian design/construction practices.
3. The procedure has been revised to consider the remaining occupancy time of greater than 5 years.
4. A new classification of consequences of failure has been adopted to take into account different levels of consequences of failure associated with life safety threat to the occupants of existing buildings.
5. A *Level 1 – PST* screening form has been developed to assist *Level 1 – PST* users when screening existing buildings.

Supporting technical documentation for the *Level 1 – PST* is provided in Part 2 of this document.

The *Level 1 – PST* authors would appreciate specific suggestions for further improvement.

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EXECUTIVE SUMMARY

There are thousands of existing buildings in Canada that could potentially suffer severe damage or collapse in the event of strong ground shaking. Assessing and mitigating seismic risk in large portfolios of existing buildings present technical and economic challenges to building owners. To address these challenges, the National Research Council Canada (NRC) developed a series of manuals and technical guidelines for seismic screening (NRC, 1993a), evaluation (NRC, 1993b), and upgrading (NRC, 1995) of existing buildings, based on the 1990 edition of the National Building Code of Canada (NBC 1990). The NRC screening manual (NRC, 1993a) was specifically developed to provide a quick and inexpensive screening procedure to identify and rank Canadian buildings in an inventory for further seismic evaluation. In 2001, Public Services and Procurement Canada (PSPC) issued the Real Property Services (RPS) Policy, which referred to the three aforementioned NRC technical guidelines. The RPS policy provides a seismic risk management approach for existing PSPC buildings.

The existing NRC technical guidelines should capture the current seismic requirements in the National Building Code as well as recent developments in seismic screening. The seismic code requirements in the 2015 edition of the National Building Code of Canada (NBC 2015) are significantly more stringent than those in the NBC 1990, on which the NRC technical guidelines and PSPC RPS Policy were based. Moreover, new methodologies for seismic screening, evaluation and retrofitting of *existing buildings* in the U.S. and around the world have emerged based on new data and research.

To update the existing PSPC seismic risk management approach, the NRC developed a multi-criteria and multi-level seismic risk management framework (Lounis *et al.*, 2016). The framework consists of three key levels:

Level 1 – PST: Preliminary Seismic Risk Screening Tool (PST);

Level 2 – SQST: Semi-Quantitative Seismic Risk Screening Tool (SQST); and

Level 3 – SEG: Seismic Evaluation Guidelines.

The aim of the framework is to minimize seismic risk while ensuring critical resources are efficiently directed toward existing buildings with potential unacceptable seismic risk by first using the *Level 1 – PST*, and subsequently *Level 2 – SQST* and/or *Level 3 – SEG*, as required, according to the results of sequenced screenings. The framework is intended only for typical existing buildings covered by Part 4 of the NBC. Existing buildings under Part 9 of the NBC are outside the scope of the framework.

The *Level 1 – PST* described in this document aims to quickly identify buildings for which the seismic performance can be assessed with reasonable certainty on the basis of four key criteria, namely: (1) seismicity; (2) benchmark NBC edition; (3) remaining occupancy time; and (4) consequences of failure. The *Level 1 – PST* also identifies special conditions that immediately

trigger *Level 3 – SEG*: (1) unknown model building type, (2) federal heritage designation, (3), change of occupancy results in increase of structural loads, (4) consequences of failure higher than original consequences of failure, (5) Site Class F (such as liquefiable soils), and (6) presence of geologic hazards.

The *Level 1 – PST* adopts a methodology based on review of available building information and a *Level 1 – PST* screening form, which is completed by trained screeners with minimum knowledge in seismic design of buildings. The *Level 1 – PST* screening forms provide space for documenting the collected data, including: building identification, seismic data, building design and applicable seismic upgrading information, model building type, building occupancy and consequences of failure, remaining occupancy time, record of building deterioration/damage, Site Class, site seismic category, and geologic hazards. Based on this information, seismic risk acceptance criteria as a matrix of benchmark NBC edition, seismicity, consequences of failure, and remaining occupancy time are checked. If the seismic risk acceptance criteria are met, the seismic risk of the structure and/or non-structural components is acceptable. Given this, the building owner is expected to assume the level of seismic risk associated with the seismic risk acceptance criteria. Buildings that fail to meet the seismic risk criteria are flagged for *Level 2 – SQST,* which is a more detailed seismic risk screening tool.

A site visit is not required when using the *Level 1 – PST*, but the procedure requires documentation of available building information that is needed to complete the screening. In some cases, missing information can be obtained by communicating with the local property manager and by navigating through street views found online. In cases where there is any ambiguity or conflicting information, the screener should always err on the side of caution and flag the building for *Level 2* – SQST or *Level 3 – SEG*.

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1.0 INTENT AND SCOPE

The *Level 1 – Preliminary Seismic Risk Screening Tool (PST)* is intended as a decision support tool for Public Services and Procurement Canada (PSPC) in quickly identifying buildings with potential unacceptable seismic risk, which will require the *Level 2 – Semi-Quantitative Seismic Risk Screening Tool (SQST)* or *Level 3 – Seismic Evaluation Guidelines (SEG)*. The *Level 1 – PST* is intended to cover existing PSPC buildings under Part 4 of the National Building Code of Canada (NBC). It is not intended for small buildings covered by Part 9 of the NBC, such as single-family or small multi-family houses.

The *Level 1 – PST* deals with life safety objectives, consistent with the NBC 2015 and does not address other objectives more stringent than life safety. A building expected to achieve objectives more stringent than life safety (e.g., post-disaster building or a building with a federal heritage designation) is still eligible for screening with the *Level 1 – PST,* but only to determine if its seismic risk associated with the life safety objective exceeds the acceptable seismic risk.

The *Level 1 – PST* was developed and written for trained screeners who are civil or structural engineering professionals, architects, or graduate students with a minimum knowledge in seismic design of buildings. To ensure consistency, high quality data collection and uniformity in decisions, it is essential to have the completed *Level 1 – PST* screening form reviewed by a licensed structural engineer.

The *Level 1 – PST* assumes that existing buildings have been designed and constructed in conformance with applicable NBC editions. Verification of such conformance is not within the scope of this tool.

2.0 NOTICE

The *Level 1 – PST* described herein is intended as a preliminary screening tool to identify existing PSPC buildings, covered by Part 4 of the NBC, that have potential unacceptable seismic risk and therefore require the *Level 2 – SQST* or *Level 3 – SEG*. Obtain written permission from the National Research Council Canada (NRC) to use the *Level 1 – PST* outside PSPC use requirements.

3.0 SUPPORTING TECHNICAL DOCUMENTATION

Further guidance on the development and use of the *Level 1 – PST* can be found in companion Part 2: Supporting technical documentation.

4.0 DEFINITIONS

Words and terms used in the *Level 1 – PST* that are not included in the following list of definitions shall have the meanings that are commonly assigned to them in the context in which they are used, including the specialized use of terms by the various trades and professions to which the terminology applies.

The words and terms in italics used throughout the *Level 1 – PST* shall have the following meanings:

Benchmark NBC edition means an applicable NBC edition in which significantly improved seismic code requirements were adopted and enforced.

Building means any structure used or intended to support or shelter any use or *occupancy*. If one or more sections of a *building* are completely separated by expansion joints, each separate section should be considered an individual *building* in the screening process.

Building collapse means that any part of the gravity system experiences dynamic instability, leading to the loss of load bearing capacity. Dynamic instability leads to severe structural deformation that is potentially life-threatening in nature, especially the falling of all or portions of a structure.

Building damage means a condition caused by non-engineered modification to the building's seismic force-resisting system or by previous accidents such as earthquakes, fire, and floods.

Building deterioration means a condition caused by weathering, cracking of concrete or masonry shear walls, corrosion of steel reinforcement in seismic force-resisting elements, etc.

Existing building means an already completed *building,* which was designed as per the code edition that is one cycle or more behind the latest NBC edition.

Federal heritage designation means a *building* that is included in the Directory of *federal heritage designations* and meets any one of the following conditions: (1) *buildings* of any age, designated as recognized or classified federal heritage at the time of screening; and (2) *buildings of age* not less than 40 years that have not been evaluated by the Federal Heritage Buildings Review Office at the time of screening.

Floor area means the space on any *storey* of a *building* between exterior walls, excluding parking area.

Full seismic upgrading NBC refers to an applicable NBC edition to which an *existing building* was upgraded, to fully comply with seismic requirements.

Geologic hazard means a condition present at or near the *building* site that has the potential to significantly increase the *building's* seismic vulnerability, including *liquefaction*, *landslide potential*, and *surface fault rupture*.

High consequences mean that the consequences of failure associated with the *life safety* threat are identified as high.

High Importance buildings are *buildings* that are likely to be used as post-disaster shelters, including *buildings* whose primary use is as:

- an elementary, middle or secondary school;
- a community centre.

Manufacturing and storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.

Landslide potential refers to potential threat to *life safety* due to a landslide at or near the *building* site.

Level 1 – PST refers to the preliminary seismic risk screening tool that aims to exempt *buildings* from the *Level 2 – SQST* or flag buildings for *Level 3 – SEG,* based on a number of key criteria and conditions.

Level 2 – SQST refers to a detailed seismic risk screening tool that aims to exempt the *buildings* from *Level 3 – SEG* and prioritize *buildings* with potential unacceptable *seismic risk* for *Level 3 – SEG* by implementing quantitative structural *seismic risk* scoring and qualitative non-structural component *seismic risk* scoring.

Level 3 – SEG refers to seismic evaluation guidelines intended to identify building deficiencies that may pose unacceptable risk to human life or injury as a result of component failure or *building* collapse.

Life safety means an acceptable maximum annual probability of death or serious injury resulting from structural failure in a *building*, which is equal to the probability of structural failure times the likelihood of death or serious injury if structural failure occurs.

Liquefaction means a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness under seismic loading.

Low consequences mean that the consequences of failure associated with the *life safety* threat are identified as low.

Model building type means a common *building type* that is defined in terms of the type of seismic force-resisting system and construction materials.

Medium consequences mean that the consequences of failure associated with the *life safety* threat are identified as medium.

New building means an already completed *building*, designed as per the latest edition of the NBC.

Number of storeys means the number of *storeys* of a *building,* counted from the lowest finished grade around the *building*.

Occupancy means the intended use of a *building* or part thereof for the shelter or support of persons, animals or property.

Occupants mean the persons for which a *building* or part thereof is designed.

Original design NBC means the applicable NBC edition to which the *building* was originally designed. If a provincial or municipal *building* code was used to design the *building*, the *original design NBC* corresponds to the NBC edition on which the provincial or municipal *building* code was based.

Penthouse means an enclosed, unoccupied rooftop structure used for sheltering mechanical and electric equipment, tanks, elevators and related machinery, and vertical shaft openings.

Post-benchmark building means a *building* that was originally designed to the applicable *benchmark NBC edition* or newer. An *existing building* that had *seismic upgrading* is considered a *post-benchmark building* only if the *building* was upgraded to fully comply with the seismic requirements of an applicable *benchmark NBC edition* or newer.

Post-disaster building means a *building* that is essential to the provision of services in the event of a disaster, and include:

- hospitals, emergency treatment facilities and blood banks,
- telephone exchanges,
- power generating stations and electrical substations,
- control centres for air, land and marine transportation,
- public water treatment and storage facilities, and pumping stations,
- sewage treatment facilities and *buildings* having critical national defence functions, and
- *buildings* of the following types, unless exempted from this designation by the authority having jurisdiction:
  - emergency response facilities,
  - fire, rescue and police stations, and housing for vehicles, aircraft or boats used for such purposes, and
  - communication facilities, including radio and television stations.

Probability of collapse (also called collapse probability) refers to the product of the probability of a *building* being in complete damage state and the probability of the building experiencing partial or complete collapse given that the building is in complete damage state.

Remaining occupancy time means the number of years of intended *occupancy* of an *existing building* until the lease of the *building* is terminated or until the *building* is decommissioned.

Seismic risk means the risk to human life and injury due to any of the following earthquake-induced conditions: (1) the entire *building* collapses, (2) portions of the *building* collapse, (3) components of the *building* fail and fall, and (4) exit and entry routes are blocked.

Seismic upgrading means the process of improving the seismic performance of a *building*'s structural or non-structural components.

Seismicity means the occurrence or frequency of earthquakes in an area of interest.

Site Class means a site category used to address the effect of foundation soil on *building* response.

Site Class F means a site category including the following soil types: (1) liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils, and other soils susceptible to failure or collapse under seismic loading, (2) peat and/or highly organic clays greater than 3 meters in thickness, (3) highly plastic clays (Plasticity Index greater than 75) more than 8 meters thick, and (4) soft to medium stiff clays more than 30 meters thick.

Site seismic category refers to a geographic area defined by threshold values of spectral response acceleration parameters for design ground motions.

Storey means the portion of a *building* that is situated between the top of any floor and the top of the next floor above it, and if there is no floor above it, that portion between the top of such floor and the ceiling above it.

Surface fault rupture means a displacement along a fault that reaches the earth's surface during slip.

Total floor area is the sum of the *floor area* of all *storeys* counted from the lowest finished grade around the building.

Trained screener means a person who is properly trained to conduct the *seismic risk* screening using the *Level 1 – PST*.

Very high consequences mean that the consequences of failure associated with the *life safety* threat are identified as very high.

Very low consequences mean that the consequences of failure associated with the *life safety* threat are identified as very low.

Year built means the year when the construction of a *building* was completed.

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5.0 INSTRUCTIONS FOR COMPLETING LEVEL 1 – PST SCREENING FORMS

Level 1 – PST screening form provided in Appendix A shall be completed by *trained screeners* based on the key *building* information collected in the office. The form is divided into the following parts:

1. **Part A: Data collection.**
2. **Part B: Seismic risk acceptance criteria.**
3. **Part C: Decision support.**

The screening form has been designed to be completed in a smooth progressive manner, with a minimum amount of writing. Appendix B presents an example of seismic risk screening for an *existing building*.

Prior to reviewing the form, the *screener* needs to determine whether or not the *building* to be screened is covered by Part 4 of Division B of the NBC, and therefore within the scope of the *Level 1 – PST*. This information may be determined by communicating with the local property manager or by checking the criteria for *buildings* covered by Part 4 of Division B of the NBC.

A *building* may be divided into one or more sections by expansion joints. If this is the case, each separate *building* section should be treated as an individual *building* when using the *Level 1 – PST*.

Buildings may have additions built after the original construction. If that is the case, consider the original *building* and addition(s) as a single *building* if the addition(s) is(are) connected to the original *building*, and consider the original *building* and addition(s) as separate *buildings* if there are any gaps or expansion joints between them.

Instruction for completing the *Level 1 – PST* screening form is provided in the sections hereunder.

5.1 Part A: Data collection

Collect the key *building* information, including *building* identification (i.e., *building* name, *federal heritage designation*, and *building* address), seismic data, *year built*, *original design NBC*, *full seismic upgrading NBC*, *model building type*, *benchmark NBC edition*, *number of storeys*, *total floor area*, *building occupancy, consequences of failure*, *remaining occupancy time*, *record of building deterioration/damage time*, *Site Class*, *site seismic category*, and *geologic hazards*. Any unknown or uncertain *building* conditions should be documented in the comments section of Part C of the screening form.

In the sections hereunder, instructions for completing Part A is provided in detail.

Building name and federal heritage designation

Building name may be recorded because it is very useful for quick identification.

Select "Yes" in the *federal heritage designation* section if the *building* is in the Directory of Federal Heritage Designations and meets any one of the following conditions:

1. A *building* of any age, designated as recognized or classified federal heritage at the time of screening; and

2. A *building of age* not less than 40 years that has not been evaluated by the Federal Heritage Buildings Review Office (FHBRO) at the time of screening.

Parks Canada provides the directory of federal heritage of Canada (https://www.pc.gc.ca/apps/dfhd/search-recherche_eng.aspx). The information may be obtained by contacting Heritage Conservation Services (E-mail: dcp.hcd@tpsgc-pwgsc.gc.ca). If there is any doubt about the *federal heritage designation,* a written letter from the *building* owner or manager is required to determine if the *building* under screening has a *federal heritage designation*.

Building address

Enter the street address, city, province, and postal code in the *building* address section.

Seismic data

Seismic data can be obtained either from Appendix C of the NBC 2015, or from the Natural Resources Canada earthquake hazard online calculator at the following website address: http://www.earthquakescanada.nrcan.gc.ca/hazard/interpolator/index_2015-en.php.

Enter the values of $S_a(0.2)$, $S_a(0.5)$, $S_a(1.0)$, PGA in this section. The value of reference peak ground acceleration, PGA_{ref}, should be recorded since it is a key parameter in determining site coefficients in Part A of the form. PGA_{ref} is calculated as follows:

- PGA_{ref} = 0.8 PGA (peak ground acceleration), for $S_a(0.2)/PGA<2$, or
- PGA_{ref} = PGA, otherwise.

Year built

Record the year when *building* construction was completed. There may not be a single *year built* designation. Certain portions of the structure may have been designed and constructed before others. If that is the case, document such in the comments section of Part C of the screening form. If this information is unavailable, leave this section blank.

Original design NBC

Enter the applicable NBC edition to which the *building* was originally designed. If a provincial or municipal *building* code was used in the original design, the *original design NBC* corresponds to the NBC edition on which the provincial or municipal *building* code was based. The *original*

design NBC is best determined based on well-documented sources such as original structural drawings or existing seismic assessment reports. If this information is unavailable, the *original design NBC* may be estimated based on the *year built*. In order to consider the lapse in time that typically occurs between design date and *year built*, the *screener* may choose to deduct a few years from the *year built* to estimate the *original design NBC*.

Full seismic upgrading NBC

Enter the applicable *full seismic upgrading NBC* only if the *building* was upgraded to fully comply with the seismic requirements of an applicable NBC edition.

Model building type

Select the *model building type*. The most common *buildings* covered by Part 4 of the NBC in Canada are grouped into seventeen *model building types* as shown in Table 5.1, based on the similarities of construction materials and type of seismic force-resisting system (SFRS). *Penthouses* do not need to be considered as they are unoccupied space (most of time) and thus do not pose significant risk associated with *life safety*.

Table 5.1: Model building types in *Level 1 – PST*

Model building type	Description
WLF	Engineered Wood Light Frame *buildings* of up to 6 storeys in height, or having an area exceeding 600 m^2
WPB	Engineered Wood Post-and-Beam *buildings* covered by Part 4 of the NBC
SMF	Steel Moment Frame
SBF	Steel Braced Frame
SLF	Steel Light Frame
SCW	Steel frame with Concrete shear Walls
SIW	Steel frame with Infill masonry shear Walls
CMF	Concrete Moment Frame
CSW	Concrete Shear Walls
CIW	Concrete frame with Infill masonry shear Walls
PCW	Precast Concrete Wall
PCF	Precast Concrete Frame
RML	Reinforced Masonry bearing walls with Light wood or metal deck diaphragms
RMC	Reinforced Masonry bearing walls with Concrete diaphragms
URM	Un-Reinforced Masonry bearing wall *buildings*
CFS	Cold-Formed Steel *buildings*
MH	Manufactured Homes

The recommended process for determining the *model building type* is as follows:

1. Identify the gravity system construction materials. Determine if the *building*'s structural material is primarily wood, steel, concrete, or masonry. Screen out materials that are not evident. This will result in arriving at one or two materials.

2. Identify the type of seismic force-resisting system, i.e., moment frame, braced frame, shear walls, or other.

3. Based on the material type from the first step and the type of seismic force-resisting system from second step, eliminate as many *model building types* as possible. Narrow down the possible *model building types* to between one and three. For buildings with more than one *model building type*, the *model building type* selection should be according to the additional guidance set forth after step 4 hereunder.

4. Determine the *model building type* and select the *model building type* on the screening form. Select "DNK" (Do Not Know) if more than three possibilities remain or the *building* does not fit any of the seventeen *model building types* in Table 5.1.

For *buildings* with more than one *model building type*, the following additional steps are recommended:

1. Select all applicable *model building types* if any of the following conditions apply:

   - a *model building type* in one direction and another *model building type* in the other direction

   - more than one *model building type* in each direction

   - one *model building type* is above another

2. In the exceptional case of an *existing building* with dual system, select the predominant *model building type* if the *building* was designed to resist all lateral forces through the predominant *model building type*. For example: concrete moment frame *buildings* with sufficient concrete shear walls around the elevator and stairwell cores. Well-documented evidence or engineering judgement made by an experienced structural engineer is required to support the selection of the predominant *model building type*.

The *model building type* is best determined based on well-documented sources such as original drawings or available seismic assessment reports.

Benchmark NBC edition

Enter the applicable *benchmark NBC edition* for the *model building type,* according to Table 5.2. If more than one *model building type* was identified, enter applicable *benchmark NBC editions* for each of them. If the *model building type* is unknown, enter "N/A" (Not Applicable).

Table 5.2: Applicable benchmark NBC editions for different model building types

Model building type	Benchmark NBC edition
WLF	2005 (≤ 4 *storeys*); 2015 (4 < *storeys* ≤ 6)
WPB	2005
SMF	2005
SBF	2010 (buckling-restrained brace frames); 2005 (other)
SLF	2005
SCW	2005
SIW	2005
CMF	2015 (two-way slabs without beams); 2005 (other)
CSW	2005
CIW	2005
PCW	2015
PCF	2005
RML	2005
RMC	2005
URM	2005
CFS	2010
MH	2005 (< 4.3 m wide and 1 *storey*)
	2010 (≥ 4.3 m wide or 2-3 *storeys*)

Post-benchmark building

Select "Yes" if the *original design NBC* or *full seismic upgrading NBC* corresponds to the applicable *benchmark NBC edition* (or newer) associated with the *model building type*. If more than one *model building type* was identified, select "Yes" only if the *benchmark NBC edition* for each *model building type* is applicable and the *building* is identified as a *post-benchmark building,* based on each applicable *benchmark NBC edition.*

Screener information

Identify the *screener*'s name, initials, or some other type of code. Check "P. Eng./ing." If the *screener* is a licensed professional engineer in Canada. The screening date should also be recorded.

Number of storeys

Enter the *number of storeys* above the lowest finished grade elevation around the *building* under screening. For *buildings* constructed on a hill or with different roof levels, use the largest *number of storeys* counted from the lowest finished grade elevation around the *building* to the corresponding roof. Applicable penthouses at the top of the *building* should not be considered

when counting the *number of storeys* because the *penthouse* is typically unoccupied and thus does not pose a significant *life safety* threat to the *building occupants*.

If the *building* has stepped levels or has a tower, document the varied numbers in the comments section of Part C of the screening form.

Total floor area (m^2)

Enter the *total floor area* for the *building* under screening as the sum of the *floor areas* (in m^2) for each *storey* above the lowest finished grade elevation around the *building*. The *floor area* may be determined based on the dimensions of each floor from the structural drawings. If one or more new floors were added and occupied, these *floor areas* should also be taken into consideration. The *floor area* of unoccupied *penthouse(s)* should not be considered because they do not pose a significant *life safety* threat to the *building occupants*. Use an asterisk or a note to indicate when the *total floor area* is estimated.

Occupancy

Determine *building occupancy* based on the following *occupancy types*:

1. office *buildings*
2. public *buildings*
3. commercial *buildings*
4. industrial *buildings*
5. educational *buildings*
6. residential *buildings*
7. care/treatment *buildings*
8. parking *buildings*
9. public assembly *buildings*
10. passenger stations

Public *buildings* refer to *buildings*, for single or multiple *occupancies*, to which the public is admitted, and/or where a wide range of government services and benefits can be provided to the public (e.g., service centers, passport offices, etc.).

There are certain *buildings* that are not classified as any of the aforementioned *occupancy* types. If that is the case, specify the *occupancy* under "Other" in the *occupancy* section.

If the *building* has more than one *occupancy* type, such as commercial and residential, select all applicable *occupancy* classes. If only a small portion of the *building* is occupied by a specific *occupancy* type, the *screener* may choose to circle the main *occupancy* type only. The decision should be made based on the judgement of an experienced structural engineer and consultation with the local property manager.

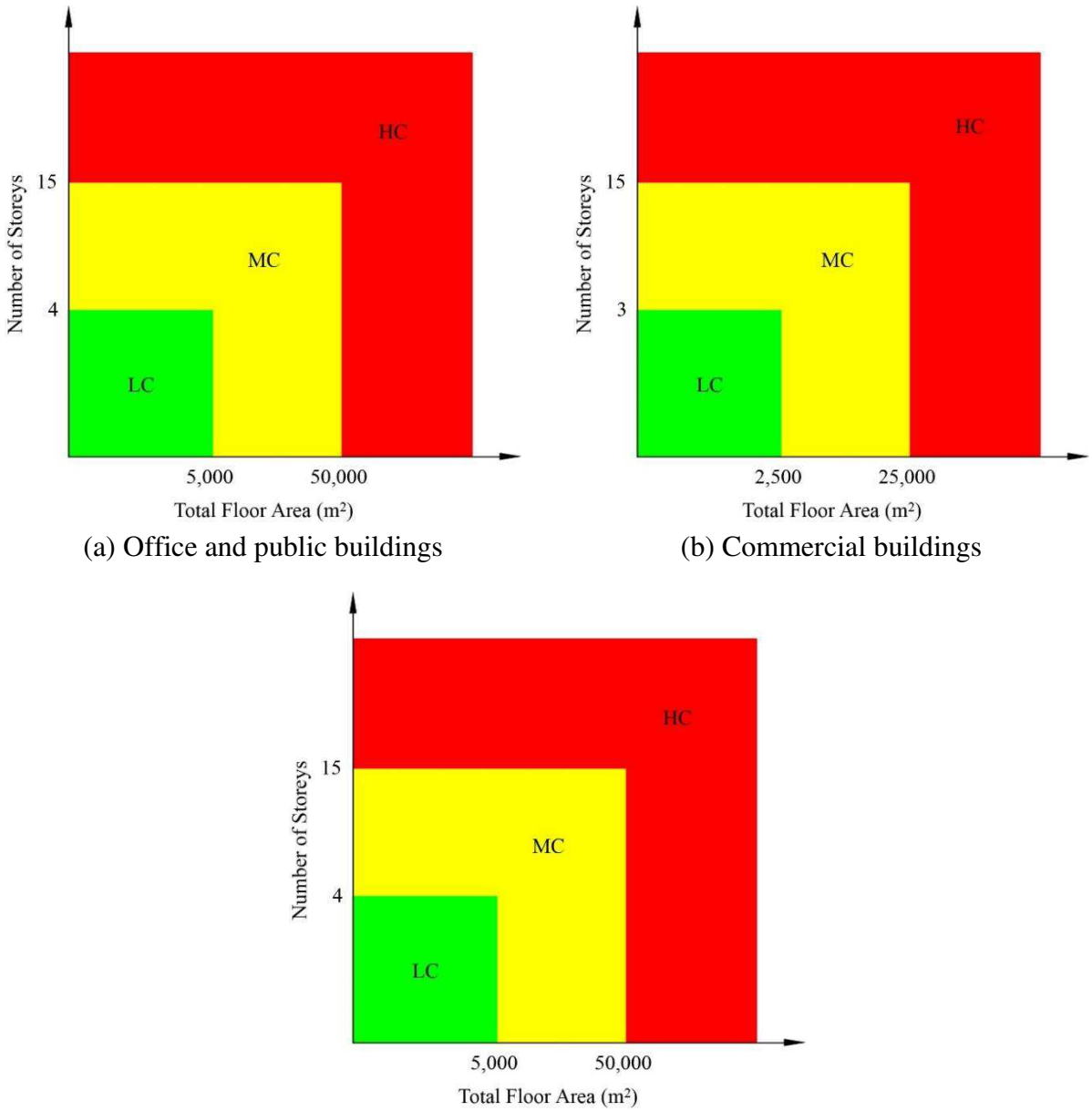
Record the *original occupancy* type in the original *occupancy* section, based on available *building* information. If this information is unavailable, select "DNK" and assume the *original occupancy* type is the same as the *occupancy* type identified in the *occupancy* section.

Select "Yes" if the *occupancy* change increases structural loads other than seismic. The structural load information may be found on structural drawings. If this information is unavailable, the structural loads from Section 4.1 of Part 4 of Division B of the NBC 2015 can be used.

Consequences of failure

Five levels of consequences of failure, namely *Very Low Consequences* (VLC), *Low Consequences* (LC), *Medium Consequences* (MC), *High Consequences* (HC), and *Very High Consequences* (VHC), are defined to describe *buildings'* lowest to highest consequences of failure. Select the *building's* consequences of failure based on the *number of storeys*, *total floor area*, and applicable *occupancy* type(s). Certain levels of consequences of failure do not apply to certain *occupancy* types. For example, *Very Low* and *Very High Consequences* do not apply to office, public, residential, commercial, educational, parking, and passenger station *occupancy* types.

Figure 5.1**Error! Reference source not found.** shows the consequences of failure for office, public, commercial, and residential *buildings* as a function of the *total floor area* and *number of storeys*. A *building*'s consequences of failure may fall directly between two consequences. If that is the case, enter the lower of the two consequences as per consequence classification (Fathi-Fazl and Lounis, 2017).



(a) Office and public buildings

(b) Commercial buildings

(c) Residential buildings

Figure 5.1: Consequences of failure for office, public, commercial, and residential buildings

Table 5.3 to Table 5.8 provide the consequences of failure for industrial, educational, care/treatment, parking, public assembly, and passenger station *occupancy* types. Definitions for Group A through Group F are presented in Table C.1 in Appendix C. The number of *occupants* is required for educational, care/treatment, public assembly, and passenger station *occupancy* types. This is estimated by multiplying the *total floor area* by the design *occupancy* load/density (person/m^2). The design *occupancy* load density may be found on the structural drawings. If this information is unavailable, the following density values, obtained from the NBC 2015, can be used:

1. Educational *buildings*: 1 person/(0.75 m^2)
2. Public assembly: 1 person/(0.75 m^2)
3. Passenger station: 1 person/(0.75 m^2)
4. Care/treatment *buildings*: 1 person/(10 m^2)

Table 5.3: Consequences of failure of industrial buildings

Low Consequences (LC)	Medium Consequences (MC)	Very High Consequences (VHC)
Group F-3 and the number of *storeys* is less than or equal to 3 ($n_s \leq 3$)	• Group F-3 and $n_s > 3$; or • Group F-2; or • Public Utility *buildings* (do not serve as *post-disaster* facilities)	• Group F-1; or • Public Utilities (serve as *post-disaster* facilities)

Table 5.4: Consequences of failure of educational buildings

Medium Consequences (MC)	High Consequences (HC)
One *storey* ($n_s = 1$) • Daycare facilities with no more than 150 *occupants*; or • Primary or secondary schools with no more than 250 *occupants*; or • Colleges or universities with no more than 500 *occupants*	Exceed one *storey* ($n_s > 1$) • Daycare facilities with more than 150 *occupants*; or • Primary or secondary schools with more than 250 *occupants*; or • Colleges or universities with more than 500 *occupants*

Table 5.5: Consequences of failure of care/treatment buildings (Group B-2/B-3)

Medium Consequences (MC)	High Consequences (HC)	Very High Consequences (VHC)
• $n_s \leq 3$ in *building* height; and • Accommodate no more than 50 *occupants* and have no surgery or emergency facilities	• $n_s > 3$ in *building* height; and • Accommodate more than 50 *occupants* and have no surgery or emergency facilities	• Have surgery or emergency treatment facilities

Table 5.6: Consequences of failure of parking buildings

Low Consequences (LC)	Medium Consequences (MC)
• $n_s \leq 5$ in *building* height; and • Do not accommodate emergency vehicles	• $n_s > 5$ in *building* height; and • Do not accommodate emergency vehicles

Table 5.7: Consequences of failure of public assembly buildings

Medium Consequences (MC)	High Consequences (HC)	Very High Consequences (VHC)

• Open-Air Assembly (Group A-4) accommodating no more than 2 000 *occupants*; or
• Indoor Assembly (Group A-1, A-2, or A-3) accommodating
  • no more than 300 *occupants*; and
  • with a total *floor area* of 1 000 m^2 or less
	• Open-Air Assembly (Group A-4) accommodating more than 2 000 *occupants,* but less than 5 000 *occupants*; or
	• Indoor Assembly (Group A-1, A-2, or A-3) accommodating
	  • more than 300 *occupants*; or
	  • with a total *floor area* of more than 1 000 m^2
		Open-Air Assembly (Group A-4) accommodating more than 5 000 *occupants*

Table 5.8: Consequences of failure of passenger stations

Medium Consequences (MC)	High Consequences (HC)
Passenger station buildings accommodating no more than 250 *occupants*	Passenger station buildings accommodating more than 250 *occupants*

If *occupancy* is identified as "Other" in the *occupancy* section, determine the consequences of failure as follows:

- Select "Very Low Consequences (VLC)" if the *building* under screening is an agricultural *building*.
- Select "High Consequences (HC)" if the *occupancy* is detention. The description of the detention *occupancy* is presented in Table C.1 of Appendix C of this Tool.
- Select "Very High Consequences (VHC)" if the *building* under screening is intended to be a *post-disaster facility*.
- Select "High Consequences (HC)" if the building is not identified as any of above conditions.

If there is more than one *occupancy* circled in the *occupancy* section, identify the consequences of failure for each applicable *occupancy*.

Record the original consequences of failure based on the original *occupancy*, *number of storeys*, *total floor area*, and number of occupants (if applicable). For *buildings* with addition(s), the *number of storeys* and *total floor area* should be determined based on the original *building* configuration.

Select "Yes" if the consequences of failure are higher than the original consequences of failure.

Remaining occupancy time

Check the *remaining occupancy time* box according to the following conditions:

1. If the *remaining occupancy time* is less than or equal to 5 years, check the "≤5" box.
2. If the *remaining occupancy time* is greater than 5 years, but less than or equal to 10 years, check the ">5 and ≤10" box.
3. If the *remaining occupancy time* is greater than 10 years or unknown, check ">10."

If "≤5" or ">5 and ≤10" is checked, a written letter from the *building* owner is required to verify the *remaining occupancy time*.

Building deterioration/damage

Select "Yes" if there is record of *building deterioration/damage*, which has not been repaired under supervision of a licensed structural engineer. The *building deterioration/damage* information may be determined based on well-documented sources such as past performance reports.

Site Class

Select the *Site Class* as designated by the letters A through F in the NBC 2015, as stipulated in Table 5.9, or "DNK" (Do Not Know) if the *Site Class* cannot be identified. If "DNK" is selected, assume *Site Class* E for screening purposes.

Table 5.9: Site classification for seismic site response (reproduced from the NBC 2015)

Site Class	**Ground profile name**	**Average properties in top 30 m**		
		Average shear wave velocity, V_{s30}, m/s	**Average standard penetration resistance, N_{60}**	**Soil undrained shear strength, s_u**
A	Hard rock	$V_{s30} > 1\,500$	n/a	n/a
B	Rock	$760 < V_{s30} \leq 1\,500$	n/a	n/a
C	Very dense soil and soft rock	$360 < V_{s30} < 760$	$N_{60} > 50$	$s_u > 100$ kPa
D	Stiff soil	$180 < V_{s30} < 360$	$15 \leq N_{60} \leq 50$	50 kPa $< s_u \leq 100$ kPa
E	Soft soil	$V_{s30} < 180$	$N_{60} < 15$	$s_u < 50$ kPa
		Any profile with more than 3 m of soil with the following characteristics: • plasticity index: PI > 20 • moisture content: w ≥ 40%, and • undrained shear strength: $s_u < 25$ kPa		
F	Other soils(1)	Site-specific evaluation required		

(1) Other soils include:

a) liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils, and other soils susceptible to failure or collapse under seismic loading;
b) peat and/or highly organic clays greater than 3 m in thickness;
c) highly plastic clays (PI > 75) more than 8 m thick;
d) soft to medium stiff clays more than 30 m thick.

If the *Site Class* was defined based on previous soil types used in the NBC 1975 through NBC 1995, the *Site Class* can be determined from the mapping shown in Table 5.10. [Note that soil types were first introduced in the NBC 1975 and replaced by *Site Classes* in the NBC 2005.] Soil types 1 and 2 are conservatively considered as *Site Class D* and *E* in the screening process, respectively. Soil type 3 and other soil types are considered as *Site Class F*.

Table 5.10: Mapping between previous soil types and Site Classes in the NBC 2015

Soil type (NBC 1975 to NBC 1995)		*Site Class* (NBC 2015)
1	Rock, dense and very dense coarse-grained soils, very stiff and hard fine-grained soils; compact coarse-grained soils and firm and stiff fine-grained soils from 0 to 15 m deep.	A, B, C, and D
2	Compact coarse-grained soils, firm and stiff fine-grained soils with a depth greater than 15 m; very loose and loose coarse-grained soils and very soft and soft fine-grained soils from 0 to 15 m deep.	D and E
3	Very loose and loose coarse-grained soils, and very soft and soft fine-grained soils with depths greater than 15 m.	E and F

There are various sources of data for the *Site Class*, including geotechnical reports. Geotechnical reports may be unavailable at the time of screening. If that is the case, available site classification maps may be used to determine the *Site Class*. Several maps have been developed for different cities in Canada (e.g., Montreal, Ottawa, and Vancouver), based on the average shear wave velocity in the top 30 meters of soil, V_{s30}. Some of these maps, however, may be unavailable to the public and should be requested from the City or an academic or public institution. Such maps should be used with some caution and in case of any doubt about the *Site Class*, the *screener* should select "DNK."

Site coefficients

The site coefficients $F(0.2)$, $F(0.5)$, and $F(1.0)$ shall be obtained from Article 4.1.8.9 of Part 4 of the latest NBC edition.

Site seismic category

Table 5.11 presents the *site seismic categories* defined by the thresholds of $S(0.2)$ [maximum of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$] and $S(1.0)$ [i.e. $F(1.0)S_a(1.0)$], respectively.

Table 5.11: Site seismic categories and corresponding spectral acceleration thresholds

Site seismic category (SSC)		*S*(0.2)		*S*(1.0)	
		>	≤	>	≤
SSC-0	Very Low		0.10 g		0.05g
SSC-1	Low	0.10 g	0.20 g	0.05g	0.10 g
SSC-2	Moderate	0.20 g	0.35 g	0.10 g	0.15 g
SSC-3	Moderately High	0.35 g	0.75 g	0.15 g	0.30 g
SSC-4	High	0.75 g	1.15 g	0.30 g	0.50 g
SSC-5	Very High	1.15 g		0.50 g	

Calculate the values of *S*(0.2) and *S*(1.0). Compare them with the corresponding thresholds to determine the *site seismic category*. The *site seismic category* based on the *S*(0.2) may be different from the *site seismic category* based on the *S*(1.0). If that is the case, select the higher as the *site seismic category.*

Geologic hazards

Identify *geologic hazards* based on available geotechnical reports and other relevant documents. For each type of *geologic hazards*, select "Yes" if the hazard is present at or near the *building* site, and select "DNK" (Do Not Know) if the presence of the hazard cannot be identified. If "DNK" is selected, assume "No" for screening purposes.

Landslide potential may be identified based on street views or aerial maps from public online sources. As a rule of thumb, if the height of the slope is greater than the distance from the nearest side of the *building* to the slope, *landslide potential* should be circled on the form (see Figure 5.2).

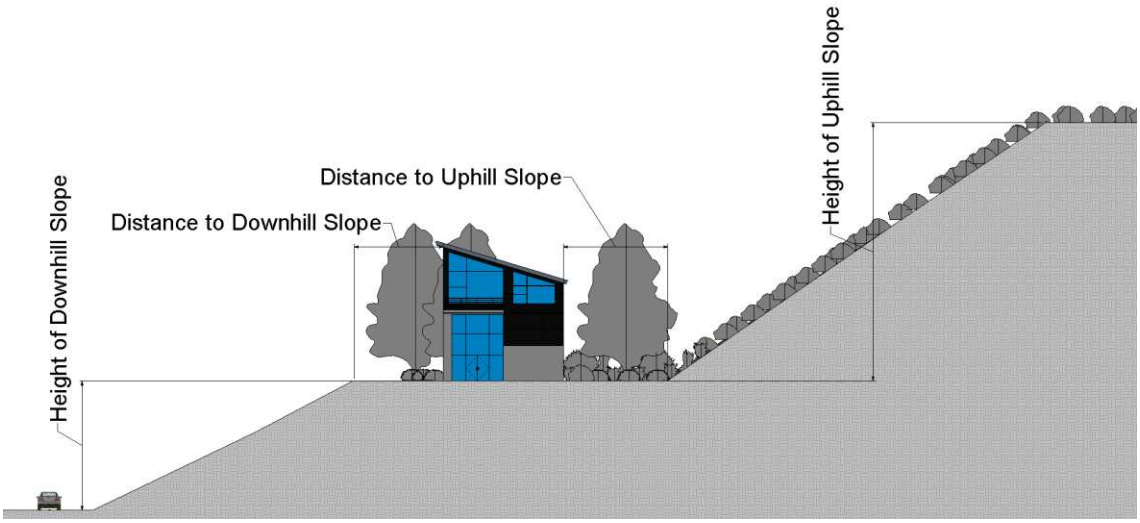


Figure 5.2: Building with landslide potential

Extent of review

Document whether drawings were reviewed for the *building*'s seismic screening. If "Yes," the *screener* should document the type of drawings reviewed, authors, and dates of issue in the comments section of Part C of the screening form.

Document the *Site Class* and *geologic hazard* sources. In addition, document the applicable authors and dates of issue.

5.2 Part B: Seismic risk acceptance criteria

In this section, the *screener* needs to check the *seismic risk* acceptance criteria based on the *building* information collected in Part A, including the *post-benchmark building*, *site seismic category*, *remaining occupancy time*, and consequences of failure.

5.3 Part C: Decision support

This section provides the actions resulting from the *Level 1 – PST*, most specifically whether the *building* requires *Level 2 – SQST* or *Level 3 – SEG*.

Comments

This section is for documenting any comments that the *screener* may wish to make regarding the collection of *building* information in Part A and the required action(s) in Part C. In addition, the *screener* should report unknown or uncertain *building* conditions.

APPENDIX A LEVEL 1 – PST SCREENING FORM

This Appendix provides the *Level 1 – PST* screening form. The form consists of a front page and a back page. The front page includes Part A: Data collection, Part B: Seismic risk acceptance criteria, and Part C: Decision support. The back page provides the intent and scope of *Level 1 – PST* and explanations of the superscripts on the front page.

Level 1 – PST Screening Form†

PART A: DATA COLLECTION

Building name: | **Federal heritage designation[1]:** ☐ Yes ☐ No

Street address: | **City/Province:** | **Postal code:**

Seismic data[2]: $S_a(0.2)$= $S_a(0.5)$= $S_a(1.0)$= PGA= PGA_{ref}=

Year built[3]: | **Original design NBC[4]:** | **Full seismic upgrading NBC (if applicable)[5]:**

Model building type[6]: WLF WPB SMF SBF SLF SCW SIW CMF CSW CIW PCW PCF RML RMC URM CFS MH DNK (Do Not Know)

Benchmark NBC edition[6]: | **Post-benchmark building:** ☐ Yes ☐ No

Screener: P.Eng./ing.: ☐ Yes ☐ No | **Date:**

No. of storeys[7]: | **Total floor area (m^2)[8]:**

Occupancy[9]: Office Public Commercial Industrial Educational Residential Care/Treatment Parking Public Assembly Passenger Stations Other_____

Original occupancy:_____ (e.g. office)

Change of occupancy increases structural loads: ☐Yes ☐No

Consequences of failure (COF)[10]: ☐ Very Low (VLC) ☐ Low (LC) ☐ Medium (MC) ☐ High (HC) ☐ Very High (VHC)

Original COF[11]:_____

COF higher than original COF: ☐ Yes ☐ No

Remaining occupancy time, *n* (Year)[12]: ☐ ≤5 ☐ >5 and ≤10 ☐ > 10

Record of building deterioration/damage[13]: ☐ Yes ☐ No

Site Class: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ DNK (assume E for screening)

Site coefficients[14]: $F(0.2)$= $F(0.5)$= $F(1.0)$=

***S* (*T*):** $F(0.2)S_a(0.2)$= $F(0.5)S_a(0.5)$= $F(1.0)S_a(1.0)$=

Site seismic category[15]: ☐ Very Low (SSC-0) ☐ Low (SSC-1) ☐ Moderate (SSC-2) ☐ Moderately High (SSC-3) ☐ High (SSC-4) ☐ Very High (SSC-5)

Geologic Hazards[16]: **Liquefaction:** ☐ Yes ☐ No ☐ DNK; **Landslide potential:** ☐ Yes ☐ No ☐ DNK; **Surface rupture fault:** ☐ Yes ☐ No ☐ DNK

EXTENT OF REVIEW

Drawings reviewed[17]: ☐ Yes ☐ No

Site Class source:_____

Geologic hazards source:_____

PART B: SEISMIC RISK ACCEPTANCE CRITERIA

Site seismic category (SSC)	Post-benchmark building: Structure – COF: Any level	Post-benchmark building: Non-structural components – COF: Any except VHC	Post-benchmark building: Non-structural components – COF: VHC	NOT post-benchmark building: Structure and non-structural components – COF: VLC	LC & MC	HC	VHC
SSC-0	☐ Met	☐ Met	☐ Met	☐ Met			
SSC-1				☐ Met		☐ Met if $n \le 10$ ☐ Not Met if $n > 10$	☐ Not Met
SSC-2		☐ Not Met	☐ Not Met	☐ Met if $n \le 10$ ☐ Not Met if $n > 10$		☐ Met if $n \le 5$ ☐ Not Met if $n > 5$	
SSC-3				☐ Met if $n \le 5$ ☐ Not Met if $n > 5$		☐ Not Met	
SSC-4 & SSC-5				☐ Not Met			

PART C: DECISION SUPPORT

Post-benchmark building

Level 3 – Seismic evaluation required[18]?

☐ Yes, any of the following conditions apply
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☐ No, none of the conditions above apply. Proceed to below

Level 2 – Semi-quantitative screening of the structure required?

☐ Yes, there is record of building deterioration/damage. Structural seismic risk may exceed the acceptable seismic risk.

☐ No, there is NO record of building deterioration/damage. Structural seismic risk does NOT exceed the acceptable seismic risk.

Level 2 – Semi-quantitative screening of the non-structural components required?

☐ Yes, any of the following conditions apply. Seismic risk of the non-structural components may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the non-structural components does NOT exceed the acceptable seismic risk.

NOT Post-benchmark building

Level 3 – Seismic evaluation required[18]?

☐ Yes, any of the following conditions apply
- ☐ Do Not Know (DNK) model building type
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☐ No, proceed to below.

Level 2 – Semi-quantitative screening of the structure and non-structural components required?

☐ Yes, any of the following conditions apply. The building's seismic risk may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. The building's seismic risk does NOT exceed the acceptable seismic risk.

Comments:

☐ Additional comments on separate page(s)

† Review the back page for the intent and scope of the tool and explanations of the superscripts on this page.

Intent and scope

The Level 1 – PST is intended to cover existing PSPC buildings under Part 4 of the National Building Code of Canada (NBC). It is not intended for small buildings covered by Part 9 of the NBC, such as single-family or small multi-family houses.

The Level 1 – PST deals with life safety objectives consistent with the NBC 2015, and does not address other objectives more stringent than life safety. A building expected to achieve objectives more stringent than life safety (e.g., post-disaster building or a building with a federal heritage designation) is still eligible for screening with the Level 1 – PST, but only to determine if its seismic risk associated with the life safety objectives exceeds the acceptable seismic risk.

The Level 1 – PST screening form shall be used in conjunction with Level 1 – PST's Part 1: User's Guide.

Explanation of Superscripts

1. Federal heritage designation means a building in the Directory of Federal Heritage Designations and meets any one of the following conditions: (1) buildings of any age, designated as recognized or classified federal heritage at the time of screening; and (2) buildings not less than 40 years of age that have not been evaluated by Federal Heritage Buildings Review Office (FHBRO) at the time of seismic risk screening. Parks Canada provides the directory of federal heritage of Canada (https://www.pc.gc.ca/apps/dfhd/search-recherche_eng.aspx). The information may be obtained by contacting Heritage Conservation Services (E-mail: dcp.hcd@tpsgc-pwgsc.gc.ca).

2. Seismic data: Natural Resources Canada provides the seismic data for all locations across Canada (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php). An alternative to obtaining the seismic data is reviewing Appendix C of Division B of the latest edition of the NBC.

PGA_{ref} is the reference peak ground acceleration and is calculated as follows:

- PGA_{ref} = 0.8 PGA, if $S_a(0.2)/PGA < 2.0$;
- PGA_{ref} = PGA, otherwise.

3. Year built means the year when the construction of a building was completed.

4. Original design NBC means the applicable NBC edition to which the building was originally designed. If a provincial or municipal building code was used to design the building, the original design NBC corresponds to the NBC edition on which the provincial or municipal building code was based. The original design NBC may be estimated by deducting a few years from the year built.

5. Full seismic upgrading NBC refers to an applicable NBC edition to which an existing building was upgraded, to fully comply with seismic requirements.

6. Model building type and benchmark NBC edition: Table 1 provides the descriptions of seventeen model building types in Level 1 – PST and corresponding benchmark NBC editions. The benchmark NBC edition means an applicable NBC edition in which significantly improved seismic code requirements were adopted and enforced. The Part1: User's Guide provides guidance on how to identify the model building type.

Table 1: Model building type and benchmark NBC edition

Model building type	Description	Benchmark NBC edition
WLF	Engineered Wood Light Frame buildings of up to 6 storeys in height, or having an area exceeding 600 m²	2015 (4 < storeys ≤ 6); 2005 (≤4 storeys)
WPB	Engineered Wood Post-and-Beam buildings covered by Part 4 of the NBC	2005
SMF	Steel Moment Frame	2005
SBF	Steel Braced Frame	2010 (BRB frames); 2005 (other)
SLF	Steel Light Frame	2005
SCW	Steel frame with Concrete shear Walls	2005
SIW	Steel frame with Infill masonry shear Walls	2005
CMF	Concrete Moment Frame	2015 (two-way slabs without beams); 2005 (other)
CSW	Concrete Shear Walls	2005
CIW	Concrete frame with Infill masonry shear Walls	2005
PCW	Precast Concrete Wall	2015
PCF	Precast Concrete Frame	2005
RML	Reinforced Masonry bearing walls with Light wood or metal deck diaphragms	2005
RMC	Reinforced Masonry bearing walls with Concrete diaphragms	2005
URM	Un-Reinforced Masonry bearing wall buildings	2005
CFS	Cold-Formed Steel structures	2010
MH	Manufactured Homes	2005 (< 4.3 m wide and 1 storey); 2010 (≥ 4.3 m wide or 2-3 storeys)

7. No. of storeys means the number of storeys counted from the lowest finished grade elevation around the building (excluding the penthouse).

8. Total floor area refers to the sum of the floor area of all storeys above the lowest finished grade elevation (excluding parking areas). The floor area may be estimated based on the dimensions of each floor of the building.

9. Occupancy: If a building has multiple occupancies, all applicable occupancies shall be selected.

10. Consequences of failure: If multiple occupancies are selected, consequences of failure corresponding to all selected occupancies shall be determined and selected. The Part 1: User's Guide provides guidance for determining the consequences of failure.

11. Original consequences of failure refers to the consequence of failure of the building when it was originally built. The original consequences of failure may change due to the occupancy change or building addition(s). Refer to the Part 1: User's Guide for guidance on how to determine the original consequences of failure.

12. Remaining occupancy time means the number of years of intended occupancy of an existing building until the lease of the building is terminated or until the building is decommissioned. If the remaining occupancy time is less than or equal to 10 years, a written letter from the building owner or manager is required to verify the remaining occupancy time. The remaining occupancy time should not be considered if the building's consequences of failure is Very High.

13. Building deterioration/damage refers to a building condition caused by deterioration (e.g., cracks in concrete shear walls and corrosion of steel reinforcements,) or previous accidents (e.g., earthquakes, fire, and floods), which has not been repaired at the time of screening. Non-engineered modification to the building SFRS is considered as one type of building damage.

14. Site coefficients: Site coefficients can be obtained from Article 4.1.8.4 of the latest edition of the NBC.

15. Site seismic category: The site seismic category shall be determined according to Table 2. The site seismic category based on the maximum of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$ may be different from the site seismic category based on $F(1.0)S_a(1.0)$. If that is the case, select the higher as the site seismic category.

Table 2: Site seismic categories and corresponding spectral acceleration thresholds

Site seismic category	Max[$F(0.2)S_a(0.2)$, $F(0.5)S_a(0.5)$]		$F(1.0)S_a(1.0)$	
	>	≤	>	≤
Very Low (SSC-0)		0.1		0.05
Low (SSC-1)	0.1	0.2	0.05	0.1
Moderate (SSC-2)	0.2	0.35	0.1	0.15
Moderately High (SSC-3)	0.35	0.75	0.15	0.3
High (SSC-4)	0.75	1.15	0.3	0.5
Very High (SSC-5)	1.15		0.5	

16. Geologic hazards: This information may be found in available geotechnical reports and other relevant documents. If geologic hazards are unknown, select DNK but assume No for screening purposes.

17. Drawings reviewed: If drawings are reviewed, record their type, authors and dates of issue in the comments section of Part C of the screening form.

18. Level 3 – Seismic Evaluation: If the building is exempt from Level 3 – Seismic Evaluation, non-existence of Site Class F and geologic hazards shall be verified by a certified geotechnical engineer.

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APPENDIX B AN EXAMPLE OF LEVEL 1 – PST PERFORMED ON AN EXISTING BUILDING

This Appendix illustrates the *Level 1 – PST* screening of a mid-rise building located in Ottawa, Ontario. The objective of this example is to assist the screener in completing *Level 1 – PST* screening forms. *The example is provided for illustrative purposes and are not necessarily representative of the actual site conditions*.

B.1 Building description

Building XYZ is part of a building complex, which consists of three separate wings. These three wings were screened separately. Since Building XYZ is not listed in the Directory of Federal Heritage Designations, it is not identified as *federal heritage designation*. The *building* was designed in 1973 and built between 1975 and 1980. The original structural drawings do not specify the NBC edition followed for *building* design. Given the design date, it was assumed that the *building* design conformed to the NBC 1970. A partial upgrade in the 3rd and 4th storeys, performed in 2011, did not improve the seismic force-resisting system (SFRS) to satisfy seismic requirements set out in the NBC 2010. Therefore, *seismic upgrading* is not considered and the full *seismic upgrading NBC* does not apply.

B.2 Data collection

Building XYZ is an office building located on a site with spectral accelerations of $S_a(0.2) = 0.439$ g, $S_a(0.5) = 0.237$ g, $S_a(1.0) = 0.118$ g at 0.2-, 0.5-, and 1.0-second periods, respectively, and peak ground acceleration (PGA) of 0.281 g. [The seismic data of the *building* was obtained from the NRCan earthquake hazard calculator.] The PGA_{ref} corresponds to 80% of PGA (i.e. 0.225 g) given that the ratio of $S_a(0.2)$ to PGA was smaller than 2.

The original structural drawings, geotechnical report, and seismic assessment report were reviewed in the office. Key information was extracted as follows:

- Building XYZ has four *storeys* above grade (excluding a mechanical *penthouse*).
- An approximate *total floor area* of 8,400 m^2 was calculated by adding the *floor area* of each *storey* above grade. The dimensions of each *storey* were obtained from the structural drawings.
- The SFRS consists of concrete columns, flat slabs, dropped panels, and four reinforced concrete shear walls around the elevator and stairwell cores. As indicated in the original structural drawings, the structure was designed to resist lateral loads through a slab-frame system formed by rigid connections between columns and slabs. Although the concrete shear walls may provide additional seismic force resistance, it was deemed that their

potential contribution to lateral loads is limited. The *building* also contains masonry block walls that may contribute to resisting seismic forces through interaction between the concrete frames and block walls. Given the structural characteristics of the *building*, both concrete moment frame (CMF) and concrete frame with infill masonry walls (CIW) were selected as *model building types*.

- The *occupancy* was identified as "Office" and no *occupancy* change was made.
- Given the *building* height, *total floor area*, and *occupancy* of the *building*, the consequences of failure were determined as *Medium Consequences* (MC).
- *Remaining occupancy time* of the *building* is greater than 10 years.
- No record of *building deterioration/damage*. The *building* is located on Site Class A.
- Site coefficients are obtained from the NBC 2015: $F(0.2)=0.69$, $F(0.5)=0.57$, and $F(1.0)=0.57$.
- The *site seismic category* is Moderate (SSC-2), based on the maximum value of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$; the *site seismic category* is Low (SSC-1), based on the value of $F(1.0)\ S_a(1.0)$. Therefore, the *site seismic category* chosen is the higher of Low (SSC-1) and Moderate (SSC-2), namely Moderate (SSC-2).
- There is no potential *liquefaction* hazard given its location on Site Class A (hard rock). A *surface fault rupture* is identified from an existing geotechnical report. No *landslide potential* is present based on the review of aerial maps of the building.

B.3 Completion of the Level 1 – PST screening form

Based on the data collected, the *Level 1 – PST* screening form was completed as shown below. Building XYZ is flagged for *Level 3 – Seismic Evaluation* because one type of *geologic hazard* is present.

Level 1 – PST screening form†

PART A: DATA COLLECTION

Building name: Building XYZ — **Federal heritage designation[1]:** ☐ Yes ☒ No

Street address: 123 Any Street — **City/Province:** Ottawa/ON — **Postal code:** K1X X1X

Seismic data[2]: $S_a(0.2)$= 0.439 $S_a(0.5)$= 0.237 $S_a(1.0)$= 0.118 PGA= 0.281 PGA_{ref}= 0.225

Year Built[3]: 1975 to 1980 — **Original design NBC[4]:** 1970 — **Full seismic upgrading NBC (if applicable)[5]:** N/A

Model building type[6]: WLF WPB SMF SBF SLF SCW SIW (CMF) CSW (CIW) PCW PCF RML RMC URM CFS MH DNK (Do Not Know)

Benchmark NBC edition[6]: 2015 (CMF), 2005 (CIW) — **Post-benchmark building:** ☐ Yes ☒ No

Screener: LC — P.Eng./ing.: ☐ Yes ☒ No — **Date:** 2018.05.24

No. of storeys[7]: 4 — **Total floor area (m^2)[8]:** 8,400

Occupancy[9]: (Office) Public Commercial Industrial Educational Residential Care/Treatment Parking Public Assembly Passenger Stations Other_____

Original occupancy: Office (e.g. office)

Change of occupancy increases structural loads: ☐ Yes ☒ No

Consequences of failure (COF)[10]: ☐ Very Low (VLC) ☐ Low (LC) ☒ Medium (MC) ☐ High (HC) ☐ Very High (VHC)

Original COF[11]: Medium (MC)

COF higher than original COF: ☐ Yes ☒ No

Remaining occupancy time, *n* (Year)[12]: ☐ ≤5 ☐ >5 and ≤10 ☒ > 10

Record of building deterioration/damage[13]: ☐ Yes ☒ No

Site Class: ☒ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ DNK (assume E for screening)

Site coefficients[14]: $F(0.2)$= 0.69 $F(0.5)$= 0.57 $F(1.0)$= 0.57

$S(T)$: $F(0.2)S_a(0.2)$= 0.303 $F(0.5)S_a(0.5)$= 0.135 $F(1.0)S_a(1.0)$= 0.067

Site seismic category[15]: ☐ Very Low (SSC-0) ☐ Low (SSC-1) ☒ Moderate (SSC-2) ☐ Moderately High (SSC-3) ☐ High (SSC-4) ☐ Very High (SSC-5)

Geologic Hazards[16]:
- **Liquefaction:** ☐ Yes ☒ No ☐ DNK
- **Landslide potential:** ☐ Yes ☒ No ☐ DNK
- **Surface rupture fault:** ☒ Yes ☐ No ☐ DNK

EXTENT OF REVIEW

Drawings reviewed[17]: ☒ Yes ☐ No

Site Class source: Geotechnical report

Geologic hazards source: Geotechnical report

PART B: SEISMIC RISK ACCEPTANCE CRITERIA

	Post-benchmark building			NOT post-benchmark building			
	Structure	Non-structural components		Structure and non-structural components			
Site seismic category (SSC)	COF	Consequences of failure (COF)		Consequences of failure (COF)			
	Any level	Any except VHC	VHC	VLC	LC & MC	HC	VHC
SSC-0	☐ Met	☐ Met	☐ Met	☐ Met			
SSC-1				☐ Met		☐ Met if $n \le 10$ ☐ Not Met if $n > 10$	☐ Not Met
SSC-2		☐ Not Met	☐ Not Met	☐ Met if $n \le 10$	☒ Not Met if $n > 10$	☐ Met if $n \le 5$ ☐ Not Met if $n > 5$	
SSC-3				☐ Met if $n \le 5$	☐ Not Met if $n > 5$	☐ Not Met	
SSC-4 & SSC-5				☐ Not Met			

PART C: DECISION SUPPORT

Post-benchmark building

Level 3 – Seismic evaluation required[18]?

☐ Yes, any of the following conditions apply
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☐ No, none of the conditions above apply. Proceed to below.

Level 2 – Semi-quantitative screening of the structure required?

☐ Yes, there is record of building deterioration/damage. Structural seismic risk may exceed the acceptable seismic risk.

☐ No, there is NO record of building deterioration/damage. Structural seismic risk does NOT exceed the acceptable seismic risk.

Level 2 – Semi-quantitative screening of the non-structural components required?

☐ Yes, any of the following conditions apply. Seismic risk of the non-structural components may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the non-structural components does NOT exceed the acceptable seismic risk.

NOT Post-benchmark building

Level 3 – Seismic evaluation required[18]?

☒ Yes, any of the following conditions apply
- ☐ Do Not Know (DNK) model building type
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☒ Presence of any geologic hazards

☐ No, none of the conditions above apply. Proceed to below.

Level 2 – Semi-quantitative screening of the structure and non-structural components required?

☒ Yes, any of the following conditions apply. The building's seismic risk may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☒ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. The building's seismic risk does NOT exceed the acceptable seismic risk.

Comments:

Original structural drawings were reviewed

☐ Additional comments on separate page(s)

† Review the back page for the intent and scope of the tool and explanations of the superscripts on this page.

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APPENDIX C THE NBC'S MAJOR OCCUPANCIES

Table C.1: Major occupancies in the NBC 2015

Group	Division	Description of major occupancies
A (Assembly occupancies)	1	Assembly occupancies intended for the production and viewing of the performing arts (e.g., theatres, opera houses, etc.)
	2	Assembly occupancies not elsewhere classified in Group A (e.g., museums, art galleries, schools and colleges, etc.)
	3	Assembly occupancies of the arena types (e.g., indoor swimming pools, rinks, etc.)
	4	Assembly occupancies in which the occupants are gathered in the open air (e.g., grandstands, stadia, etc.)
B (Detention, Treatment, and Care occupancies)	1	Detention occupancies where people are restrained from or are incapable of evacuating to a safe location without the assistance of another person because of security measures not under their control (e.g., jails, prisons, etc.)
	2	Treatment occupancies where overnight accommodation is available to facilitate the treatment (e.g., hospitals, healthcare facilities, etc.)
	3	Occupancies where care is provided to residents (e.g., assisted/supportive living facilities, children's custodial homes, etc.)
C (Residential occupancies)	-	Residential occupancies for whom sleeping accommodation are provided but who are not harbored for the purpose of receiving care or treatment and are not involuntarily detained (e.g., apartments, hotels, motels, etc.)
D (Business and personal services occupancies)	-	Business and Personal Services occupancies where the transaction of business or the rendering or receiving of professional or personal services are provided (e.g., banks, offices, medical offices, dental offices, etc.)
E (Mercantile occupancies)	-	Mercantile occupancies where displaying or selling of retail goods, wares or merchandises are provided (e.g., shops, department stores, supermarkets, etc.)
F (Industrial occupancies)	1	High-hazard industrial occupancy containing sufficient quantities of highly combustible and flammable or explosive materials which, because of their inherent characteristics, constitute a special fire hazard (e.g., laboratories, factories, creameries, etc.)
	2	Medium-hazard industrial occupancy in which the combustible content is more than 50 kg/m^2 or 1 200 MJ/m^2 of floor area and not classified as a high-hazard industrial occupancy (e.g., aircraft hangars, box factories, printing plants, etc.)
	3	Low-hazard industrial occupancy in which the combustible content is not more than 50 kg/m^2 or 1 200 MJ/m^2 of floor area (e.g., feed mills, flour mills, mattress factories, etc.)

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