Seismic Project Identification Report

SPIR GUIDELINES

Edition 3.0

Structural Engineering Guidelines for the Performance-based Seismic Assessment and Retrofit of Low-rise British Columbia School Blocks

The Seismic Project Identification Report (SPIR) is a specific report format that documents the seismic risk and the retrofit concepts proposed for a seismically deficient school block.

The Ministry of Education (Ministry) requires that School Districts provide an SPIR for any school block that is identified as having high seismic risk.

Please note that SPIRs should not be initiated without the prior approval from the Ministry.

Engineers & Geoscientists BC, as the Ministry's technical advisor for the Seismic Mitigation Program, was requested by the Ministry to develop the format and technical requirements for the SPIR. This manual provides the necessary guidance for a consultant to prepare a SPIR on behalf of a School District.

SPIRs are due diligence documents that are designed to confirm the seismic risk and present seismic upgrading options to assist seismic safety planning by both School Districts and the Ministry. The expectation is that SPIR information will guide the seismic upgrading of a school block in a consistent, safe and cost-effective manner.

From a structural engineering perspective, the SPIR leads into the preparation of the PDR through the list of PDR requirements given in Chapter 11 of the SPIR.

On-going feedback from engineering practitioners is encouraged to advance future refinements of the SPIR document.

SPIR Guidelines Edition 3.0 includes the following significant revisions made after release of the SPIR Guidelines Edition 2.2 in May 2016:

(a) SPIRs should not be initiated without prior approval from the Ministry of Education;

(b) Phased option to be produced only at the request of the School District or the Ministry of Education (Chapter 1 – Retrofit Concepts)

(c) Amended SPIR consulting fee schedule (Appendix D);

(d) Revised SRG references to SRG3.

The SPIR version in use at present was updated and released in March 2016.
It is expected an updated version of the SPIR will be developed over the coming months and will be issued as an on-line form.

The following acronyms have been used in this document:

SPRFS is the Seismic Project Request Fact Sheet that a School District submits to the Ministry to document the School District's application for project support. The SPRFS details the project rationale and project scale as presented in the School District Facilities Plan. SPRFS's are supported by Seismic Project Assessments (SRA's), an on-line form that is used to confirm seismic risk to blocks.

PDR is the Project Definition Report that a School District submits to the Ministry as a precursor for a Capital Project Funding Agreement for a supported project. The PDR details all aspects of the supported project so that the project can proceed to Project Design and Development after the Capital Project Funding Agreement is finalized.

TRB is the Technical Review Board that is administered by Engineers and Geoscientists British Columbia (the Association) on behalf of the Ministry. The TRB is comprised of structural engineers, geotechnical engineers and construction cost consultants who have extensive experience in seismic engineering projects. All SPIRs and PDRs are to be reviewed by the TRB before acceptance by the Ministry.

Introduction

This chapter presents the general the general requirements for completing an SPIR. The SPIR form to be used by consultants is given in Appendix B (SPIR blank template).

Mandatory Submission

The Ministry of Education (Ministry) requires that School Districts provide an SPIR for any school block that is identified as having high seismic risk.

Please note that SPIRs should not be initiated without the prior approval from the Ministry.

SPIR Funding

A School District is required to initially fund the preparation of the SPIR. The Ministry will reimburse the School District in accordance with the established fee schedule. Reimbursement will include any TRB-approved additional work (geotechnical, materials testing, architectural, mechanical or electrical) required to complete the SPIR. Reimbursement will be provided through the Certificate of Approval mechanism after the project funding has been approved.

SPIRs developed for capital plan submissions will be reimbursed by the Ministry when the project becomes a supported project. The Ministry can reimburse SPIR costs for supported projects as soon as these SPIR costs are incurred.

SPIR Contract Award

A School District shall engage a prime consultant to prepare the SPIR on the basis of the fee schedule given in Appendix D. If a RFP is issued by the School District, the School District is to clearly specify the established floor area for the block to be used in determining the total consulting fees.

The prime consultant SPIR fees for a complex block are to be determined by the TRB in consultation with the prime consultant prior to the prime consultant commencing the SPIR.

Objective

The objective of the SPIR is to define the scope, schedule, risks and costs for the work required to seismically upgrade a H1, H2 or H3 Retrofit Priority Ranking block to a specified performance level.

The proposed scope of work for the seismic upgrade shall include only that work (structural, architectural, electrical and mechanical) to implement the seismic upgrade. Renovation or renewal work is to be excluded from the SPIR if such work is not an essential part of the implementation of the seismic upgrade.

Initiating a SPIR

At the onset of commencing a SPIR, the prime consultant initiates a SPIR project through the EGBC portal (https://www.egbc.ca/Security?ReturnUrl=%2fPORTAL%2fSeismic).

Instructions for initiating a SPIR are provided by the TRB. The prime consultant is to meet with the TRB at the onset of starting the SPIR.

Retrofit Concepts

All SPIRs are to detail and document a life safety retrofit option.

SPIRs for gymnasiums are to detail and document a life safety retrofit option, and an enhanced retrofit option.

A Phased option (a retrofit that would reduce seismic risk to Medium) should be produced for any block at the request of the School District or the Ministry of Education.

SPIR Summary Page

As given in Appendix B, all SPIRs are to include a SPIR summary page that highlights the significant features of the proposed seismic project.

H3 Blocks

The SPIR for a H3 block is to be completed to the end of Chapter 5 (first five chapters) as given in the SPIR template. The SPIR is then to be submitted to the TRB for review. The scope of the SPIR beyond Chapter 5 is to be based on the outcome of the TRB review. The fees for the submission of the first five chapters are 50% of the total SPIR fees detailed in Appendix D.

The purpose of preparing the first five chapters of the SPIR for a H3 block is to determine its retrofit priority ranking. If the resulting retrofit priority ranking is H3, H2 or H1, the H3 block will be part of the overall high risk seismic retrofit project for the school. Under such circumstances, the TRB will most likely ask the prime consultant to complete the SPIR for the H3 block. The fees for completing the SPIR are 50% of the total SPIR fees detailed in Appendix D unless otherwise negotiated with the TRB.

Technical Reference

The technical reference for all SPIR studies is the current edition of the Seismic Retrofit Guidelines. The current edition is the third edition of the Seismic Retrofit Guidelines (SRG3). Any technical criteria that do not conform to SRG3 must be approved by the TRB in the initial phase of the SPIR.

Schedule

Schedule is an essential part of the SPIR documentation. Confirmation that the construction can be completed within an extended summer period can eliminate costly temporary accommodations, or phasing, and can have a significant impact on project planning in the PDR phase.

Risks

All factors that could have a significant impact on the reliability of the proposed retrofit options (e.g., contaminants, existing condition, heritage designation) shall be clearly documented in the SPIR.

Prime Consultant Qualifications

The prime consultant for an SPIR shall meet the following requirements:

(a) structural engineering consultant;

(b) project manager or project engineer has either attended the EGBC June 22, 2017 SRG3 seminar or has viewed the video of the SRG3 seminar, as verified by a signed attestation.

Construction Cost Consultant

Preparation of Class C cost estimates for the proposed retrofit concepts is an essential component of the SPIR. Qualified construction cost consultants shall be engaged by the prime consultant at the onset of preparing a SPIR.

Refer to Appendix E for a listing of the inclusions and exclusions for the Class C cost estimates.

Construction Cost Consultant Review

All Class C cost estimates are to be reviewed by an independent qualified cost consultant. The construction cost review consultant will be engaged by and will be retained through the Technical Review Board (TRB) under contract to the Association.

The scope of work for the construction cost consultant preparing the Class C cost estimates shall include a reasonable allowance for facilitating the construction cost review.

Refer to Appendix F for the scope of the construction cost review.

Construction Cost Consultant Qualifications

The Association will provide a list of qualified construction cost consultants upon request.

Architectural, Mechanical and Electrical Engineering Services

All SPIRs shall have contributions from architectural, mechanical and electrical engineering design professionals (A / M / E). The A / M / E contributions shall complete Chapter 10 and Appendix B of the SPIR (refer to SPIR Blank Template Appendix B).

The A / M / E contributions may vary from nominal contributions for small blocks to significant contributions for large blocks. The fees for A / M / E services are detailed in Appendix D.

Specific guidelines for A / M / E services are given in Chapter 4. Highlights of these guidelines are as follows:

(a) A / M / E work to be defined in the SPIR and the PDR as “Base Seismic Upgrade Requirements” or “Optional Non-seismic Improvements”;

(b) Base Seismic Upgrade Requirements are funded by SMP;

(c) Optional Non-seismic Improvements are funded by alternate funding sources.

Geotechnical Investigations

The Site Classification for an SPIR shall meet one of the following two requirements:

(a) written geotechnical opinion stating the Site Classification;

(b) Site Classification is clearly defined on the SRG3 soil hazard map (Manual No. 9).

Any clarification of issues related to the SRG3 soil hazard map shall be directed to the TRB. Any work associated with a custom site response analysis is a separate study that is outside the scope of the SPIR.

If the prime consultant is of the opinion that further geotechnical investigation is essential for the development of less conservative SPIR retrofit options, the prime consultant is to make a written submission to the TRB requesting approval for the additional geotechnical investigation.

Field Testing

Field testing, if required, shall be limited to a nominal investigation.

If the prime consultant is of the opinion that more field testing is crucial to the reliability of the SPIR retrofit options, the prime consultant shall undertake one of the following two actions:

(a) document recommendations for the additional field testing in the PDR;

(b) make submission to TRB, in the initial phase of the SPIR, for additional field testing during the SPIR to obtain a less conservative and more representative SPIR cost estimate.

Relevant Reference Documents

Relevant field testing and geotechnical reports are to be included in Appendix F of the SPIR.

Coordination of Multi-disciplinary Team

The prime consultant shall retain and coordinate the work of members of the SPIR multi-disciplinary team (construction cost consulting with architectural, mechanical or electrical services, and geotechnical engineer or materials testing firm, as required).

Reference SPIRs

The prime consultant must be a registered user of the BC Seismic Retrofit Program Database. The prime consultant is to select, from the database, several completed SPIRs that have similar blocks to the block that is the subject of the new SPIR. These similar SPIRs are listed in the new SPIR as reference SPIRs.

The purpose of these reference SPIRs is to demonstrate that the prime consultant has considered best current practice in advocating the most appropriate retrofit concepts.

OFCs (Non-structural Hazards)

With the exception of heavy partition walls, the SPIR construction cost estimate is to exclude an allowance for the Operational and Functional Components (OFCs). The cost for the OFC abatement is to be established by the structural Engineer-of-Record during the PDR as detailed in Chapter 3 and Appendix G.

The Ministry intends to fund OFC abatement in conjunction with the structural seismic retrofit.

Next Steps

The SPIR is technically complete when the prime consultant has satisfied the TRB review comments in an appropriate manner.

The SPIR is formally complete when the following five steps have been taken:

(a) Obtain the Cost Review sign-off letter from the TRB cost reviewer:

(b) Obtain the sign-off letter from the TRB Panel Lead.

(c) Send a copy of the Final SPIR to the School District.

(d) For each SPIR email the final report, TRB review, Cost review and a photo of the block to twhite@bushbohlman.com. The heading of the email should contain the SPIR number. The SPIR and review files should be in PDF format. The photo of the block should be in JPG format. Also provide one keyplan for the entire school (if it has multiple SPIRs) showing block numbers. This file should be a JPG and should not be specifically linked to any one block in the school. Send an individual email for each block SPIR in a school.

(e) If everything is in order, you will receive a confirmation email. Once you receive this email the SPIR is officially complete and will be uploaded to the BCSRP Database.

If the School District decides that work is to proceed to a PIR or PDR, the requirements of Chapter 10 of the SPIR are to be satisfied, including a transparent correlation of the SPIR Class C construction cost with the PIR, PDR and Project Agreement construction cost estimates. The PDR is subject to TRB review, as detailed in Chapter 3.

All SPIRs are to be reviewed by the TRB. The scope of work for the SPIR documentation shall include at least two meetings of the consultant with the Technical Review Board (TRB). The consultant shall meet with the TRB at the beginning and at near completion of the SPIR study. The TRB shall use its discretion in determining the need for an intermediate meeting.

A SPIR is only to be submitted by the District to the Ministry when accompanied by a written confirmation from the TRB that the SPIR conforms to the SPIR Guidelines.

The fees for TRB members conducting the SPIR review are based on time and disbursements with charge-out rates and the maximum fees established at the onset of the TRB review by the TRB Chair in consultation with the TRB review panel members. All fees for TRB members are to be invoiced to the Association who are administering the TRB on behalf of the Ministry.

Introduction

The Technical Review Board (TRB) review process is to continue beyond the completion of the SPIR. This chapter details these TRB PDR requirements, as referenced in Chapter 10 of the completed and approved SPIR. The minimum PDR requirements are to be reviewed by the TRB during the development of the PDR.

TRB Review Panel Lead

For efficiency, the TRB review during the PDR development is to be conducted by the TRB Review Panel Lead for the SPIR. If the SPIR TRB Lead is not available, the TRB can select an alternate TRB Lead who will, as a first step, become familiar with the key elements of the SPIR.

Continuity of Retrofit Concept

The Ministry's expectation is that the SPIR and the PDR are prepared by the same structural engineer-of-record. Under exceptional circumstances where this is not the case, the retrofit concept will be reviewed by the TRB Lead during the PDR development to ensure the concept is equal or better to that defined in the SPIR and that the PDR retrofit concept is cost-effective relative to the SPIR retrofit concept.

Scope of TRB Review Meetings

The scope of the TRB review during the PDR development is to be informal and efficient. The review is to focus on the "stand-alone" seismic retrofit option to the exclusion of renewal or replacement options. The scope of the review is at the discretion of the TRB Lead in consultation with the TRB Manager. All reviews are to include the minimum requirements as noted above. It is anticipated that most reviews will consist of 2 – 3 short meetings.

Changes to SPIR

All significant changes (concept, cost) to the SPIR are to be documented in the PDR by the PDR structural engineer-of-record.

Operational and Functional Components (OFCs)

The PDR structural engineer-of-record is to coordinate the compilation and cost estimate for the Operational and Functional Components (OFCs) or non-structural hazards in accordance with the details given in Appendix G.

Administration

The administrative work for the proposed TRB review of the PDR is to be kept to a minimum. An email from the TRB Lead to the PDR structural engineer-of-record at the completion of the TRB review will be, with few exceptions, the only formal correspondence during the PDR review.

Ministry-directed Specialized TRB Review

The TRB review is intended to complement, not supplant, the Ministry's current prerogative to request a formal and more detailed specialized TRB review of any PDR.

Due Diligence

The above proposed TRB review during the PDR phase extends the TRB due diligence from initiation of the SPIR through to signing of the Project Agreement.

Sign-off

The PDR structural engineer-of-record is required to receive a written notification of review completion from the TRB Panel Lead before the Ministry will accept the completed PDR.

Lessons Learned

At the discretion of the TRB Panel Lead or the TRB Manager, any significant lessons learned from the TRB review may be concisely documented for the benefit of future projects.

Background

This guideline is intended for architectural, mechanical and electrical *design professionals* when providing services on a seismic upgrade under the Seismic Mitigation Program (SMP). The SMP requires the use of the Seismic Retrofit Guidelines (SRG) published by Engineers and Geoscientists British Columbia (the Association); this document is part of SRG. *Design Professionals (or Registered Professionals)* is a defined term in both the British Columbia Building Code (BCBC) and the Vancouver Building Bylaw (VBBL) as professional engineers registered with APEGBC or architects registered with the Architectural Institute of BC (AIBC). The SRG generally provides technical guidelines for structural and geotechnical engineers; this document therefore applies to mechanical and electrical engineers and architects.

The SMP requires as part of the Ministry of Education project approval process a Seismic Project Identification Report (SPIR) that analyses the seismic risk, identifies the structural systems required to retrofit the building and provides a cost estimate. The cost estimate is construction only and includes allowances to remove and replace building systems (architectural, mechanical and electrical) but does not include any soft costs. Some projects at the Project Definition Report (PDR) stage carry estimates that are higher than normal adjustments for soft costs due in large part to the inclusion of non-seismic improvements. While these non-seismic improvements are often important to the enhanced operations of the building, from a funding perspective, they need to be identified as either required as part of the base seismic upgrade and therefore fundable through the SMP, or as non-seismic improvements that require alternate funding sources. The challenge presented to the design professionals is identifying the scope required for mechanical, electrical and architectural building systems retrofits to comply with building codes and bylaws and professional practice standards as part of a seismic upgrade. This document is intended to provide clarity and consistency in identifying the requirements for a base seismic upgrade thus permitting the identification of any proposed non-seismic improvements.

British Columbia Building Code (BCBC)

BCBC 2012 Part 1 Compliance states:

"1.1.1.2. Application to Existing Buildings.

1. Where a building is altered, rehabilitated, renovated or repaired, or there is a change in occupancy, the level of life safety and building performance shall not be decreased below a level that already exists. (See Appendix A)"

"*A-1.1.1.1.(1) Application to Existing Buildings. …It is not intended that the British Columbia Building Code be used to enforce the retrospective application of new requirements to existing buildings…."*

The British Columbia Building Code exempts owners from upgrading a building to current BCBC standards when the owner performs a voluntary upgrade, such as a seismic retrofit under the Seismic Mitigation Program.

Vancouver Building Bylaw (VBBL)

Similar to the BCBC 2012, the VBBL 2014 Section 11.2.1.1 Upgrade Objectives states:

"*(f) the level of safety and building performance shall not be decreased below the existing level."*

Additionally, the Vancouver Building Bylaw (VBBL) has always published an existing building upgrade mechanism with triggers that identify the levels of upgrade required. The current requirements are articulated in VBBL2014 Part 11 – Existing Buildings. The specific clause applicable to a voluntary seismic upgrade under the Seismic Mitigation Program is:

"A-11.2.1.2 Existing Building Upgrade Mechanism Model

Where a voluntary upgrade for...seismic work...is performed, it is not the intent of this By-law to require the owner to further upgrade the building provided no other work is included in the project. If other work is included in the project, the upgrade requirement will only be based on the non-voluntary work proposed."

This stated intent relating to voluntary upgrades is reinforced in Rehabilitation Project Flow Chart No.1 of A-11.2.1.2. This flow chart identifies the "triggers" for the level of upgrade required for rehabilitation projects as a function of the category of work. The Upgrade Level required increases from a "Voluntary Upgrade" to "Repair", "Minor Renovation", Major Renovation", and "Reconstruction" . The scope of work for a seismic upgrade may in fact coincide with one of the other Rehabilitation Project types, nonetheless, it is clear from the stated intent and Flow Chart No.1 that a Voluntary Upgrade is exempt from other upgrade requirements. In fact, if an owner were to undertake a voluntary seismic improvement that did not meet new building requirements (e.g., a Phased Retrofit to achieve medium risk), that is permitted under VBBL 11.2.1.2.

For example, installing a full building mechanical system complying with the current energy requirements of the VBBL is only required under the most stringent Project Type, Reconstruction. Reconstruction occurs when the building is completely gutted including all exterior cladding, floors, roof membranes, all interior finishes etc. It is unlikely that a seismic upgrade would be this extensive, however, in the unlikely event that this were the case, it does not negate the fact that the upgrade is voluntary and would therefore not dictate a new fully compliant mechanical system. Any piece of mechanical equipment that perhaps cannot be relocated and would need to be replaced as a result of the seismic retrofit would need to be at least as efficient as the equipment being replaced.

The Vancouver Building By-law exempts owners from upgrading a building to current VBBL standards when the owner performs a voluntary upgrade, such as a seismic retrofit under the Seismic Mitigation Program.

Professional Practice Standards

In addition to compliance with building regulations, design professionals are bound by a code of ethics and practice standards established by their respective regulatory bodies, EGBC and AIBC.

EGBC Guidelines to Professional Practice Principle 9 includes in the commentary the following statement:

"If the immediate physical safety of the public is in jeopardy, speedy notification of the owner, operator, or appropriate regulatory authorities is the immediate duty of the member."

In the context of a voluntary seismic upgrade under the Seismic Mitigation Program, a design professional is only required to object to the continued use of existing building systems and components if they pose an immediate life safety threat. Studying options to improve building performance through the replacement of systems or system components is of course the prerogative of the design professional and the owner.

Structural Engineering Post-SPIR

Once a project moves through the SPIR stage into the PDR stage, the mechanical, electrical and architectural design professionals must establish more detailed scopes of work for their respective project components. It is imperative that the structural engineer of record be included in a fulsome way to offer options to the geometry of the seismic reinforcing to minimize the cost impact on the building systems. For example, relocating shear walls, or adding shear walls to avoid floor diaphragm reinforcing may ease the burden on the re and re requirements of the building systems. The process should not be linear by which the structural engineer completes an SPIR and the other design professionals add their component requirements; it should be inclusive and somewhat iterative to minimize costs and disturbance. To ensure the effectiveness of the design process, the entire design team should be maintained from SPIR stage through to project completion.

Architectural Building Systems

As indicated above, the base professional responsibility of an architect in a voluntary upgrade is to ensure that level of safety and building performance is maintained. The following are examples of base requirements for architectural building systems and optional non-seismic improvements:

Base Seismic Upgrade Requirements – SMP Funding

- Ensure the integrity of fire protection assemblies such as fire separations, fire walls and construction type (combustible versus non-combustible) are maintained.
- Ensure fire exits, and access to exits (corridors and stairwells), are maintained.
- Ensure that seismic works do not reduce the accessibility and function of the existing building.
- Ensure the building envelope moisture, air and thermal barriers are maintained including wall cladding and roofing.

Optional Non Seismic Improvements – Alternate Funding Sources

- Fire protection upgrades to current codes for fire separations, combustibility and exiting.
- Building envelope upgrades.
- Window and door upgrades.
- Accessibility upgrades.
- Upgrade to interior finishes including millwork.
- Exterior improvements to wall surfaces or grounds.

Mechanical and Electrical Building Systems

As indicated above, the base professional responsibility of the mechanical and electrical engineers in a voluntary upgrade is to ensure that level of safety and building performance is maintained. The following are examples of base requirements for mechanical and electrical building systems and optional non-seismic improvements:

Base Seismic Upgrade Requirements – SMP Funding

- Remove and replace existing equipment, piping, conduits and fixtures as required to construction seismic components. Re-commission as required.
- Remove and replace existing fire protection systems including suppression sprinklers, piping and fire alarm equipment as required to construction seismic components. Fire suppression sprinkler testing and fire alarm verification.

Optional Non Seismic Improvements – Alternate Funding Sources

- Fire protection upgrades including suppression sprinkler systems.
- Fire alarm system upgrades.
- Upgrade exit signage and emergency lights.
- Mechanical Heating, Ventilation, Air Conditioning, and energy system upgrades to improve building performance.
- Plumbing and electrical fixture replacements.

Conclusion

Based on the requirements of prevailing codes, bylaws and professional standards, when undertaking a seismic upgrade under the Seismic Mitigation Program the following is required:

1. The responsibilities of the owner and the architectural, mechanical and electrical design professionals are to ensure that the level of safety and building performance is not decreased below the existing level.
2. The base requirements for architectural, mechanical and electrical building systems scope of work in a seismic upgrade undertaken under the Seismic Mitigation Program is to remove and replace existing systems to facilitate the construction of the seismic improvement components.
3. Exceptions to the base requirements exist if an immediate or imminent threat to public safety is discovered.
4. In consultation with the owner, the design team may consider the merits of optional non-seismic improvements including replacing or upgrading architectural, mechanical and electrical systems to improve building performance and longevity. It may be practical and rational to undertake these concurrent with the seismic structural upgrade.
5. The optional non-seismic improvements are not fundable by the SMP. As an exception, the Ministry of Education acknowledges that life safety improvements such as fire protection systems upgrades may be funded through the SMP.
6. To facilitate management of the Seismic Mitigation Program, a clear reporting of “Base Requirements” versus “Optional Non Seismic Improvements” shall be provided by the design professionals in accordance with the scope delineation presented in this document.

APPENDIX A

DEFINITIONS

The following common definitions have been provided below for ease of reference. The complete set of definitions is given in the Seismic Retrofit Guidelines first edition.

CAPACITY (C) of an element is the factored resistance of that element.

DEMAND (D) for an element is the minimum factored force that the element must be capable of sustaining to meet its performance requirements (e.g., maximum permissible PDE value for the risk assessment of an LDRS).

DESIGN DRIFT LIMIT (DDL) for a vertical load-bearing support or for a participating LDRS is the maximum permissible total drift that ensures the structural damage to the principal element meets the specified performance requirements.

DRIFT is the horizontal displacement of the top of a storey relative to the bottom of the storey expressed as a percentage of the clear storey height.

GOVERNING DRIFT LIMIT (GDL) is the maximum inter-storey drift permitted in an LDRS or group of LDRS such that the maximum drift does not exceed the DDL of any participating LDRS or interconnected VLS.

LATERAL DEFORMATION RESISTING SYSTEM (LDRS) is comprised of the vertical building elements that have similar seismic performance characteristics and that generate significant resistance to inter-storey horizontal shear deformations in the building.

PERFORMANCE-BASED ANALYSIS is an analysis that models the full range of inelastic deformation in a building for lateral deformations up to the specified drift limit for a specific earthquake ground motion record.

PROBABILITY OF DRIFT EXCEEDANCE (PDE) for a given building or a given principal building element at a given geographic location is the percent probability that the governing drift limit will be exceeded over 50 years for all levels of shaking and for all types of earthquakes.

SITE CLASS is the soil type designation defined in Table 4.1.8.4.A of the building code.

SURCHARGE for a wall in a given storey is the weight of the building bearing on the top of the wall. The top of the wall is defined as the vertical location of the wall's top lateral support. Surcharge is expressed as a percentage of the weight of the wall from base of wall to top of wall in that storey.

TOOLBOX METHOD is the simplified procedure for combining the resistance contributions of different LDRSs in a drift-compatible manner.

VERTICAL LOAD-BEARING SUPPORT (VLS) is a building element that supports vertical load and that is a non-LDRS element.

APPENDIX B

SPIR BLANK TEMPLATE

Seismic Project Identification Report

REPORT NO. SPIR-XX-XX

for

BLOCK #XX-X (BLOCK NAME)

SCHOOL NAME

School Address

Facility No: xxxxxxx

School District No. XX
Name of School District

Structural Engineering Guidelines for the Performance-based Seismic Assessment and Retrofit of Low-rise British Columbia School

No.	Technical Topic	Summary
1	School Name and School District	• •
2	Block No. / Name	• •
3	Floor Area	•
4	Year, Number of Storeys and Type of Construction	• • • • •
5	Soil Type	•
6	Liquefaction Potential	•
7	Risk	•
8	Life Safety Retrofit Features	• • • • •
9	Phased Retrofit Features	• • • • •
10	Enhanced Performance Retrofit Features	•
11	Schedule	•
12	Construction Risks	•
13	Cost Estimates	• •
14	PDR Requirements	•

(Structural Engineer
Professional Seal and Signature)

Date

Figure 1.1: Elevation – Wing

Figure 1.2: Elevation – Wing

Figure 2.1: Key Plan for

Identification of Retrofit Block (Box #2-1)

Adjacency (Box #2-2)

☐ No Significant Adjacency Issues
☐ Significant Adjacency Issues

Adjacency Comments (Box #2-3)

School District (Box #3-1)

Block Name (Box #3-2)

Structural Firm (Box #3-3)

Engineer-of-Record (Box #3-4)

Years of Construction (Box #3-5)

Floor Area (Box #3-6)

Construction Type (Box #3-7)

Site Classification (Box #3-8)

Comments on Construction Type (Box #3-9)

Number of Storeys (Box #3-10)

Clear Storey Heights (Box #3-11)

Previous Seismic Upgrade (Box #3-12)

☐	No
☐	Yes

Previous Seismic Upgrade Details (Box #3-13)

List of Testing Reports (Box #3-14)

(1) Vertical Load-bearing Supports (VLS)

VLS Type (Box #4-1)

VLS DDL (Box #4-2)

Supports Description (Box #4-3)

(2) LDRSs

Number of LDRS Prototypes (Box #4-4)

LDRS Prototype Details (Box #4-5)

Shaking Direction	Prototype No.	LDRS Prototype Description	Max DDL	Capacity

Comments on LDRS Prototypes (Box #4-6)

(3) Out-of-Plane URM Walls

URM Walls (Box #4-7)

☐ No

☐ Yes

Out-of-Plane Prototype Details (Box #4-8)

Prototype No.	Prototype Description	Max. Height	Wall Thickness	Surcharge

Comments on Out-of-Plane Prototypes (Box #4-9)

(4) Roof Diaphragm

Roof Diaphragm Material (Box #4-10)

☐ Wood ☐ Concrete

☐ Steel Deck ☐ Braced Steel

Roof Diaphragm Prototype Details (Box #4-11)

Prototype No.	Roof Diaphragm Prototype Description	Span	Max. Movement	Capacity

Comments on Roof Diaphragm (Box #4-12)

(5) Floor Diaphragm

Floor Diaphragm Material (Box #4-13)

☐ Wood	☐ Concrete
☐ Steel Deck with Concrete Topping	

Floor Diaphragm Prototype Details (Box #4-14)

Prototype No.	Floor Diaphragm Prototype Description	Span	Max. Movement	Capacity

Comments on Floor Diaphragm (Box #4-15)

(6) Connections

Connection Risk (Box #4-16)

Connection	C/D	Non-Brittle	Risk
VLS / Roof Diaphragm		☐ Yes ☐ No	
VLS / Floor Diaphragm		☐ Yes ☐ No	
Roof Diaphragm / LDRS		☐ Yes ☐ No	
Floor Diaphragm / LDRS		☐ Yes ☐ No	
LDRS / Foundation		☐ Yes ☐ No	
Other (Specify)		☐ Yes ☐ No	

Note:

(1) Connections do not have an assigned RPR value (Chapter 5)

(2) Connection risk is determined as below:

(a) H (High): brittle connections with C/D < 1.0

(b) M (Medium): brittle connections with 1.0 ≤ C/D < 2.0
non-brittle connections with 0.5 ≤ C/D > 1.0

(c) L (Low): brittle connections with C/D ≥ 2.0
non-brittle connections with C/D ≥ 1.0

(3) In Note (2) above, capacity (C) values are overstrength values.

Comments on Connections (Box #4-17)

(7) Liquefaction

Liquefaction Potential (Box #4-18)

Significant Risk of Liquefaction for Hazard Return Period of 2500 Years	☐ Yes ☐ No

Liquefaction Movement (Box #4-19)

Risk of Significant Vertical Differential Movement	☐ Yes ☐ No
Risk of Punching Failure	☐ Yes ☐ No
Risk of Significant Horizontal Differential Movement	☐ Yes ☐ No

Comments on Risk of Liquefaction (Box #4-20)

Comments on Risk of Vertical Differential Movement (Box #4-21)

Comments on Risk of Punching Failure (Box #4-22)

Comments on Risk of Horizontal Differential Movement (Box #4-23)

Risk Assessment Results (Box #5-1)

Principal Element	Prototype No.	Prototype Description	PDE	RPR[(2)]
LDRS				
Diaphragm				–
Out-of-Plane				
		Maximum PDE / RPR		
			Liquefaction Risk	
			Existing Block Retrofit Priority Ranking	

Note:

(1) RPR – Retrofit Priority Ranking

(2) Liquefaction is not assigned a PDE value. The RPR value is assigned for liquefaction on the following basis:
   (a) H (High): significant risk of structural failure due to liquefaction movement
   (b) L (Low): no significant risk of structural failure due to liquefaction movement

(3) Maximum assigned RPR for an out-of-plane element is H3 for non load-bearing walls and is not restricted for load-bearing walls.

(4) Diaphragms do not have an assigned RPR value (refer to Guidelines and Commentary).

Comments on Seismic Deficiencies, Recommended Testing and Risk Assessment Results (Box #5-2)

Retrofit Options Documented (Box #6-1)

No.	Retrofit Performance Level	Chapter

Comments on Documented Retrofit Options (Box #6-2)

(1) Retrofit Concept

Figure 7.1: Typical Section –

Figure 7.2: Typical Section –

Comments on Figure 7.1 and Figure 7.2 (Box #7-1)

(2) Retrofit LDRSs

Number of Retrofit LDRS Prototypes (Box #7-2)

Retrofit LDRS Prototype Details (Box #7-3)

Shaking Direction	Prototype No.	LDRS Prototype Description	Max PDE	Max DDL	R_m

Comments on Retrofit LDRS Prototypes (Box #7-4)

(3) Reference SPIRs

Reference SPIRs (Box #7-5)

Reference SPIR No.	Reference SPIR Description	Retrofit Cost ($ / m^2)
Comments:		

(4) Scope of Retrofit

Refer to Appendix A for details on the scope of work for both the structural and non-structural retrofits.

(5) Retrofit Cost Estimate

Refer to Appendix B for details on the retrofit cost estimate for the phased retrofit. A summary of the phased retrofit is given on page (iii).

(6) Schedule

Schedule (Box #7-6)

Duration of Construction Period	months
Comments on Operational Disruption:	

(7) Construction Risks

Risks (Box #7-7)

Risk Description	Significant Risk	
Asbestos	☐ Yes	☐ No
Vermiculite	☐ Yes	☐ No
Lead Paint	☐ Yes	☐ No

Risk Management Comments (Box #7-8)

(1) Retrofit Concept

Figure 8.1: Typical Section –

Figure 8.2: Typical Section –

Comments on Figure 8.1 and Figure 8.2 (Box #8-1)

(2) Retrofit LDRSs

Number of Retrofit LDRS Prototypes (Box #8-2)

Retrofit LDRS Prototype Details (Box #8-3)

Shaking Direction	Prototype No.	LDRS Prototype Description	Max PDE	Max DDL	R_m

Comments on Retrofit LDRS Prototypes (Box #8-4)

(3) Liquefaction Retrofit

Figure 8.3: Typical Section for Liquefaction Retrofit

Comments on Figure 8.3 (Box #8-5)

(4) Reference SPIRs

Reference SPIRs (Box #8-6)

Reference SPIR No.	Reference SPIR Description	Retrofit Cost ($ / m^2)
Comments:		

(5) Scope of Retrofit

Refer to Appendix A for details on the scope of work for both the structural and non-structural retrofits.

(6) Retrofit Cost Estimate

Refer to Appendix B for details on the retrofit cost estimate for the life safety retrofit. A summary of the life safety retrofit is given on page (iii). Note that the retrofit cost estimate includes the liquefaction retrofit, where applicable.

(7) Schedule

Schedule (Box #8-7)

Duration of Construction Period	months
Comments on Operational Disruption:	

(8) Construction Risks

Risks (Box #8-8)

Risk Description	Significant Risk	
Asbestos	☐ Yes	☐ No
Vermiculite	☐ Yes	☐ No
Lead Paint	☐ Yes	☐ No

Risk Management Comments (Box #8-9)

Summary of Enhanced Performance Retrofit (Box #9-1)

Architectural Scope of Work (Box #10-1)

Mechanical Engineering Scope of Work (Box #10-2)

Electrical Engineering Scope of Work (Box #10-3)

Architectural, Mechanical and Electrical Engineering Construction Risks (Box #10-4)

TRB PDR Requirements (Box #11-1)

No.	PDR Structural Details	TRB Requirement
1	Additional Field Testing	☐ Yes ☐ No
2	Custom Site Response Analysis	☐ Yes ☐ No
3	Ambient Vibration Testing	☐ Yes ☐ No
4	Additional Figures	☐ Yes ☐ No
5	Additional Photographs	☐ Yes ☐ No
6	Class C Cost Estimate	☐ Yes ☐ No
7	Other	☐ Yes ☐ No
Note: PDR Requirements are agreed to by both the Engineer-of-Record and the TRB.		

Risk Management Comments (Box #11-2)

Seismic Project Identification Report

APPENDIX A
SCOPE OF RETROFIT DETAILS
for
BLOCK #XX-X (BLOCK NAME)
SCHOOL NAME

Table A.1: Scope of Structural Phased Retrofit

No.	Construction Activity	Approx. Quantity

Table A.2: Scope of Structural Life Safety Retrofit

No.	Construction Activity	Approx. Quantity

APPENDIX B

SCOPE OF ARCHITECTURAL, MECHANICAL AND ELECTRICAL ENGINEERING WORK

for

BLOCK #XX-X (SCHOOL BLOCK)

SCHOOL NAME

Introduction

This appendix is comprised of stamped reports, one report for each discipline, for the scope of work for architectural, mechanical and electrical engineering work.

APPENDIX C
RETROFIT COST ESTIMATE REPORT
for
BLOCK #XX-X (SCHOOL BLOCK)
SCHOOL NAME

Retrofit Cost Estimate Report

APPENDIX D
LIQUEFACTION STRUCTURAL DETAILS
for
BLOCK #XX-X (SCHOOL BLOCK)
SCHOOL NAME

Liquefaction Retrofit Structural Details

APPENDIX E
REPRESENTATIVE STRUCTURAL DETAILS
for
BLOCK #XX-X (SCHOOL BLOCK)
SCHOOL NAME

Representative Structural Details

APPENDIX F
PHOTOGRAPHS
for
BLOCK #XX-X (SCHOOL BLOCK)
SCHOOL NAME

Photographs

APPENDIX G
RELEVANT REFERENCE DOCUMENTS
for
BLOCK #XX-X (SCHOOL BLOCK)
SCHOOL NAME

Relevant Reference Documents

APPENDIX C

SPIR BLANK TEMPLATE COMMENTARY

Introduction

This chapter provides the engineer with guidance on the type of information to be entered into the SPIR blank template to complete the SPIR.

Cover

The SPIR number on the cover page and in the footers will be assigned by the TRB Manager.

SPIR Summary

This summary page gives a succinct overview of the SPIR report with the emphasis on scope, cost, schedule and construction risks for the retrofit.

Table of Contents

The table of contents may change based on the details of the proposed block retrofit. Note that all chapters and all appendices are to be included in the SPIR.

Chapter 1

Two representative block photographs are recommended. Additional photographs can be provided in Appendix D.

Chapter 2

Identification of Retrofit Block (Box #2-1): It is imperative that the block to be upgraded be clearly identified in the key plan. All other school blocks also need to be identified on the key plan.

Adjacency Comments (Box #2-3): Adjacency comments should address the SRG3 requirements.

Chapter 3

Floor Area (Box #3-6): The consultant is to calculate the floor area from the drawings for the SPIR documentation. This floor area is calculated for the footprint defined by the exterior face of the block. This area is to be used in all Class C cost estimates.

Construction Type (Box #3-7): All engineers will be issued an updated list of construction types.

Chapter 4

VLS Type (Box #4-1): Use the VLS description similar to that given in SRG3 Table 8.1

LDRS Prototype Details (Box #4-5): Provide the LDRS details in the two orthogonal directions.

Floor Diaphragm Material (Box #4-13): Note that this information will be inapplicable for a one-storey block. In such a case, the two options are to either (a) enter "not applicable" in the appropriate locations or (b) delete "(5) Floor Diaphragm" section from Chapter 4 and renumber the following boxes accordingly.

Chapter 4 (continued)

Connection Risk (Box #4-16): This box provides a risk rating of the connections to highlight any connection shortcomings. This connection risk does not directly affect the block RPR. Inadequate connections could reduce the capacity of an LDRS and thereby increase the LDRS PDE, thereby elevating the corresponding RPR value.

The concern with connections is the potential for brittle behavior (sudden failure without warning). Connections are divided into the two categories of brittle connections and those connections not considered brittle (non-brittle).

Refer to Table C.1 and Table C.2 for a list of brittle connections and non-brittle connections. Contact the TRB if you require clarification on the classification of connections not listed in these two tables.

Liquefaction (Box #4-18 to Box #4-23): Liquefaction is a new and evolving consideration in the preparation of SPIRs. Mitigation of structural life safety risks arising from liquefaction effects requires a close collaboration between the structural engineer and the geotechnical engineer. All SPIRs that include significant liquefaction will be subject to detailed TRB review. The consultant is encouraged to consult with the TRB at regular intervals in developing structural retrofit options for mitigating the life safety risk arising from liquefaction.

Chapter 5

Risk Assessment Results (Box #5-1): Provide the PDE results for all significant principal elements. The governing PDE and the corresponding retrofit priority ranking are the most important entries in this table. Liquefaction is also a consideration in assigning the risk rating for the existing block.

Chapter 6

Comments on Documented Retrofit Options (Box #6-2): Provide a short clarification on each of the three possible retrofits as detailed in Chapters 7 – 9.

Chapter 7 – Phased Retrofit

Comments on Figure 7.1 and Figure 7.2 (Box #7-1): Provide as many figures as necessary to illustrate the essence of the proposed retrofit concept. Additional figures have to be provided in Appendix C.

Retrofit LDRS Prototype Details (Box #7-3): Provide the retrofit LDRS details in the two orthogonal directions.

Reference SPIRs (Box #7-5): The intention of this box is to list similar SPIRs given in the BC Seismic Retrofit Program Database. These similar SPIRs are an important reference in planning the proposed retrofit concepts for the SPIR under consideration. The TRB will use the reference SPIRs as a yardstick for evaluating the SPIR.

Schedule (Box #7-6): The elapsed duration of the construction period is of prime interest to both the School District and the Ministry. Anticipated disruption to educational operations is also another important consideration. No requirement for swing space (no portables) is a major cost and disruption advantage.

Risks (Box #7-7): Risk can include more than hazardous materials. Stringent heritage-related issues are one example of a construction risk not related to hazardous materials.

Chapter 8 – Life Safety Retrofit

This chapter is very similar to Chapter 7.

Chapter 9 – Enhanced Performance Retrofit

Summary of Enhanced Performance Retrofit (Box #9-1): If the block under consideration is not a gymnasium, an enhanced performance retrofit will not be required. Retain this chapter and simply state that an enhanced performance retrofit is outside the scope of the SPIR. If the block is a gymnasium that is to have an enhanced performance retrofit, Chapter 9 will have a format similar to that for Chapter 7, where all details of the enhanced performance retrofit are provided.

Chapter 10 – TRB PDR Requirements

The purpose of Chapter 10 is to provide the consultant with a checklist of structural issues that need to be addressed in the PDR. It is crucial that the PDR be prepared in a manner that is consistent and transparent with the content of the SPIR.

The TRB will use this checklist as a basis for signing off on the structural portion of the PDR.

Appendix A

Appendix A is to list the approximate quantities that have been generated to permit the cost consultant to prepare a Class C cost estimate. All significant retrofit elements should be listed in this appendix.

Appendix B

This appendix comprises the stamped reports from architectural, mechanical and electrical engineering sub-consultants.

Appendix C

This appendix includes a copy of the cost consultant's report. The Class C cost estimate should provide a cost for each of the retrofit elements listed in Appendix A. The cost consultant exclusions should be clearly stated.

Appendix D

Appendix D is to provide the details of the structural remedial measures to mitigate the life safety risks posed by liquefaction. Figures similar to those in Appendix E are important to clarify the proposed liquefaction retrofit (where applicable).

Appendix E

Appendix E provides additional structural details to further illustrate the retrofit concepts described in Chapters 7 – 9.

Appendix F

Appendix F provides additional photographs of the SPIR block.

Appendix G

Appendix G is the depository of relevant documents that have a significant influence on the proposed retrofit concepts (hazmat reports, field testing reports, etc.)

Table C.1: List of Brittle Connections

Material	No.	Connection Type
Wood Frame	1	Toe-nailed connections
	2	Bolts with inadequate end / edge distance
Steel	11	Fillet-welded connections (shop and field)
	12	All non-tested field welds
Concrete	21	Splice with inadequate development length
	22	Adhesive and mechanical anchors
	23	FRP retrofits
Masonry	31	Connections between unreinforced masonry elements
	32	Adhesive and mechanical anchors
	33	FRP retrofits

Table C.2: List of Non-Brittle Connections

Material	No.	Connection Type
Wood Frame	101	Sheathing nailing
	102	Face nailing
	103	Screwed connections
	104	Bolts with adequate end / edge distance
	105	Lag-screw connections
Steel	110	Full penetration and partial-penetration shop welds
	111	Bolted connections
	112	Tested non-fillet field welds
Concrete	120	Splices with adequate development
Masonry	130	Splices with adequate development in reinforced masonry

APPENDIX D

SPIR CONSULTING FEE SCHEDULE

Introduction

This document details the consulting fee schedule for the preparation of SPIRs for high risk school blocks.

Consulting Fees – One Block

The consulting fees for the preparation of a SPIR for one classroom block are given in Table D1. The consulting fees for the preparation of a SPIR for one gymnasium block are given in Table D2. The fees given in Table D1 and Table D2 exclude GST.

The consulting fee schedule for other types of school blocks (shops, auditoriums, etc.) is the same as that for classroom blocks, as given in Table D1.

Note that the consultant fees given in Table D1 and Table D2 are the total fees for the multi-disciplinary consultant team (refer to SPIR Guidelines for requirements for multi-disciplinary team).

Consulting Fees – Similar Blocks

If the consultant is retained to prepare SPIRs for two similar classroom blocks, the fees for the similar buildings are calculated as follows:

(a) fees for the classroom block with the larger floor area are calculated in accordance with Table D1;

(b) fees for the classroom block with the smaller floor area are set at 80% of the fees given in Table D1.

Similar classroom blocks are defined as blocks that conform to all of the following requirements:

(a) located at the same school;
(b) same block type (classroom, auditorium, etc.);
(c) same construction type;
(d) same number of storeys.

The consulting fees for all gymnasiums (similar or otherwise) are in accordance with Table D2.

Consulting Fees – Blocks on Liquefiable Soils

The SPIR fees for blocks on liquefiable soils are dependent on the complexity of the structural retrofit options to mitigate the effects of potential liquefaction.

The SPIR fees for blocks on liquefiable soils are to be determined by the TRB in consultation with the consultant. In general, the additional fees to consider liquefaction are anticipated to be in the range of 20% – 40% of the SPIR fees, excluding liquefaction.

Consulting Fees – H3 Block

The consulting fees for preparing a SPIR for a H3 block and for submission to the TRB are 50% of the fees for the same block if it were classified as a H1 or H2 block.

As noted in Chapter 1, the scope of work for a SPIR for a H3 block comprises the preparation of the first five chapters of the SPIR. The consulting fees for any follow-on work beyond the submission of the first five chapters to the TRB are to be determined by the TRB in consultation with the consultant.

Consulting Fees – Multi-disciplinary Team

All SPIRs are to include contributions from a cost consultant, an architect, a mechanical engineer and an electrical engineer (A/M/E), as detailed in Chapter 1.

The maximum fee allocation for all consultants, including the prime consultant (structural engineer), is given in Table D3. The fees for each discipline are given as a percentage of the total consultant fees given in Table D1 or Table D2.

The scope of A/M/E services and the corresponding fee allocation are determined by the prime consultant in consultation with the architect member of the multi-disciplinary team. The A/M/E fees given in Table D3 are the maximum A/M/E fees. In certain projects, the prime consultant and the architect may agree that an A/M/E allowance less than the maximum fees is appropriate. For complex projects, the prime consultant could request the Technical Review Board (TRB) for approval of A/M/E fees in excess of the limit given in Table D3.

The maximum cost consultant fee given in Table D3 reflects the level of effort anticipated to prepare a Class C cost estimate. In certain simpler projects, the appropriate fee (and the corresponding level of effort) for the cost consultant may be less than the maximum fees given in Table D3. In such cases, the maximum cost consultant fee allocation is determined by the prime consultant in consultation with the cost consultant.

Consulting Fees for Cost Review

The consulting fees are based on time and disbursements, excluding taxes, for the review of the Class C cost estimate with the maximum total fees the greater of:

(a) $1000;

(b) 25% of the cost consulting fees.

Fee Formula for School

If a consultant is retained to prepare SPIRs for several high risk blocks at a given school (one SPIR for each of several blocks), the consultant fees are calculated on a block-by-block basis, not on the basis of the aggregate floor area for the given blocks. The one qualification is for multiple similar blocks, as noted above.

Table D1: Consulting Fees for a SPIR for One Classroom Block

Floor Area	Consulting Fees
≤ 1000 m^2	$15,000
5000 m^2	$35,000
> 5000 m^2	$7 / m^2

Notes:

(1) Fees based on floor areas documented by District.
(2) Above fees exclude GST.
(3) Fees for building in the (1,000 m2 – 5,000 m2) range calculated by interpolation.

Table D2: Consulting Fees for a SPIR for One Gymnasium Block

Floor Area	Consulting Fees	
	Enhanced Performance Retrofit Included	Enhanced Performance Retrofit Excluded
≤ 600 m^2	$15,000	$13,500
> 600 m^2	$25 / m^2 (≤ $25,000)	$22 / m^2 (≤ $22,000)

Notes:

(1) Fees based on floor areas documented by District.
(2) Above fees exclude GST.

Table D3: Multi-disciplinary Team Consulting Fees

Discipline	Percent Total Fees
Structural	70%
A/M/E	≤ 17.5%
Cost Consultant	≤ 12.5%

APPENDIX E

CLASS C CONSTRUCTION COST ESTIMATE

Cost Estimate Inclusions and Exclusions

The cost consultant engaged to prepare a Class C cost estimate for the seismic retrofit shall include the following items in the Class C cost estimate:

(a) structural seismic upgrade;
(b) associated architectural work to restore functionality and finishes;
(c) removal, reinstallation or replacement (where necessary) of mechanical and electrical systems impacted by the seismic upgrade;
(d) abatement of asbestos and other hazardous material.

The Class C cost estimate shall exclude the following items:

(a) consultants' fees and expenses;
(b) construction contingency;
(c) provincial and federal sales taxes;
(d) temporary accommodation costs;
(e) cost escalation;
(f) owner's management fees;
(g) owner supplied and installed fittings and equipment;
(h) material testing;
(i) municipal fees;
(j) insurance;
(k) legal fees;
(l) finance fees;
(m) furnishings and equipment;
(n) cost premiums associated with phased work, out-of-hours work, work in an occupied building and LEED upgrades.

Basis of Cost Estimate

The purpose of the cost estimate is to provide a reasonable estimate of the construction costs based on fair value for the work to be performed.

APPENDIX F

SCOPE OF REVIEW OF CONSTRUCTION COST ESTIMATE

Scope of Review

The cost consultant retained by the Technical Review Board (TRB) to prepare a review of the SPIR Class C construction cost estimate shall prepare a short report that comments on the following aspects of the SPIR cost estimate:

(a) completeness of cost estimate;
(b) confirmation of cost inclusions and exclusions, as itemized in Appendix E;
(c) overall cost in relation to the type of block, the size of the block floor and the scope of the proposed seismic upgrade;
(d) allowance included for abating hazardous materials;
(e) allowance for associated architectural, mechanical and electrical work;
(f) allowance for General Contractor's overhead and profit;
(g) allowance for design contingency.

Review Report

The short report to be prepared by the cost consultant for the review of the SPIR Class C construction cost estimate shall include the following items:

(a) project name;
(b) project location;
(c) brief project description;
(d) name of cost consultant who prepared the SPIR Class C construction cost estimate;
(e) scope of review;
(f) comments on the review items, as noted above;
(g) document materials provided for the review;
(h) document significant outcomes of the telephone calls and meetings associated with the review;
(i) concluding overall statement confirming the appropriate nature, or otherwise, of the SPIR Class C construction cost estimate.

APPENDIX G

OFCs REQUIREMENTS

INTRODUCTION

This Appendix provides details of the OFC (Operational and Functional Components) requirements that the PDR structural engineer-of-record (EOR) needs to conform to for the satisfactory completion of the PDR. These PDR requirements will be reviewed as part of the TRB review of the PDR.

The OFC requirements are summarized as follows:

(1) Doors

Doors have the potential to jam within their frames for large in-plane shear deformations in the enclosing walls. UBC's Earthquake Engineering Research Facility (EERF) is currently undertaking a testing program to review this issue. By September, 2016, the EERF will make recommendations to the Technical Review Board (TRB) on the appropriate method of addressing doors as a potential at-risk Operational Functional Component (OFC).

In the interim, the TRB recommends that the PDR OFC budgets include the following allowances for doors:

(a) $\$5/m^2$ for one storey blocks;

(b) $\$4/m^2$ for blocks higher than one storey;

(c) $\$3/m^2$ for gymnasiums;

(d) 75% of the above allowances in the project budget and 25% of the above allowances in the risk reserve.

(2) OFCs

The detailed requirements for the OFCs are given below.

A checklist in the form of a spreadsheet is provided to assist the structural EOR in the completion of the OFC data. The completed spreadsheet is a necessary part of the PDR deliverables.

(3) Heavy Partition Walls

Heavy partition walls are excluded from these OFC requirements. Heavy partition walls are included in the scope of the structural retrofit (refer to the current edition of the SRG Guidelines and Commentary).

OFCs

During the PDR phase, for each Block, at the noted school, the structural EOR is to use the attached checklist (or something equivalent), with assistance from the architect, electrical and mechanical engineers, and / or a specialty structural engineer as required, to identify all OFCs, determine any seismic restraint deficiencies, indicate mitigation schemes for the deficiencies, and have a cost estimate prepared. All seismic restraint of the OFCs to meet the requirement per British Columbia Building Code (BCBC 2012) with an importance factor of $I_E = 1.0$. The checklist is to be completed, signed and sealed and attached to the PDR.

The mitigation and seismic restraint shall:

- **Be limited to only those OFCs that are considered a Life Safety risk in both interior and exterior public spaces and / or that affect means of egress both inside the block and immediately outside the block, except as noted below**.
- For gymnasiums only, the OFCs that, if damaged or dislodged, would render the space unoccupiable after the earthquake shall also be considered. (**Note**: gymnasiums are intended to be occupiable as a physical shelter post-earthquake; however, there is no requirement to have power, heat, etc.)

The attached checklist is divided into four sections: Architectural Hazards, Mechanical Hazards, Electrical Hazards, and Furnishings & Building Contents Hazards. A simple example checklist is also attached.

Note: Lateral Deformation Resisting Systems (LDRS), Vertical Non-LDRS Load-Bearing Supports (VLS), and heavy partition walls addressed for Out-of-Plane rocking per SRG3 are excluded.

A reference document is CAN/CSA Standard S832-06 (R2011) – Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings. Table 9 of this standard lists Typical OFC problems and mitigation techniques.

During the PDR phase, it is recommended that the school district and specific school provide maintenance personnel as required to assist the structural EOR (or their designate(s)) on site.

During the detailed design phase, the EOR, with assistance from a specialty structural engineer if required, is to verify completion of the actual mitigation that was performed. The checklist is to be completed, signed and sealed.

Seismic Mitigation of OFCs

District	District Name and #	Block	Block #, Name
School	School Name	Date	mm/dd/yyyy

Architectural Seismic Hazards		PDR Phase		Design/Construction Phase	
Component	Principal Concerns	Deficient Area(s) and Further Comments as Required	Estimated Cost	Actual Mitigation(1)	Site Verified
Unbraced Suspended ceilings	Dropped acoustical tiles, perimeter separation of runners and cross-runners, swinging damage,				
Plaster ceilings	Collapse, local spalling				
Cladding	Falling, damaged panels and connections,				
Ornamentation	Falling				
Plaster and gypsum board partition walls	Cracking, out of plane failure due to inadequate top support				
Demountable partitions	Collapse				
Raised access floors	Collapse, separation between modules				
Recessed light fixtures & HVAC diffusers	Dropping out of suspended ceilings				
Glazing, skylights, Glass elevator enclosures	Breakage, out of plane failure, falling glass, shattering glass				
Doors	Jamming				
Other:	Description:				
		Total Estimated Cost	**$** -	**Actual Cost $**	
		Engineer's Seal Date		Engineer's Seal Date	

(1) Mitigation may refer to tables in CSA-S832-06 (R2011) or to specialty structural engineer specific details.

Table G.1: OFCs – Architectural Seismic Hazards

Seismic Mitigation of OFCs

District	District Name and #	Block	Block #, Name
School	School Name	Date	mm/dd/yyyy

Mechanical and Pumbing Equipment Seismic Hazards		**PDR PHASE**		**Design/Construction Phase**	
Component	**Principal Concerns**	**Deficient Area(s) and Further Comments as Required**	**Estimated Cost**	**Actual Mitigation(1)**	**Site Verified**
Ducts, diffusers, louvers	damage due to relative displacements, falling due to joint failure, stairwell ducts part of fire suppression systems				
Elevators (counterweights, drives and equipment	Dislodged counterweights, falling of drives and panels				
Suspended Equipment (HVAC, fans)	Swinging and Falling				
Equipment on vibration isolators	adequate connections to prevents equipment from falling of isolators				
Floor-mounted, non-isolated equipment	displacement, breakage of connections, overturning, damage to adjacent equipment, explosion or rupture high pressure or high temperature vessels				
Piping, (water, waste water, fire suppression, gas)(2)	Rupture, inoperation or emergency systems				
Other:	Description:				
		Total Estimated Cost $ -		**Actual Cost $**	
		Engineers Seal Date		Engineer's Seal Date	

(1) Mitigation may refer to tables in CSA-S832-06 (R2011) or to specialty engineer specific details.
(2) All these shall have seismic restraint in public spaces and in areas of egress

Table G.2: OFCs – Mechanical and Plumbing Equipment Architectural Seismic Hazards

Seismic Mitigation of OFCs

District	District Name and #	Block	Block #, Name
School	School Name	Date	mm/dd/yyyy

Electrical Equipment Seismic Hazards		PDR PHASE		Design/Construction Phase	
Component	Principal Concerns	Deficient Area(s) and Further Comments as Required	Estimated Cost	Actual Mitigation(1)	Site Verified
Lighting fixtures, emergency lighting	Loss of vertical support, falling, swinging				
Electrical bus ducts, cable trays	Failure due to relative displacements, damage to support framing				
Electrical Racks	Overturning, falling of rack contents				
Electrical generators, motors and transformers	Broken and damaged connections due to relative displacement, overturning of tall units				
Rooftop tele-communication equipment	Falling, failure, sliding of large parabolic antennas, breakage of cables				
Other:	Description:				
		Total Estimated Cost $ -		Actual Cost $	
		Engineers Seal Date		Engineer's Seal Date	

(1) Mitigation may refer to tables in CSA-S832-06 (R2011) or to specialty engineer specific details.

Table G.3: OFCs – Electrical Equipment Seismic Hazards

Seismic Mitigation of OFCs

District	District Name and #	Block	Block #, Name
School	School Name	Date	mm/dd/yyyy

Building Contents Seismic Hazards		PDR PHASE		Design/Construction Phase	
Component	Principal Concerns	Deficient Area(s) and Further Comments as Required	Estimated Cost	Actual Mitigation(1)	Site Verified
Shelving, bookcases, storage racks	Overturning, sliding, falling books and materials				
Room decorations	Large potted plants, heavy sculptures, hanging art pieces etc. falling, sliding, overturning				
Wheel-mounted equipment	Impact with other equipment, blocking egress				
Kitchen equipment	Failure can lead to flooding, gas leaks; spillage can cause severe injuries				
Desk- mounted equipment	Property damage and potential blocking of egress				
Moveable partitions	Misalignment causing the wall to be inoperable, dislodge from track				
Hazardous materials	spills, ruptures, flamable or toxic substances				
Gymnasium - basketball backboard and other ceiling/wall mounted equipment	Falling				
Other:	Description:				
			$ -	Actual Cost $	
		Engineers Seal Date		Engineer's Seal Date	

(1) Mitigation may refer to tables in CSA-S832-06 (R2011) or to specially engineer specific details.

Table G.4: OFCs – Building Contents Seismic Hazards