DEPARTMENT OF FACILITIES MANAGEMENT REQUEST FOR PROPOSALS (OPEN)

FOR

ENGINEERING CONSULTING SERVICES

FOR

PRIMARY DATA CENTRE REPLACEMENT #CSF-004-23

RFP Number: RFP-017-24

Issued: Thursday, May 2, 2024

Submission Deadline: Thursday, May 23, 2024 @ 3:00 PM NDT

<table>
<tr><th colspan="4">Request for Proposal</th></tr>
<tr><td>Title:</td><td colspan="3">Engineering Consulting Services for Primary Data Centre Replacement #CSF-004-23</td></tr>
<tr><td>RFP Number:</td><td>RFP-017-24</td><td>Issue Date:</td><td>Thursday, May 2, 2024</td></tr>
<tr><td>Questions Deadline:</td><td>72 hours prior to close time</td><td>Closing Date and Time:

Proposal Submission Format:

Opening Date & Time:</td><td>Thursday, May 23, 2024 @ 3:00PM NDT

opencalls@mun.ca

Thursday, May 23, 2024 @ 3:00 PM NDT

Via Conference line:
1-416-915-6530 (toll free) Access Code: 2774 275 6846
Attendee ID: Please press Pound(#)</td></tr>
<tr><td colspan="3">Proposals Irrevocable Period after Submission Deadline:</td><td>45 days</td></tr>
<tr><td colspan="4">Proposal Submission: Responses to this solicitation must be submitted by email to opencalls@mun.ca. Email subject line must read: RFP-017-24 Engineering Consulting Services for Primary Data Centre Replacement #CSF-004-23.</td></tr>
<tr><th colspan="4">Inquiries and Communication</th></tr>
<tr><td colspan="4">Inquiries and communication: Strategic Procurement Office, Financial and Administrative Services, Memorial University of Newfoundland, opencalls@mun.ca. Inquiries accepted only via email. No phone calls will be accepted.

Please reference RFP-017-24 Engineering Consulting services for Primary Data Centre Replacement #CSF-004-23in subject line. Emails not containing this requirement information in the subject line will NOT be responded to.

Proposals submitted by fax, mail, courier, drop-off or by any other means of delivery other than by email stated above shall not be accepted.</td></tr>
</table>

ABOUT MEMORIAL UNIVERSITY

As Newfoundland and Labrador's only university, Memorial has a special obligation to the people of this province. Established as a memorial to the Newfoundlanders who lost their lives on active service during the First and Second World Wars, Memorial University draws inspiration from these shattering sacrifices of the past as we help to build a better future for our province, our country and our world.

We are a multi-campus, multi-disciplinary, public university committed to excellence in teaching and learning, research and scholarship, and to public engagement and service. We strive to have national and global impact, while fulfilling our social mandate to provide access to university education for the people of the province and to contribute to the social, cultural, scientific and economic development of Newfoundland and Labrador and beyond.

The Memorial experience goes beyond academics; it invites a discovery of self, community and place. At Memorial, we celebrate our unique identity through the stories of our people – the work of scholars and educators, the ingenuity of students, the achievements of alumni – and the impact we collectively make in the province, the country and the world. Memorial is the natural place where people and ideas become.

Memorial University has more than 18,500 students and 3,600 faculty and staff spread across four campuses and nearly 100,000 alumni active throughout the world. From local endeavors to research projects of national importance, Memorial's impact is felt far and wide.

Mission, Vision and Values

Vision

Memorial University will be one of the most distinguished public universities in Canada and beyond, and will fulfill its special obligation to the people of Newfoundland and Labrador.

Mission

Memorial University is an inclusive community dedicated to innovation and excellence in teaching and learning, research, scholarship, creative activity, service and public engagement. Memorial welcomes and supports students and scholars from all over the world and contributes knowledge and expertise locally, nationally and internationally.

Values

Excellence: Encouraging and promoting excellence through innovation and creativity, rigor and pragmatism.

Integrity: Being honest and ethical in all interactions, maintaining the highest ethical standards in teaching, research, public engagement and service.

Collegiality: Engaging others with respect, openness and trust in pursuit of a common purpose, having regard for individuals, ideals and the institution as a whole.

Inclusiveness and diversity: Embracing and acting on responsibility to guarantee diversity and equity.

Responsiveness: Being receptive to individuals and communities.

Accountability: Accepting responsibility for achievement of common goals and objectives.

Freedom and Discovery: Supporting the freedom to pursue knowledge that is based on individual and collective intelligence, curiosity, ingenuity and creativity.

Recognition: Acknowledging, tangibly, all aspects of university enterprise including teaching and learning, research, scholarship, creative activity and public engagement.

Responsibility to place: Valuing and fulfilling the special obligation to the people of Newfoundland and Labrador by supporting and building capacity for excellence that:

- addresses needs and opportunities for Newfoundland and Labrador;
- engages the university community on matters of national and international significance;
- produces and delivers academic programs of national and international calibre; and,
- Recognizes the dynamic opportunities presented by a multi-campus institution.

Responsibility to learners: Recognizing students as a first priority and providing the environment and support to ensure their academic and personal success.

Interdisciplinary collaboration: Supporting overarching themes in all pursuits that cut across academic units and address significant opportunities and challenges for which Memorial is particularly well positioned to build nationally and internationally recognized capacity.

Sustainability: Acting in a manner that is environmentally, economically and socially sustainable in administration, academic and research programs.

Memorial's exceptional staff and students contribute to the vitality and positive environment of the university through active community engagement. Memorial University has always been a publicly engaged institution. Since the founding of the University in 1949, the work of many of Memorial's students, faculty and staff has emphasized the importance of strong, sustained partnerships with members of the public of Newfoundland and Labrador and beyond.

Faculty and Staff

Memorial is one of the largest employers in the province, with approximately 3,600 faculty and staff. Memorial has been recognized as an Employer of Distinction by the Newfoundland and Labrador Employers' Council, which is reflective of its investment in comprehensive benefits, services such as childcare and recreation facilities, emphasis on work-life balance, and its vibrant work environment.

Governance and Administration

The management, administration and control of the property, revenue, business and affairs of the University are vested in a Board of Regents. The Board is appointed under the *Memorial*

University Act and is responsible for the management, administration, and control of the property, revenue, business and affairs of the university. Matters of an academic character are in general charge of the Senate of the University.

For more information on Memorial University of Newfoundland, please

visit: Memorial home page: http://www.mun.ca/

Land Acknowledgement

We respectfully acknowledge the territory on which we gather as the ancestral homelands of the Beothuk, and the island of Newfoundland/ Ktaqmkuk as the ancestral homelands of the Mi'kmaq and Beothuk. We would also like to recognize the Inuit of Nunatsiavut and NunatuKavut and the Innu of Nitassinan, and their ancestors, as the original people of Labrador. We strive for respectful relationships with all the peoples of this province.

PART 1 – SUBMISSION INSTRUCTIONS

1.1 Proposals to be Submitted on Time

Proposals must be submitted as set out above on or before the Submission Deadline. Proposals submitted after the Submission Deadline will be rejected. Onus and responsibility rests solely with the proponent to submit its Proposal to the email indicated in the Request for Proposal on or before the Submission Deadline. The Owner does not accept any responsibility for any proposals submitted by means other than the email listed above. Proponents making submissions near the deadline do so at their own risk due to server availability. The time for the closing will be determined according to the inbox time stamp on opencalls@mun.ca . Proposals received after the closing time based on this time stamp, will NOT be considered.

1.2 Proposals to be Submitted in Prescribed Format

Proponents should submit **One (1)** email submission as a single file in PDF format. Please note: File size cannot exceed 15 MB. Otherwise server may reject proposal submission due to size. Proposals submitted by fax, mail, courier, drop off or by any other means of delivery other than by email stated above shall not be accepted.

1.3 Amendment of Proposals

Proponents may amend their Proposals after they have been submitted if, and only if, the amendment is emailed prior to the Submission Deadline marked PROPOSAL SUBMISSION AMENDMENT followed by **RFP-017-24 Engineering Consulting Services for Primary Data Centre Replacement CSF-004-23.** Proposal revisions, changes and alterations may be made only by completing a new proposal. Previous submissions will be cancelled and the submission with the most recent date and time will be considered the final proposal.

Email inquiries and requests for clarification shall be accepted up to **72 hours** prior to the closing time. Inquiries and requests for clarification received after this date shall not be addressed. The Strategic Procurement Office will be the only official source of information regarding this Open Call for Proposals and information from any other source shall be considered unofficial and may not be correct.

To ensure consistency and quality in the information provided to Proponents the Owner shall provide, by way of amendment to this request for proposals in the form of an addendum, any relevant information with respect to the Request for Proposal inquiries received in writing without revealing the source of those inquiries. Proponents are cautioned that it is their responsibility to ensure that they receive all information relevant to this Request for Proposal. The Owner shall not be responsible for Proponents who fail to inform themselves regarding the scope and nature of the work. The Owner shall publish all amendments on Memorial University's website at https://www.mun.ca/finance/strategic_procurement/ or current service providers: MERX: www.merx.com, Bids: www.bids.ca and PODS: www.pods.net .Proponents should check on a regular basis for Request for Proposal updates. Proponents are solely responsible for ensuring they are aware of and have complied with all amendments by proposal submission closing time**.** **In the event there is discrepancy between the service providers, MERX, Bids, and PODS and the https://www.mun.ca/finance/strategic_procurement/ website, the official website is https://www.mun.ca/finance/strategic_procurement.** Proponents are welcome to register their email address through opencalls@mun.ca to receive addendum notifications from Open Calls as a matter of courtesy. This does not relieve any Proponent of their responsibility to ensure all addenda has been received.

1.4 Withdrawal of Proposals

Proponents may withdraw their Proposals prior to the Submission Deadline. To withdraw a Proposal, a notice of withdrawal must be sent to the opencalls@mun.ca prior to the Submission Deadline and must be signed by an authorized representative of the Proponents. The Owner is under no obligation to return withdrawn Proposals.

1.5 Proposals Irrevocable after Submission Deadline

Proposals shall be irrevocable for a period of **45** days running from the moment that the Submission Deadline passes.

1.6 Delivery

Delivery of all materials and services must be DAP (delivered at place) or DDP (delivered duty paid (all locations) and local environs.

1.7 Signature

Memorial University, in consideration of section 11 of the Electronic Commerce Act, confirms its acceptance of electronic signatures, or other acceptable form of electronic consent, in satisfaction of the signature requirement for proposal submissions. The electronic form of signature or consent must be directly related to the relevant proposal submission at issue and must be reliable, in a manner as determined by Memorial University, for the purpose of identifying the person submitting the proposal response. By submitting a proposal under this process, the proponent confirms that the signatory has the appropriate and proper authority to bind the proponent to its submission, a confirmation upon which Memorial University relies in the processing of the proposal submission. **Proponents must complete Appendix B – Submission Form. Proposals received without Appendix B completed will be deemed non- compliant.**

1.8 Closure

In the event that the University is closed earlier than normally expected prior to a scheduled Request for Proposal closing for that day, or for the full day, the closing date for those Request for Proposal will be extended to the next business day for the University at the same time as listed originally.

1.9 Corporations Act

The Corporations Act of Newfoundland and Labrador requires that an extra-provincial company be registered before it begins or carries on business in the Province. If your company is not registered, please apply for the appropriate forms and procedures to:

Commercial Registrations Division
Department of Government Services
PO Box 8700
St John's, NL Canada A1B 4J6
Phone: 709-729-3317, Fax: 709-729-0232
Website: http://www.gs.gov.nl.ca/registries/companies/corp_art_inc.html

[End of Part 1]

PART 2 – EVALUATION AND AWARD

2.1 Stages of Evaluation

The Owner will conduct the evaluation of Proposals in the following stages:

2.2 Stage I – Mandatory Submission Requirements

Stage I will consist of a review to determine which Proposals comply with all of the mandatory submission requirements. Proposals that do not comply with all of the mandatory submission requirements as of the Submission Deadline will, subject to the express and implied rights of the Owner, be disqualified and not evaluated further. The submission form (**Appendix B**) must be completed. Submission without **Appendix B completed will be disqualified.**

2.3 No Amendment to Forms

Other than inserting the information requested on the mandatory submission forms set out in the Request for Proposal, a Proponent may not make any changes to any of the forms. Any Proposal containing any such changes, whether on the face of the form or elsewhere in the Proposal shall be disqualified.

Stage II will consist of the following:

2.4 Mandatory Technical Requirements

The Owner will review the proposals to determine whether the mandatory technical requirements as set out in **Appendix A** been met. Proposals that do not comply with all of the mandatory technical requirements will, subject to the express and implied rights of the Owner, be disqualified and not evaluated further.

2.5 Rated Criteria

The Owner will evaluate each qualified proposal on the basis of the rated criteria set out in **Appendix C.**

2.6 Selection of Proponent

After the completion of Stage II proponents will be ranked based on their total scores, all scores from will be added together and proponents will be ranked based on their total scores. Subject to the reserved rights of the Owner, the top-ranked proponent may be selected to enter into the Agreement in accordance with the following section.

Provincial suppliers, suppliers with a place of business in Newfoundland and Labrador, will be given provincial supplier preference provision. This mandates an allowance of ten percent for provincial suppliers for all procurement below trade agreement thresholds.

Please note, the supplier preference does not apply when the estimated value of the commodity is above the trade agreement threshold shown below.

Public Body	Thresholds			
	Goods	Services	Public Works	Lease of Space
Memorial University	$133,800	$133,800	$334,400	$100,000

2.7 Notification

Notice of selection by the Owner to the preferred supplier(s) shall be in writing.

2.8 Failure to Enter into Agreement

If a preferred supplier fails to satisfy the pre-conditions of award within fifteen (15) days of notice of selection, the Owner may, without incurring any liability, proceed with the selection of another proponent and pursue all remedies available to the Owner

2.9 Payment Terms

The University's standard payment terms are net 30 days after delivery of goods, or net 15 days after successful completion of installation as applicable. In the case of services, payment terms are also net 30 days after successful completion of the service. These terms shall also apply in the case of sub- contracted items. Prepayments will not be considered unless the supplier provides an irrevocable standby letter of credit, or the supplier provides a credit reference from its banker satisfactory to the Director of Financial and Administrative Services.

[End of Part 2]

PART 3 – TERMS AND CONDITIONS OF THE OPEN CALL PROCESS

3.1 Incorporated into Proposal

All of the provisions of this Request for Proposal are deemed to be accepted by each Proponent and incorporated into each Proponents' Proposal. A Proponent who submits conditions, options, variations or contingent statements to the terms as set out in this Request for Proposal, either as part of its Proposal or after receiving notice of selection, unless otherwise indicated, may be disqualified. If a Proponent is not disqualified despite such changes or qualifications, the provisions of this Request for Proposal, including any agreement set out in will prevail over any such changes or qualifications in the Proposal.

3.2 Proponents to Follow Instructions

Proponents should structure their Proposals in accordance with the instructions in this Request for Proposal. Where information is requested in this Request for Proposal, any response made in a Proposal should reference the applicable section numbers of this Request for Proposal.

3.3 Proposals in English

All Proposals are to be in English only.

3.4 No Incorporation by Reference

The entire content of the Proponent's Proposal should be submitted in a fixed form, and the content of websites or other external documents referred to in the proponent's Proposal but not attached will not be considered to form part of its Proposal.

3.5 References and Past Performance

In the evaluation process, the Owner may include information provided by the Proponents references and may also consider the Proponents past performance or conduct on previous contracts with the Owner or other institutions.

3.6 Information in Request for Proposal Only an Estimate

The Owner and its advisers make no representation, warranty or guarantee as to the accuracy of the information contained in this Request for Proposal or issued by way of addenda. Any quantities shown or data contained in this Request for Proposal or provided by way of addenda are estimates only, and are for the sole purpose of indicating to Proponents the general scale and scope of the Deliverables. It is the Proponents' responsibility to obtain all the information necessary to prepare a Proposal in response to this Request for Proposal.

3.7 Proponents to Bear Their Own Costs

The Proponent will bear all costs associated with or incurred in the preparation and presentation of its Proposal, including, if applicable, costs incurred for interviews or demonstrations.

3.8 Proposal to be Retained by the Owner

The Owner will not return the Proposal or any accompanying documentation submitted by a Proponent.

3.9 Trade Agreements

Proponents should note that procurements falling within the scope of the Canadian Free Trade Agreement and/or the Canada-European Union Comprehensive Economic Trade Agreement are subject to those trade agreements but that the rights and obligations of the parties will be governed by the specific terms of this Request for Proposal.

3.10 No Guarantee of Volume of Work or Exclusivity of Contract

The Owner makes no guarantee of the value or volume of work to be assigned to the successful Proponent.

3.11 Proponent to Review Request for Proposal

Proponents shall promptly examine all of the documents comprising this Request for Proposal, and

(a) shall report any errors, omissions or ambiguities; and

(b) may direct questions or seek additional information

in writing by email to the Request for Proposal contact on or before the Deadline for Questions. All questions or comments submitted by Proponents by email to the Contact shall be deemed to be received once the email has entered into the contact's email inbox. No such communications are to be directed to anyone other than the Request for Proposal Contact, and the Owner shall not be responsible for any information provided by or obtained from any source other than the Request for Proposal Contact. The Owner is under no obligation to provide additional information. It is the responsibility of the Proponent to seek clarification from the Request for Proposal Contact on any matter it considers to be unclear. The Owner shall not be responsible for any misunderstanding on the part of the Proponents concerning this Request for Proposal or its process.

3.12 All New Information to Proponents by Way of Addenda

This Request for Proposal may be amended only by addendum in accordance with this section. If the Owner, for any reason, determines that it is necessary to provide additional information relating to this Request for Proposal, such information will be communicated to all Proponents by addenda. Each addendum forms an integral part of this Request for Proposal and may contain important information, including significant changes. Proponents are responsible for obtaining all addenda issued by the Owner. In the Submission Form **(Appendix B)**, Proponents shall confirm their receipt of all addenda by setting out the number of each addendum in the space provided. Proponents who **fail** to acknowledge all posted addenda will be deemed non-compliant and disqualified.

3.13 Addenda and Extension of Submission Deadline

Any addendum added within four (4) calendar days of the Request for Proposals closing (Including on closing day) will extend closing by a reasonable period to be determined by Memorial University

3.14 Verify, Clarify and Supplement

When evaluating Proposals, the Owner may request further information from the Proponent or third parties in order to verify, clarify or supplement the information provided in the Proponent's Proposal. The response received by the Owner shall, if accepted by the Owner, form an integral part of the Proponent's Proposal.

3.15 Notification to Other Proponents

In accordance with section 30 of the *Public Procurement Regulations*, once the Agreement is awarded by the Owner, the outcome of the Request for Proposal will be publicly posted at Public Procurement Agency Website.

3.16 Debriefing

Unsuccessful Proponents may request a debriefing within ten (10) business days after the award has been posted. The request must be sent in writing to the Request for Proposal Contact. The intent of the debriefing information session is to aid the Proponent in presenting a better Proposal in subsequent procurement opportunities. The debriefing process is not for the purpose of providing an opportunity to challenge the procurement process or its outcome.

3.17 Supplier Complaint Process

If a Proponent wishes to register a complaint with respect to the Request for Proposal process, it should provide it in writing and within the parameters established by section 25 of the *Public Procurement Regulations*, as amended. The notice must provide a detailed explanation of the Proponent's concerns with the procurement process or its outcome, in addition to such other information as may be required by the *Regulations.* Proponents should note that these complaint procedures are separate and distinct from any dispute resolution processes that may be provided for under applicable trade agreements. If a Proponent wishes to dispute a matter under an applicable trade agreement, the Proponent must follow the process set out in the trade agreement.

3.18 Conflict of Interest

The Owner may disqualify a Proponent for any conduct, situation or circumstances, determined by the Owner, in its sole and absolute discretion, to constitute a conflict of interest.

The Owner reserves the right to disqualify any Proponent that in the Owner's sole opinion has an actual or potential conflict of interest or an unfair advantage, or may permit the Proponent to continue and impose such terms and conditions, as the Owner in its sole discretion may require.

For the purposes of this Request for Proposal, the term "Conflict of Interest" includes, but is not limited to, any situation or circumstance where in relation to the Request for Proposal process, the Proponent has an unfair advantage or engages in conduct, directly or indirectly, that may give it an unfair advantage, including but not limited to: (i) having, or having access to, confidential information of the Owner in the preparation of its Proposal that is not available to other

Proponents, (ii) communicating with any person with a view to influencing preferred treatment in the Request for Proposal process (including but not limited to the lobbying of decision makers involved in the Request for Proposal process), or (iii) engaging in conduct that compromises, or could be seen to compromise, the integrity of the open and competitive Request for Proposal process or render that process non-competitive or unfair.

Proponents are required to disclose, to the Request for Proposal Contact, any potential or perceived conflict of interest issues prior to Request for Proposal closing date and time.

3.19 Disqualification for Prohibited Conduct

The Owner may disqualify a Proponent, rescind a notification of selection or terminate a contract subsequently entered into if the Owner determines that the Proponent has engaged in any conduct prohibited by this Request for Proposal.

3.20 Proponents Not to Communicate with Media

Proponents must not at any time directly or indirectly communicate with the media in relation to this Request for Proposal or any agreement entered into pursuant to this Request for Proposal without first obtaining the written permission of the Request for Proposal Contact.

3.21 No Lobbying

Proponents must not, in relation to this Request for Proposal or the evaluation and selection process, engage directly or indirectly in any form of political or other lobbying whatsoever to influence the selection of the successful Proponent(s).

3.22 Illegal or Unethical Conduct

Proponents must not engage in any illegal business practices, including activities such as Proposal-rigging, price-fixing, bribery, fraud, coercion or collusion must not engage in any unethical conduct, including lobbying, as described above, or other inappropriate communications; offering gifts to any employees, officers, agents, elected or appointed officials or other representatives of the Owner; deceitfulness; submitting Proposals containing misrepresentations or other misleading or inaccurate information; or any other conduct that compromises or may be seen to compromise the competitive process provided for in this Request for Proposal.

3.23 Past Performance or Past Conduct

The Owner may prohibit a supplier from participating in a procurement process based on past performance or based on inappropriate conduct in a prior procurement process, including but not limited to the following:

(a) illegal or unethical conduct as described above;

(b) the refusal of the supplier to honour submitted pricing or other commitments; or

(c) any conduct, situation or circumstance determined by the Owner, in its sole and absolute discretion, to have constituted a Conflict of Interest.

In addition, the Owner may suspend the proposal privileges of a supplier in regard to non-compliant or substandard performance in accordance with section 26 of the *Public Procurement Regulations*.

3.24 Confidential Information of the Owner

All information provided by or obtained from the Owner in any form in connection with this Request for Proposal either before or after the issuance of this Request for Proposal:

(a) is the sole property of the Owner and must be treated as confidential;

(b) is not to be used for any purpose other than replying to this Request for Proposal and the performance of the Agreement;

(c) must not be disclosed without prior written authorization from the Owner; and

(d) must be returned by the Proponent to the Owner immediately upon the request of the Owner.

3.25 Confidential Information of Proponents

This procurement process is subject to the *Access to Information and Protection of Privacy Act, 2015* (*ATIPPA, 2015*). A Proponent must identify any information in its Proposal or any accompanying documentation supplied in confidence for which confidentiality is requested to be maintained by the Owner. The confidentiality of such information will be maintained by the Owner, except as otherwise required by law or by order of a court or tribunal. Proponents are advised that their Proposal will, as necessary, be disclosed, on a confidential basis, to advisers retained by the Owner to advise or assist with the Request for Proposal process, including the evaluation of Proposals.

The Proponent agrees that any specific information in its submission that may qualify for an exemption from disclosure under subsection 39(1) of the *ATIPPA, 2015* has been identified in its submission. If no specific information has been identified it is assumed that, in the opinion of the Proponent, there is no specific information that qualifies for an exemption under the subsection 39(1) of the *ATIPPA, 2015*.

Contracting with the Owner is a public process. Information provided through this process will be disclosed when requested under the *ATIPPA, 2015*, except where disclosure of that information is harmful to the business' interests, as set out in the three-part test in the *ATIPPA, 2015*.

Information, including the financial value of a contract resulting from this procurement process, will be publicly released as part of the award notification process, in accordance with section 30 of the *Public Procurement Regulations*.

If a Proponent has any questions about the collection and use of personal information pursuant to this Request for Proposal, questions are to be submitted to the Request for Proposal Contact. Further information relating to subsection 39(1) of the ATIPPA, 2015 is provided in guidance documents available through the Office of the Information and Privacy Commissioner at https://oipc.nl.ca/guidance/documents.

3.26 Reserved Rights of the Owner

The Owner reserves the right to:

(a) make public the names of any or all Proponents as well as Proposal price and value of contract;

(b) make changes, including substantial changes, to this Request for Proposal provided that those changes are issued by way of addendum in the manner set out in this Request for Proposal;

(c) request written clarification or the submission of supplementary written information in relation to the clarification request from any Proponent and incorporate a Proponent's response to that request for clarification into the Proponent's Proposal. This shall not be an opportunity for Proposal repair;

(d) assess a Proponent's Proposal on the basis of: (i) a financial analysis determining the actual cost of the Proposal when considering factors including quality, service, price and transition costs arising from the replacement of existing goods, services, practices, methodologies and infrastructure (howsoever originally established); and (ii) in addition to any other evaluation criteria or considerations set out in this Request for Proposal, consider any other relevant information that arises during this Request for Proposal process;

(e) waive formalities and accept Proposals that substantially comply with the requirements of this Request for Proposal;

(f) verify with any Proponent or with a third party any information set out in aProposal;

(g) check references other than those provided by any Proponent;

(h) disqualify a Proponent, rescind a notice of selection or terminate a contract subsequently entered into if the Proponent has engaged in any conduct that breaches the process rules or otherwise compromises or may be seen to compromise the competitiveprocess;

(i) cancel this Request for Proposal process at any stage;

(j) cancel this Request for Proposal process at any stage and issue a new Request for Proposal for the same or similar deliverables;

(k) accept any Proposal in whole or in part; or

(l) reject any or all Proposals;

and these reserved rights are in addition to any other express rights or any other rights that may be implied in the circumstances.

3.27 Limitation of Liability

By submitting a Proposal, each Proponent agrees that:

(a) neither the Owner nor any of it employees, officers, agents, elected or appointed officials, advisors or representatives will be liable, under any circumstances, for any claim arising out of this Request for Proposal process including but not limited to costs of preparation of the Proposal, loss of profits, loss of opportunity or for any other claim; and

(b) the Proponent waives any right to or claim for any compensation of any kind whatsoever, including claims for costs of preparation of the Proposal, loss of profit or loss of opportunity by reason of the Owner's decision not to accept the Proposal submitted by the Proponent, to enter into an agreement with any other Proponent or to cancel this open call process, and the Proponent shall be deemed to have agreed to waive such right orclaim.

3.28 Governing Law and Interpretation

These Terms and Conditions of the Request for Proposal Process (Part 3):

(a) are intended to be interpreted broadly and independently (with no particular provision intended to limit the scope of any other provision);

(b) are non-exhaustive and shall not be construed as intending to limit the pre-existing rights of the Owner; and

(c) are to be governed by and construed in accordance with the laws of the Province of Newfoundland & Labrador and the federal laws of Canada applicable therein.

3.29 Facility Compliance Requirement

(a) Equipment, power tools, instruments and appliances intended for use within Memorial University's facilities must comply with all regulatory requirements related to use and/or installation in University facilities. This includes but is not limited to certification/listing by recognized agencies, Pressure Vessel Act of Newfoundland and Labrador and similar.

(b) Items provided related to this open call that receive power from the University's electrical system must be certified or listed for use within Canada by a recognized agency such as Canadian Standards Association (CSA) or Underwriter Laboratories Canada (ULC). A full list of agencies recognized by Memorial University is available upon request.

(c) Equipment, tools, instruments and appliances that generate pressure may require registration as a pressure system with the Province of Newfoundland and Labrador. Compliance with the Boiler, Pressure Vessel and Compressed Gas Regulations under the Public Safety Act of Newfoundland and Labrador and the Boiler, Pressure Vessel, and Pressure Piping Code CSA B51:19 shall be demonstrated.

The vendor is responsible for all costs associated with ensuring the system is compliant with legislative requirements and for the application and registration processes. Field certifications may be considered but all costs and efforts for such scenarios are the responsibility of the vendor.

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APPENDIX A – SPECIFICATIONS & SCOPE

Background

Memorial University's Office of the Chief Information Officer (OCIO) operates two data centres: The primary data centre, which is for Memorial University and ACENET, is located in the Henrietta Harvey (Mathematics) building, and a secondary data centre is located in the Engineering & Applied Sciences building. The OCIO delivers the University's enterprise services (networks, communications, internet, wireless, enterprise applications, storage, backups, etc.) and most other IT services through both the Henrietta Harvey and Engineering data centres.

Henrietta Harvey has been Memorial University's primary data centre since the 1980s and, as an aging facility, has been experiencing issues such as floor load and raised floor tiles giving way, water due to aging/leaking pipes, aging electrical and many of the key environmental controls needing review/replacement (universal power supplies, roof chillers, air conditioning units). There have been ongoing maintenance and repair efforts to reduce the risks within the Henrietta Harvey data center, however, these are costly and not long-term solutions.

Various options/locations for the new primary data centre have been considered and assessed, which included a new, standalone building and renovations/fit-ups in Henrietta Harvey, Science Building Block A and Core Science Facility (CSF) Level 5 and Level 1. Ultimately, a footprint in CSF Level 1, Pavilion A, which is currently shell space, was selected as the preferred option. A Concept Design Report for this option has since been completed and was accepted in April 2024 by both OCIO and the Department of Facilities Management (FM).

Through this RFP process, a consultant will be engaged for the provision of services identified herein.

Scope of Project

To provide architectural, engineering, consulting and contract administration services for the design and construction of a new primary data centre, located on Level 1, Pavilion A in CSF (currently shell space). The general scope of this engagement will be to build on the existing CSF Data Centre Concept Design Report and deliver/provide: a design development package, detailed design documents for tender, tendering support services, contract administration and commissioning, as detailed in the Scope of Services Summary (Table 1).

The scope of the CSF Data Centre Concept Design Report was to establish the following:

- Functional space program
- Review of potential location on Level 1, including advantages and disadvantages
- Concept outline and floor plan
- Class D Construction cost estimate
- Anticipated infrastructure and ancillary systems to support the facility and its redundancies required to provide a minimum Tier II, maximum Tier III facility.

The concepts supporting the design, are as follows:

- Minimum Tier II, Maximum Tier III facility (See Appendix J)

    - A Tier II Data Centre has a single path for power and cooling and some redundant and backup components. It has an expected uptime of 99.741% (22.6 hours of downtime annually).
    - A Tier III Data Centre has multiple paths for power and cooling and systems in place to update and maintain it without taking it offline. It has an expected uptime of 99.982% (1.6 hours of downtime annually).
- Accommodate cabinets:
    - The estimated cabinet capacity based on the available area and required function is 30 (depending on final layout and density, as below).
    - The expectation is that most cabinets will be of a medium server density, which will enable a reduction in the overall cabinet footprint. We also understand that research users may utilize higher server density cabinets.
- Local Electronic Safety and Security measures. Lockable cabinets may be required for security purposes.
- Environmental monitoring of spaces, electrical and mechanical infrastructure via the University's Building Automation System.
- Operational space to include an adjacent staging area.
- Emergency power to support the Data Centre infrastructure. Two new exterior packaged generator units with built-in fuel tanks, exhaust and ventilation systems will likely be the most viable option to provide emergency power to the facility. The generators will provide emergency power to critical data centre equipment and associated cooling during power outages and will provide power to two automatic transfer switches. The generators will be sized to accommodate the initial load plus additional growth capacity. Each unit will be capable of sustaining the entire data Centre load, providing 100% emergency power redundancy.
- Connection to the CSF data centre normal power supply with independent generator, transfer switch and dual Uninterruptable Power Supplies.
- The proposed fire protection approach is a double interlock pre-action sprinkler system fed from the existing building wet pipe sprinkler system. Due to the mission critical nature of the facility, further protection is deemed to be required, and it is recommended that a water mist system be considered for this aspect. Space has been allocated within the conceptual plans to accommodate a pre-action system coupled with an early response water mist system.
- In order to provide acceptable indoor air quality with the data centre, the space will be provided with basic fresh air ventilation from the base building HVAC system. The data centre, UPS, and staging spaces will be provided with VAV boxes connected to the air handling systems to deliver the prescribed amount of outside air required for occupant comfort and wellbeing. The base building HVAC system will not provide cooling for the data centre.
- The proposed critical cooling solution for the data centre includes the use of 8 x Vertiv CR035A in-row refrigerant based cooling units providing N+1 redundancy. The proposed system will have a supply of 245kW of system cooling capacity with the critical cooling load expected to be 216kW.
- Humidification will be required within the in-row cooling units.
- The UPS room will be provided with a refrigerant-based split air conditioning system appropriate for critical cooling use. Two equal duty ceiling-mounted fan coil type air conditioners (Vertiv Mini-Mate3 design basis) are proposed in order to accommodate the space cooling load and provide 100% cooling redundancy. The capacity is yet to be determined based on UPS cooling load. A remote outdoor condenser will be provided for each indoor fan coil and is proposed to be located on the north side of the building as indicated on the conceptual plans.
- The data centre cabinet layout is arranged on the conceptual plans in a hot aisle-cold aisle arrangement, with the cold aisle being located between the server

cabinets. Aisle containment involves enclosing the cold aisle with doors on the ends of the aisle and a roof (optional) over top of the aisle.
- Industry standards compliant, such as ISO, ANSI, ASHRAE, TIA and BICSI.

The concept design report allowed for the following mechanical and electrical system redundancies:

System	Redundancy	Tier Equivalency
Normal Power (utility)	N	II
Emergency Power (generators)	N+1	II
UPS Power	N+1	III
Data Centre Cooling	N+1	III

The following should also be consideration in response to this RFP/during detailed design:

- Time is of the essence to complete the design phase and produce tender ready documents and a Class A estimate.
- Aesthetically pleasing solutions need to be developed for exterior equipment related to the axillary systems, such as the emergency generators and condensers. A proposed location for the generators and condensers are shown in the concept design sketches (Appendix I), however alternate locations will need to be provided and assessed during design development.
- Existing structural steel (V-shaped bracing) near the south end of the data centre was not illustrated on the concept plan and needs to be accommodated in the final layout and will influence the location of the entry door to any planned data centre.
- There is also an elevated ‘mezzanine’ level services platform / catwalk that has vertical column supports, which will need to be encapsulated, near the planned entrance.
- There’s an adjacent Freight Elevator serving the levels about and suitable approach space in front of this feature will need to be maintained.
- The existing sprinkler main for the building passes over the proposed location, and this risk will need to be managed and accommodated in the Data Centre wall and roof assemblies as this project is developed.
- The new Data Centre will require FRR construction, and consideration regarding a clean agent suppression system with associated engineering and space for storage.
- The egress and path of travel from the Data Centre, and for future tenants of the residual ground floor space, must be holistically planned as part of a masterplan for this space with the required emergency, lighting and directional signage.
- Design and constructability for working within the CSF with respect to zero energy isolation procedures, fire and life safety system operations, dust controls, floor penetrations, etc.
- The CSF is an occupied building, and disruptions to areas adjacent to and above Level 1, Pavilion A are to be kept to a minimum and eliminated wherever possible.
- The successful consultant team will be expected to consult and work in depth with both FM and the OCIO throughout the duration of this project.
- Equipment with long lead times may require a separate tendering package to minimize construction timeline and delays.

Concept design sketches and the concept Electrical Riser Diagram from the report are provided in Appendix I. Please note that the Electrical Riser Diagram is a concept design and may require additional components to satisfy redundancy requirements. The report in full will be provided to the successful proponent.

Additional consulting and/or contract administration services may be required and will be completed on a per diem basis. **Please submit a schedule of rates with your proposal**.

The University will provide any and all existing building drawings on file.

Form of Agreement

The form of agreement can be found in **Appendix G – Department of Facilities Management Consultants Services Agreement** of this document.

Prime Consultant's Summary of Services

Table 1: Scope of Services Summary summarizes and amends the Scope of Services for the engagement:

TABLE 1: SCOPE OF SERVICES SUMMARY

Section		**Included**
3.1	General Principles	☒
3.2	Additional Services	☒
3.3	Work Schedule	☒
3.4	Cost Control	☒
3.5	Sub-Consultants	☒
3.6	Functional Programming Development and Advisory Services	☐
3.7	Concept Design (Includes Schematics)	☐
3.8	Design Development	☒
3.9	Construction Contract Documents	☒
3.10	Bidding and Construction Contract Award	☒
3.11	Construction Contract Administration	☒
3.12	Resident Supervision (Additional Services)	☐
3.13	Insurance	☒
Conditions/Amendments		
3.10	- Preparation of tender documents and addenda by Consultant; issuing of tender documents and addenda by the Owner.	
3.11	- Consultant team will be expected to chair bi-weekly design meetings with the Owner's project team throughout the design phase. This cost will be part of the LS Fee. - Consultant team will be expected to attend bi-weekly construction meetings with the Owner's project team and general contractor throughout the construction phase. This cost will be part of the LS Fee.	

	Include the following subsections only: (g) – Preparation of Change Orders by Consultant, issuance by MUN; (h) – Recommend to the Owner the amounts owing to the Contractor under the Contract based on the Consultant's observations and evaluation of the Contractor's application for payment; (i) – Transcribe "as-built" information from the Project, as provided by the Contractor, to the original drawings, provide a set of such documents to the Owner in electronic format acceptable to the Owner. The cost of the Consultant's staff in the preparation of the as-built reproducible information will be part of the Fee; (j) – Organize, through the Contractor, a complete commissioning of all the components of the Project to determine that the various parts are operating in the manner as intended by the Contract Documents. The Substantial Performance Certificate will not be issued until the final commissioning of the work has been successfully completed and so certified by the Consultant; (k) – Upon achievement of Substantial Performance by the Contractor prepare, sign and deliver to the Owner the Substantial Performance Certificate. Prior to issuance of such Substantial Performance Certificate, the Consultant shall ensure that the Owner has been provided with all Deliverables related to the Contract and shall provide any remaining Deliverables forthwith including, without limitation, a complete set of the contract drawings revised to record all changes "as-builts"; (l) – Upon achievement of Total Performance by the Contractor (including the rectification of any deficiencies), prepare a Total Performance Certificate for issuance to the Contractor. The Total Performance Certificate, in order to be valid, will require the signature of the Consultant, the Contractor and the Owner.

Deliverables

See *Table 4: Scope of Services Deliverables Acknowledgement* in **Appendix B – Submission Form**.

Concept Parameters

As described but not limited to the following:

1. Develop in accordance with current building design and code standards, including, but not limited to:

   A. National Building Code
   B. Barrier Free Access
   C. Washroom Design
   D. Life Safety
   E. Canadian Electrical Code
   F. Telecommunications Distribution Methods Manual (TDMM)
   G. Telecommunication Industry Association's (TIA) "ANSI/TIA-942 Telecommunication Infrastructure Standards for Data Centre"
   H. ANSI/BICSI 002-2019 Data Center Design Standard
   I. BICSI 009-2019 Data Center Operations and Maintenance Best Practices
   J. Uptime Institute's Data Centre Site Infrastructure TIER Standard: Topology
   K. Uptime Institute's Operational Sustainability Standard

2. All existing Memorial University standards to be reviewed and incorporated into the design package where applicable, including but not limited to:

   A. Memorial University Point Naming Conventions (Honeywell EBI)
   B. Memorial University Electrical Panel Color Code Panels
   C. Facilities Management Color Pallet Standard
   D. Memorial University Title Blocks (AutoCAD)
   E. Memorial University Interior Signage Manual 1.0
   F. MUNet Specification (Communications)
   G. Zero Energy Isolation Program
   H. Furniture Standard Level of Acceptance, where applicable.
   I. Space Management Standards and Guidelines

Above documents/templates will be made available to the successful Proponent after contract award, unless requested otherwise;

3. All existing reports to be reviewed and incorporated into the design where necessary, including but not limited to:

   A. RJ Bartlett Engineering Ltd. CSF Design Development Building Code Analysis **(see Appendix K)**
   B. CSF Data Centre Concept Design Report (full report will be provided to the successful proponent)

4. If available, Core Science Facility as-built drawings (in .dwg format) will be made available to the successful Proponent upon request; However, the proponent is to validate its accuracy with physical site visits;

5. Proponents should be prepared to interview end users for specific user requirements including room, programming and furniture layouts;

6. The Proponent should note that all design finishes, materials, fixtures and furnishing throughout the building shall be incorporated into this fit up plan. This will include but not limited to washrooms, electrical design, mechanical design and

architectural design details;

7. The Proponent is expected to ensure access to existing services is maintained and incorporated into the design. Allow allowances for relocations where necessary;

<u>Project Construction Budget:</u>

The Proponent is hereby notified that the project construction budget does not represent a figure against which a percentage of fees should be set. The Owner specifically requires the fee to be based on a level of effort and no additional fee shall be requested or paid as a result of construction cost escalation.

The Proponent is advised of their responsibilities under Section 3.4 of the Consultant's Services Agreement Terms and Conditions **(see Appendix G)**, where so engaged, and their requirement to complete the services within the construction cost budget.

APPENDIX B – SUBMISSION FORM

<u>Proponent's Information</u>

Please complete *Table 2: Proponent's Information*:

TABLE 2: PROPONENT'S INFORMATION

Please fill out the following form, naming one person to be the Proponent's contact for the Open Call process and for any clarifications or communication that might be necessary	
Full Legal Name of Proponent:	
Any Other Relevant Name under which Proponent Carries on Business:	
Street Address:	
City, Province/State:	
Postal Code:	
Phone Number:	
Company Website (if any):	
Proponent's Contact Name and Title:	
Proponent's Contact Phone:	
Proponent's Contact Email:	

<u>Offer</u>

The Proponent has carefully examined the Open Call documents and has a clear and comprehensive knowledge of the Deliverables required under the RFP. By submitting a Proposal, the Proponent agrees and consents to the terms, conditions and provisions of the RFP, including the Form of Agreement, and offers to provide the Deliverables in accordance therewith at the rates set out in the pricing section.

<u>Rates</u>

The Proponent has submitted its rates in accordance with the instructions in the RFP. The Proponent confirms that it has factored all the provisions of **Appendix A – Specifications & Scope**, including insurance and indemnity requirements, into its pricing assumptions and calculations.

<u>Addenda</u>

The Proponent is deemed to have read and accepted all addenda issued by the Owner. The onus is on Proponents to make any necessary amendments to their Proposals based on the addenda. The Proponent is required to confirm that it has received all addenda by listing the addenda numbers in *Table 3: Addenda Received*: **(For example, if Addendum 1 has been issued, enter 1 in the table, if there are two addenda, enter 1,2.)**

NOTE: FAILURE TO COMPLETE TABLE 3 BELOW SHALL RESULT IN BID DISQUALIFICATION:

TABLE 3: ADDENDA RECEIVED

Addenda Number(s)

Proponents who fail to complete this section will be deemed to have not received all posted addenda and shall be deemed **NON-COMPLIANT**.

Deliverables

Memorial University is seeking a team to help in establishing the items listed in *Table 4: Scope of Services Deliverables Acknowledgement*. Please initial next to each item in Table 4 to acknowledge its inclusion in the Proponent's proposal:

NOTE: FAILURE TO COMPLETE TABLE 4 BELOW SHALL RESULT IN BID DISQUALIFICATION:

TABLE 4: SCOPE OF SERVICES DELIVERABLES ACKNOLEDGEMENT

Section	Item Description	Proponent Initials
A	Design Development documents and Class C cost estimate (see Consultant's Services Agreement section 3.8).	
B	90% complete Contract documents and a Class B cost estimate (see Consultant's Services Agreement, Section 3.9).	
C	Issued for Tender documents and a Class A, pre-tender cost estimate (see Consultant's Services Agreement, Section 3.9).	
D	Tender support services, including responses to inquiries, preparation of addenda and attending site visit(s).	
E	Memorial University will administer all facets of tendering.	
F	Issued for Construction documents.	
G	Review and recommendation of Owner or Consultant generated Contemplated Change Orders, Contractor generated Change Order Requests and progress claims.	
H	Preparation of Non-compliance Reports.	
I	Review and tracking of all required submittals, including shop drawings, as outlined in the construction contract package.	
J	Response to and tracking of all Request for Information (RFI) generated by the general contractor during construction.	

K	Generation of contemplated change orders resulting from RFI Responses. And review and recommendation of Contractor's pricing in response these contemplated change orders.	
L	Consultant representation at the construction kick-off meeting and all subsequent biweekly construction meetings.	
M	Transcribe "as-built" information from the Project, as provided by the Contractor, to the original drawings, provide a set of such documents to the Owner in electronic format acceptable to the Owner in original, editable format (.dwg)	
N	Organize, through the Contractor, a complete commissioning of all the components of the Project and certify commissioning results prior to issuance of Substantial Performance Certificate	

* Includes but not limited to the items listed above, full scope as described in the RFP documents

No Prohibited Conduct

The Proponent declares that it has not engaged in any conduct prohibited by this RFP.

Disclosure of Information

The Proponent hereby agrees that any information provided in this Proposal, even if it is identified as being supplied in confidence, may be disclosed where required by law or by order of a court or tribunal. The Proponent hereby consents to the disclosure, on a confidential basis, of this Proposal by the Owner to the advisers retained by the Owner to advise or assist with the RFP process, including with respect to the evaluation of this Proposal.

Proposal Irrevocable

The Proponent agrees that its proposal shall be irrevocable for a period of 45 Days following the submission deadline.

Required Signatures

Failure to submit this signature section will render the Proposal **NON-COMPLIANT** and the Proposal will be disqualified.

Signature of Proponent’s Representative

Name of Proponent’s Representative

Title of Proponent’s Representative

Date

<u>I have the authority to bind the Proponent</u>

IN SIGNING THIS PAGE AND SUBMITTING YOUR PROPOSAL, THE PROPONENT ACKNOWLEDGES HAVING READ AND UNDERSTOOD AND AGREED TO THE TERMS AND CONDITIONS OF THIS DOCUMENT.

APPENDIX C – PROPOSAL EVALUATION & RATED CRITERIA

Proposal Evaluation

Proposals will be evaluated by the Owners RFP Evaluation Committee. The Committee will first evaluate and score each firms Technical Proposal using the criteria as outlined in **Appendix C**. Upon completion of the Technical Proposal evaluations, the Price Proposals will be opened and scored. All proposals will then be ranked based upon the Technical and Price Proposal combined score, the Total Score, with the highest scoring proposal being considered for award.

Proponents who do not meet a minimum technical threshold score of **50 Points** will not proceed to the price evaluation stage of the evaluation process.

Evaluation Criteria and Weighting

The following sets out the categories, weightings and descriptions of the rated criteria of the RFP. Proponents who do not meet a minimum technical threshold score of 75 points will not proceed to the next stage of the evaluation process.

TABLE 5: RATED CRITERIA

Rated Criteria Category	Weighting (Points)
Project Manager	5
Lead Designer/Project Team	15
Past Technical Experience	15
Understanding of Scope	10
Local Presence of Team	10
Duration (Appendix F)	10
Schedule	5
Technical Score	**70**
Price Proposal	**30**
Total Score	**100**

Experience and Qualifications

Each Proponent should provide the following in its proposal:

1. A brief description of the Proponent;
2. A description of its knowledge, skills and experience relevant to the Deliverables;
3. The roles and responsibilities of the Proponent and any of its agents, employees and sub-contractors who will be involved in providing the Deliverables, together

with the identity of those who will be performing those roles and their relevant respective expertise.

There is no maximum page number allotment for Proposal submittals though the Proposal shall not exceed the file size limits as stated in Part 1 – Submission Instructions.

Technical Proposal Evaluation

Technical proposal submissions will be evaluated based on the following qualification criteria, which should be highlighted by the submission:

1. **Project Manager**: A description of the proposed Project Manager (PM) shall be provided which clearly identifies their experience and formal project management credentials, if any, or other qualifications which enable them to oversee and direct the full delivery of the scope of the services while emphasizing quality, schedule and stakeholder management. The Proponent's ability to provide continuity of project management should be highlighted as part of the submission. The PM must be located in the greater St. John's area and be reasonably able to commit themselves to a project of this scale and duration. The PM duties may not be delegated to an alternate team member during the course of the project. The proposed PM may be replaced during the course of the project, by agreement with Memorial University, as to the qualifications of the proposed replacement PM. The PM is expected to attend all meetings and relevant project inspections and is required to review all correspondence and approved submissions. **The Project Manager shall not be the Architect or Engineer of Record**;

2. **Lead Designer/Project Team**: The balance of the Project Team should be made up of those individuals and/or firms which have been identified by the Prime Consultant as providing value and technical skills required to deliver per the understanding of the scope of work. Each of the sub-consultants within the design team must provide a brief description of their company, its history, size, organizational structure, range of expertise, past projects and past working relationships with the design team as well as those individuals to be utilized for this project. Provide an organizational chart explaining the overall prime/sub-consultants' relationships, the project manager(s), the quality assurance system, the discipline leaders and other key design personnel within each discipline.

   It is recognized that certain key personnel and skill sets may be required from firms or individuals located outside of the province and all staff should define their primary physical location in their submission;

3. **Past Technical Experience**: The Proponent should highlight their technical skill and experience designing and delivering projects of similar scale, complexity and duration completed within the past five years. As well the system design configurations, with an emphasis on operating infrastructure, should be outlined. In cases where the firm did not act as the prime consultant, the Proponent should specifically identify their role and proportionate involvement. (i.e. Electrical was 25% of $5M project construction value.). Projects referenced are to be relevant to the proposed team members included in the proposal;

4. **Understanding of Scope**: The Proponent should attempt to interpret the scope of work as it has been provided and, in their own words, provide an overview of the goals and methodologies of the project. The Proponent must have a clear and

concise understanding of the objectives of the project which will be demonstrated by providing a review of the conceptual methodology and highlight or expand upon the solution or provide an alternate approach. The solution should introduce as low a risk as possible to Memorial University's operations and utilities while providing the highest value.

The response should indicate any positive or negative risks, potential mitigation measures, or alternative approaches that reflect their value added to the undertaking.

5. **Local Presence of Team**: The complexity of this project, along with the requirement for interfacing with Memorial University's Facilities Management and Stakeholder groups, will require a project team that is agile and responsive to the changing demands this project will introduce.

6. **Duration and Schedule: The Proponent shall complete and submit the Duration Form (Appendix F)** and shall include a schedule in Gantt chart format for completing the items as described in the Scope of Services.

   Memorial University will not prescribe durations however for the purpose of comparative analysis of the submissions, it is reasonable to require a level of effort assessment and corresponding duration and schedule submittal **for those tasks which are within the consultant's controls and responsibility**. It is expected the Proponent will be available to start performing the Services included within two weeks of receiving the purchase order.

   Duration is scored based on a relative duration formula with each Proponent receiving a percentage of the total possible points allocated to duration in accordance with the following formula:

   Lowest Total Duration ÷ Proponent's Total Duration X Weighting = Proponent's Evaluation Points

   The Proponent is advised of their responsibilities under Section 3.3 of the Consultant's Services Agreement Terms and Conditions **(see Appendix G)**, where so engaged, and the service requirements referenced within.

   Schedule is scored based on level of detail and quality.

7. **Price Proposal:** Pricing is scored based on a relative pricing formula using the rates set out in **Appendix E – Pricing Form**. Each Proponent will receive a percentage of the total possible points allocated to price in accordance with the following formula:

   Lowest Price ÷ Proponent's Price X Weighting = Proponent's Evaluation Points

Evaluation Committee

Members of the Evaluation Committee (or their designate) are as follows:

1. Manager, Major Capital Projects (Facilities Management)
2. Project Manager, Major Capital Projects (Facilities Management)
3. Associate Director, Infrastructure Services (OCIO)
4. Manager, Data Centre Services (OCIO)
5. Manager, Network Services (OCIO)

Committee members will review the Technical Proposals individually prior to meeting as a group to discuss and score the Technical Proposals as per the rated criteria as described in Appendix C and throughout the RFP.

Interview Request

The Owner may, at its discretion, shortlist Proponents to participate in a 30-minute interview and/or presentation.

APPENDIX D – PROPOSAL PARTICULARS

Proposal Submission

Proponents should submit **One (1)** email submission, with the subject as stated on the RFP cover page, containing **two** separate PDF attachments titled as per below:

1. CSF-004-23 RFP Response (Company Name)

2. CSF-004-23 RFP Fee Schedule (Company Name)

Please note: File size cannot exceed 15 MB. Otherwise, the server may reject the proposal submission due to size. Proposals submitted by fax, mail, courier, drop off or by any other means of delivery other than by email stated above shall not be accepted.

Fee Proposal

Submissions of fees should be broken down into:

1. ***Scope of Services*:**

   Lump sum (maximum upset) fee for all services included in Table 1: Scope of Services Summary (**see Appendix A**), including that of any sub-consultants;

2. **Expenses**:

   Expenses will be paid as a disbursement at cost with per diems for meals. A backup for travel costs is required to be submitted with expense claims. Proponents should provide an estimate of anticipated travel expenses as a separate line item of the fee proposal. Additional information can be found in **Appendix G**;

Include the completed Pricing Form (Appendix E) in the fee proposal.

Submit a schedule of per diem rates for additional design and/or contract administration services.

Fees submitted for this work are to be calculated in accordance with the respective fee schedules (where applicable) for associations which may govern the discipline. Where such schedules are used their source should be identified.

Proposal Award

The successful proponent will enter into good faith negotiations with the Owner towards the conclusion of a Consultant's Agreement in a form acceptable to the Owner. The Owner attaches a copy of its Prime Consultant's Summary of Services **(see Appendix A)**, and the Consultant's Services Agreement **(see Appendix G)**, to be executed.

APPENDIX E – PRICING FORM

<u>Instructions on How to Complete the Pricing Form</u>

Rates must be provided in Canadian funds, inclusive of all applicable duties and taxes except for HST, which should be itemized separately.

Rates quoted by the Proponent must be all-inclusive and must include all labour and material costs, all travel and carriage costs, all insurance costs, all costs of delivery, and all other overhead, including any fees or other charges required by law.

Please complete *Table 6: Pricing Form*:

TABLE 6: PRICING FORM

Item	Service	Fee
A	Design Development	
B	Construction Contract Documents	
C	Bidding and Construction Contract Award	
D	Construction Contract Administration	
E	**LUMP SUM MAXIMUM UPSET FEE (A+B+C+D) - SEE APPENDIX A**	
F	Travel Expenses (estimated)	
G	Other Reimbursable Expenses (estimated)	
H	**SUBTOTAL OF ESTIMATED EXPENSES (F+G)**	
I	**EXPECTED TOTAL FEE (E+H) (Excludes HST)**	

The price evaluated shall be based upon line I of the Pricing Form.

APPENDIX F – DURATION FORM

Instructions on How to Complete the Duration Form

The duration to complete the contract deliverables listed below is required for evaluation. It is based on a start-to-finish relationship for each scope of service item, with no overlaps or gaps being considered (i.e. Owner review periods). The successful proponent, once awarded, will be required to submit an updated schedule based on the actual relationship between activities, which will include allowances for deliverable reviews and approvals by the Owner.

Please complete *Table 7: Duration Form* below. All durations are to be in business days.

TABLE 7: DURATION FORM

Item No.	Scope of Services Item	Duration
1	Deliver Design Development documents and Class C cost estimate.	
2	Deliver 90% complete Contract documents and a Class B cost estimate.	
3	Deliver Issued for Tender documents and a Class A, pre-tender cost estimate.	
	Total Duration (business days)	

APPENDIX G – DEPARTMENT OF FACILITIES MANAGEMENT CONSULTANT'S SERVICES AGREEMENT

DEPARTMENT OF FACILITIES MANAGEMENT
CONSULTANT'S SERVICES AGREEMENT

for

Click here to enter text.

THIS AGREEMENT made in on the ________ day of _________________

BETWEEN: Memorial University of Newfoundland (the "Owner")

AND: Click here to enter text. (the "Consultant")

RECITALS:

A. The Owner issued a Request for Click here to enter text. on Click here to enter a date. (the "Request for Proposals"(RFP)) for the Services (defined below), as amended by the Addenda and Clarifications (defined below), if any.

B. The Consultant submitted the Consultant Proposal (defined below).

C. The Owner has agreed to accept the Consultant Proposal on the terms and conditions hereinafter set out, and the Consultant has agreed that it will provide the Services required by the RFP (as such term is defined in Appendix 1 – Terms and Conditions) and under this Agreement (as such term is defined in Appendix 1 – Terms and Conditions).

D. This initial part of the Agreement, which is comprised of the Parties, Recitals, Section 1 and execution page(s), is referred to herein as the "Cover Pages", and the Agreement is comprised of the Cover Pages and all appendices thereto including the specific appendices and other items referred to in Section 1.2 of Appendix 1 – Terms and Conditions.

NOW THEREFORE this Agreement witnesses that in consideration for the mutual covenants and agreements contained herein, the Parties agree as follows:

1. That the Owner hereby engages the Consultant to perform the Services, and the Consultant hereby agrees to provide the Services, all in accordance with this Agreement, which for greater certainty includes the following additional specific details:

TABLE 1 - DETAILS	
RFP for Click here to enter text.:	The project description is as outlined in the RFP for the Services, as amended by the Addenda and Clarifications, if any, attached hereto as Appendix 2. Click here to enter text. (the “Project”)
Consultant Address for Service:	The Consultant’s address for service for the purpose of Section 14.4 of Appendix 1 – Terms and Conditions is: Click here to enter text. Click here to enter text. Click here to enter text. Attention: Click here to enter text. Facsimile: Click here to enter text.
Consultant Proposal:	Proposal dated Click here to enter a date. comprised of a Technical Submission and a Financial Submission and Additional Services (if applicable) Click here to enter text., attached hereto as Appendix 3. (the (“Consultant Proposal”)
Description of Services:	The services to be provided by the Consultant shall include the services marked below: ☐ Work Schedule - Section 3.3 of Appendix 1 (if applicable, attach Appendix 5). ☐ Cost Control - Section 3.4 of Appendix 1 ☐ Sub-consultants – Section 3.5 of Appendix 1 ☐ Functional Program Development and Advisory Services – Section 3.6 of Appendix 1 ☐ Concept Design (includes Schematics) – Section 3.7 of Appendix 1 ☐ Design Development – Section 3.8 of Appendix 1 ☐ Construction Contract Documents – Section 3.9 of Appendix 1 ☐ Bidding and Construction Contract Award – Section 3.10 of Appendix 1 ☐ Construction Contract Administration – Section 3.11 of Appendix 1 ☐ Additional Services in accordance with the requirements of Section 3.2 of Appendix 1 (if applicable, attach in Appendix 3)

<table>
<tr><td></td><td>(collectively, the “Services”).</td></tr>
<tr><td>Addenda and Clarifications:</td><td>• Click here to enter text.

Attached hereto as Appendix 2 (collectively, the “Addenda and Clarifications”).</td></tr>
<tr><td>Specified Deliverables:</td><td>Click here to enter text.

(collectively, the “Specified Deliverables”)</td></tr>
<tr><td>University Guidelines, Policies and Specifications:</td><td>The Consultant must request from the Owner all guidelines, policies and specifications of the Owner which relate or inform the Services being provided. Without limiting the generality of the foregoing, the Owner advises that the following guidelines, policies and specifications are applicable to the Services:

• Computing and Communication MUNet Specs;
• Memorial University of Newfoundland Campus Master Plan;
• University Space Standards and Guidelines;
• Click here to enter text.

All guidelines, policies and specifications related to or informing the Services, including, without limitation, those specified above are referred to herein as the “University Guidelines, Policies and Specifications”).</td></tr>
<tr><td>Insurance Coverage:</td><td>The Consultant is required to have insurance coverage as set out in Section 3.13 of Appendix 1 - Terms and Conditions.

The Consultant is required to have Click here to enter text. of insurance coverage for this project.</td></tr>
<tr><td>Owner’s Representatives:</td><td>The Owner advises that the person(s) listed below are the authorized representatives of the Owner for the Project with decision making authority to resolve on behalf of the Owner all matters that may arise during the performance of the Services.

<table>
<tr><th>Name</th><th>Position</th><th>Contact Information (e-mail, telephone, fax, address)</th></tr>
<tr><td>Click here to enter text.</td><td>Click here to enter text.</td><td>e-mail: Click here to enter text.
Phone: Click here to enter text.
Fax: Click here to enter text.</td></tr>
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<tr><td></td><td><table>
<tr><td></td><td></td><td>Room Click here to enter text.
Facilities Management Building
Memorial University
St. John’s, NL A1C 5S7
Canada</td></tr>
<tr><td>Click here to enter text.</td><td>Click here to enter text.</td><td>e-mail:
Phone:
Fax:

Room
Facilities Management Building
Memorial University
St. John’s, NL A1C 5S7
Canada</td></tr>
<tr><td colspan="3"></td></tr>
</table></td></tr>
<tr><td>Owner Address for Service:</td><td>The Owner’s address for service for purpose of Section 14.4 of Appendix 1 – Terms and Conditions is:

Click here to enter text.
Room Click here to enter text.
Facilities Management Building
Memorial University
St. John’s, NL A1C 5S7
Canada

Facsimile: Click here to enter text.</td></tr>
<tr><td>Fee:</td><td>The total compensation for the performance of the Services (not including Additional Services) shall be $Click here to enter text. + HST (the “Fee”).

The fee for Additional Services shall be determined in accordance with Section 8.2 of Appendix 1 – Terms and Conditions.</td></tr>
<tr><td>Delivery of Payment Requirements:</td><td>Payment requirements under Subsection 8.5(b) of the Appendix 1 – Terms and Conditions shall be delivered to the attention of:

Click here to enter text.

by ONE (not both) of the following:

E-mail at: FMAdmin@mun.ca</td></tr>
</table>

	Or **Mail to**: c/o Administrative Services Facilities Management Memorial University St. John's, NL A1C 5S7

IN WITNESS WHEREOF the Parties hereto have executed this Agreement on the date first written above.

Witness (Signature)	Authorized Signatory (Signature) Memorial University of Newfoundland
Witness (Print Name)	Authorized Signatory (Print Name and Title) Memorial University of Newfoundland
Witness (Signature)	Consultant (Signature)
Witness (Print Name)	Consultant (Print Name and Title)

APPENDIX 1

TERMS AND CONDITIONS

INDEX OF APPENDIX 1 - TERMS AND CONDITIONS

1. DEFINITIONS

1.1 "Addenda and Clarifications", if used, has the meaning ascribed on the Cover Pages hereof.

1.2 "Agreement" means this Services Agreement entered into between the Owner and the Consultant and consisting of the following:

(a) The executed Cover Pages;

(b) The Terms and Condition attached to the Cover Pages in this Appendix 1, as may be amended, supplemented or restated in writing signed by the Parties from time to time;

(c) The Request for Proposals including all Addenda and Clarifications, if any, attached in Appendix 2;

(d) The Consultant Proposal attached in Appendix 3;

(e) The Protection of Privacy Requirements attached in Appendix 4;

(f) Initial Services Schedule attached in Appendix 5, if applicable;

(g) Applicable Reimbursement Requirements attached in Appendix 6;

(h) University Guidelines, Policies and Specifications included on the Cover Pages hereof.

1.3 "Approved Construction Cost Budget" means from time to time the latest budget for construction of the Project which has been approved in writing by the Owner, whether that be a Class D (+/- 20%), C (+/- 15%), B (+/- 10%) or A (+/- 5%) budget estimate.

1.4 "Consultant" has the meaning ascribed on the Cover Pages hereof.

1.5 "Consultant Proposal" has the meaning ascribed on the Cover Pages hereof.

1.6 "Contractor" means the person(s), firm(s) or corporation(s) contracting with the Owner to provide labour, materials and equipment for the execution of the Project.

1.7 "Contract" is the agreement between the Owner and the Contractor for the provision of the labour, materials and equipment for the execution of the Project by the Contractor.

1.8 "Contract Documents" consists of the executed agreement between the Owner and the Contractor, the general conditions of the Contract, the drawings and such other documents as are identified in the Contract and the general conditions as constituting part of the Contract Documents.

1.9 "Cover Pages" has the meaning ascribed on the Cover Pages hereof.

1.10 "Deliverables" shall include, where applicable, but are not limited to:

(a) Land survey data and reports;

(b) Geotechnical surveys, data and reports;

(c) Fire and Life Safety code review documents;

(d) National Building Code of Canada long form and backup documentation for submission;

(e) Copies of (a) submissions made by the Consultant, and (b) materials used or prepared by the Consultant for submissions to be made by the Owner to the Government Services Centre of the Department of Service NL or the applicable department of the Government of Newfoundland and Labrador in respect of permits and accessibility;

(f) 33% drawings, 66% drawings and specifications and 99% drawings and specifications;

(g) Class "D", "C", "B" and "A" Estimates;

(h) Issued for tender drawings and specifications;

(i) Issued for constructions drawings and specifications;

(j) Cost and schedule forecasting reports;

(k) Commissioning Plan;

(l) Substantial Performance Certificate;

(m) Total Performance Certificate;

(n) As-built drawings;

(o) Samples, models, mock-ups and renderings;

(p) Operations and maintenance manuals;

(q) Building Information Management (BIM) models;

(r) Shop drawings;

(d) Testing reports and inspections;

(t) Correspondence with contractors;

(u) Requests for information, contemplated change notices, change orders and all similar documents and associated drawings and supporting documentation;

(v) Meeting minutes;

(w) Inspection forms and notes (written or digital) and inspections shall use Uniformat;

(x) Substantial performance inspection report complete with valuation of deficiencies;

(y) Pre-warranty expiry inspection report complete with valuation of repairs/corrections; and

(z) Specified Deliverables identified on the Cover Pages hereof.

1.11 "Holdback" means an amount equal to 10% of a payment due to the Consultant plus any Liens.

1.12 "Fee" has the meaning ascribed to that term on the Cover Pages hereof.

1.13 "Liens" means all amounts claimed by any person(s) pursuant to the Mechanics' Lien Act of which the Owner has notice and any other lien.

1.14 "Losses" means collectively any and all manner of action and actions, cause and causes of action, proceedings, suits, debts, duties, liabilities, rights, sums of money, accounts, controversies, losses, penalties, damages, costs, agreements, promises, contracts, claims or demands of any type or nature whatsoever by any person including, without limitation, third parties, directors, officers, employees, servants and agents of any party, under the laws of all jurisdictions in contract, tort, by statute or otherwise and in law or in equity, whether known or unknown, suspected or unsuspected, conditional or unconditional, matured or unmatured, liquidated or unliquidated, fixed or contingent.

1.15 "Mechanics' Lien Act" means *Mechanics' Lien Act*, RSNL 1990 c. M-3, as amended (or any successor or replacement legislation).

1.16 “Owner” means Memorial University of Newfoundland.

1.17 “Party” or “Parties” means a party to this Agreement.

1.18 “Project” (i) if used, has the meaning ascribed on the Cover Pages hereof, or (ii) if “Project” is not defined on the Cover Pages, Project shall mean the Services.

1.19 “Request for Proposals” has the meaning ascribed on the Cover Pages hereof.

1.20 “RFP” means the Request for Proposals and any Addenda and Clarifications thereto.

1.21 “Reimbursement Requirements” means the requirements for the reimbursement of external consultants for expenses attached as Appendix 6.

1.22 “Services” means the provision and the execution of those Services for which the Consultant has been engaged by the Owner, as detailed on the Cover Pages hereof and set out throughout this Agreement.

1.23 “Specified Deliverables” has the meaning ascribed to such term on the Cover Pages hereof.

1.24 “Substantial Performance” has the meaning ascribed to that term in Section 2 of the Mechanics’ Lien Act.

1.25 “Substantial Performance Certificate” means the certificate prepared by the Consultant certifying Substantial Performance by the Contractor.

1.26 “Total Performance” means, as the context requires, (i) the entire construction to be performed by the Contractor under the Contract Documents has been completed and is so certified by the Consultant, or (ii) the completion of all Services by the Consultant under this Agreement and is so certified by the Owner.

1.27 “Total Performance Certificate” means, as the context requires, (i) the certificate prepared by the Consultant and signed by the Owner and Contractor certifying Total Performance by the Contractor, or (ii) the certificate prepared by the Owner certifying Total Performance by the Consultant.

1.28 “University Guidelines, Policies and Specifications”, if used, has the meaning ascribed on the Cover Pages hereof.

1.29 “Warranty Period” has the meaning ascribed to that term in Section 13.2.

2. THE OWNER'S RESPONSIBILITIES

2.1 Site Survey Information

If applicable to the services provided by the Consultant, the Consultant shall procure an accurate survey of the Contract site as necessary to perform the Work. The provision of such survey shall be an Additional Service (as defined below); however, no fee shall be charged by the Consultant for time spent by the Consultant, but all disbursements related to such survey shall be reimbursed by the Owner. The Owner shall furnish all relevant information in its possession for such purpose. The Owner agrees that the survey requirement does not require the Consultant to provide a legal real property survey.

If site survey required, the site survey will include all information required for the setting out of the Project, existing grades and lines of streets, pavements, curbs, sidewalks, manholes, catch basins, invert elevations, location of all underground sanitary sewer, storm sewer and water supply pipelines, above and underground electrical and other public utilities, adjoining properties, existing buildings and other structures, restrictions, easements, boundaries and topography of/or affecting the Contract site.

If site survey required, it shall be the Consultant's responsibility to ensure that all necessary data concerning the site conditions will be supplied by the surveyor.

The responsibility of data accuracy remains with the surveyor.

2.2 Soils Survey Information

If applicable to the Services provided by the Consultant, the Owner shall furnish all relevant soils survey information in its possession for review by the Consultant, and it shall be the Consultant's responsibility to determine if all necessary information is contained in such soil survey information and whether such soil survey information is sufficient and appropriate for the performance of the Work. Should the Consultant determine that additional soil survey information is required, it shall advise the Owner of the need for such additional information and the procurement of such shall be subject to the Owner's prior written approval. If the Owner determines that such additional information is required, the Consultant and the Owner, both acting reasonably, shall agree on the soils survey information required and the appropriate party to procure such additional soils survey. If the Consultant procures any such additional soils survey, such soils survey shall be an Additional Service (as defined below); however, no fee shall be charged by the Consultant for time spent by the Consultant, but all disbursements related to such soils survey shall be reimbursed by the Owner. If soil survey required, it shall be the Consultant's responsibility to determine that all of the necessary information is supplied by the soils consultant.

The responsibility of data accuracy remains with the soils consultant.

2.3 Owner’s Decision

The Owner shall give due consideration to all sketches, drawings, specifications, tenders, proposals, contracts and other documents laid before the Owner by the Consultant, and wherever prompt action is necessary, the Owner shall inform the Consultant of its decisions in such reasonable time as not to delay the Services.

2.4 Owner’s Representative

The Owner shall appoint an individual or individuals with decision-making authority and identified as such on the Cover Pages hereof as its official representative(s) for the term of this Agreement. Only the official representatives identified in the Cover Pages shall have the authority to resolve on behalf of the Owner all matters that may arise during the performance of the Services.

If the Owner engages a third party agent, the Owner will advise the Consultant in writing of such appointment and of the level of authority such third party agent has for and on behalf of the Owner.

3. CONSULTANT’S SERVICES

3.1 General Principles

The Consultant agrees to provide the Services as indicated on the Cover Pages and as required by the RFP. The Services shall be performed for the Fee. The Consultant agrees that the hourly rates set forth in the Consultant Proposal shall apply for the duration of the Services.

Throughout the provision of the Services, the Consultant shall provide the Owner with all Deliverables applicable to the Services, at such time as each such Delivery becomes available. All deliverables including drawings, operation and maintenance manuals, shop drawings, as-builts and subconsultant reports must be submitted in electronic format acceptable to the Owner at its sole discretion. Original, editable and workable file formats should be preserved and delivered to the Owner where possible. Acceptability of PDF files will be at the sole discretion of the Owner.

3.2 Additional Services

The Consultant shall also provide additional services as may be required from time to time by the Owner in writing (the “Additional Services”).

This Agreement, including Article 8. FEES and Section 8.2 Additional Services, shall apply to the Additional Services. For greater certainty, reference in this Agreement to "Services" shall include any Additional Services.

3.3 Work Schedule

The agreed timeline for the performance of the Services by the Consultant is attached as Appendix 5 (the “Initial Services Schedule”) which shall be updated by the Consultant within fourteen (14) days of the date hereof to include the detail required by the Owner (the “Updated Services Schedule”). The Updated Services Schedule and the Initial Services Schedule shall be referenced in this Agreement collectively as the “Services Schedule”.

The Consultant shall perform the Services in accordance with the Services Schedule.

Where Work Schedule is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant will:

(a) Ensure that Project meetings with other Consultants, sub-consultants and suppliers are called and held when necessary and attend all such meetings. In addition, the Consultant shall keep minutes at all such meetings and forward to the Owner within seven (7) days. Such meetings shall be held not less than once a month and notification by the Consultant shall be given not less than one (1) week in advance;

(b) Prepare and issue instructional drawings as may be necessary for the proper execution of the Project; and

(c) If applicable, undertake all other scheduling matters related to the Services that are identified in Section 3.11.

3.4 Cost Control

Where Cost Control is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall provide such Services in accordance with this Section 3.4.

The Consultant will adhere to the Approved Construction Cost Budget throughout all stages of the Project.

If at any time the Consultant considers its estimates indicate cost which exceed the Approved Construction Cost Budget limits, the Consultant will immediately advise the Owner. If, in the opinion of the Owner, the excess is due to design cost factors or matters under the control or reasonably foreseeable by the Consultant, the Owner may require the Consultant, at its expense and at no additional cost to the Owner, forthwith to do everything by way of revision of design to bring the cost estimate within the Approved Construction Cost Budget limits.

If the lowest qualified and acceptable tender for the Project or any part or phase for which the Consultant has prepared the design(s) or estimate(s) exceeds the Approved Construction Cost Budget for reasons which, in the opinion of the Owner, the Consultant should have foreseen and could have guarded against, the Consultant, at its own expense and at no additional cost to the Owner, will, if required by the Owner, do everything necessary including redesign to bring the cost of the tendered work within the Approved Construction Cost Budget limits.

Cost control will culminate by adherence to the Approved Construction Cost Budget in the preparation of the final working drawings and specification. This is to be substantiated by a final, Class 'A' elemental cost analysis prepared by the Consultant and presented to the Owner with the final tender documents.

Any rework or redesign or revisions required by this Section shall not derogate from or in any way amend the Consultant's obligation to perform in accordance with the Work Schedule.

3.5 <u>Sub-consultants</u>

The Consultant acknowledges and agrees that it is taking full responsibility for the performance of this Agreement and that the Owner shall not be required to deal directly with any of the Consultant's sub-consultants. The Consultant shall not assign this Agreement or subcontract the whole or any part of the Services without the prior written consent of the Owner.

If the Owner consents in writing to the sub-contracting of the whole or any part of the Services, the terms of this Agreement shall apply to the sub-contract and the sub-consultant *mutatis mutandis*. The assignment of this Agreement, or the subcontracting of any Services, shall not relieve Consultant of its obligations under this Agreement.

The Consultant shall pay any permitted sub-consultants out of the Fee and no additional amounts shall be payable by the Owner to the Consultant or any sub-consultant for Services provided by sub-consultant.

3.6 <u>Functional Program Development and Advisory Services</u>

Where Functional Program Development and Advisory Services are indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall:

(a) Prepare a functional program for the Project to examine and define the Owner’s needs and objectives for the Project and establish criteria for evaluating potential design solutions or strategic alternatives;

(b) Identify, research and observe, as part of the functional program process:

(i) The users of the proposed Project and their work activities (including, without limitation, function-by-function, room-by-room, or department-by-department activity plans, staffing plans and storage requirements);

(ii) The volume of activity planned for Project components (including, without limitation, throughput and flow patterns);

(iii) The planning impacts of the Project on local infrastructure;

(iv) The social impact of the program on the community; and

(v) The impact of the Project’s occupants and processes on the built environment.

(c) Prepare a functional program report, including, without limitation:

(i) The Owner’s philosophy, value, goals and image;

(ii) Site requirements (such as parking, circulation, orientation);

(iii) Explicit space requirements;

(iv) Financial requirements and a preliminary budget;

(v) Scheduling and time frame for the project;

(vi) Other requirements relating to regulatory issues, authorities, community goals/concerns, or ecological or environmental concerns, as applicable; and

(vii) A recommended construction project delivery method.

3.7 <u>Concept Design (includes Schematics)</u>

Where Concept Design is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall provide such Services in accordance with this Section 3.7.

The Consultant shall investigate and review the RFP and all of the available documentation referenced therein and prepare schematic design studies consisting of drawings and other documents setting forth the general concept and functional requirements of the Project, identifying the fire and life safety and code issues and identifying the design criteria for the various systems.

These studies shall be summarized with recommendations in a concept/schematic design report to the Owner. Such a report shall include a Class ‘D’ budget and planning time schedule.

3.8 Design Development

Where Design Development is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall provide such Services in accordance with this Section 3.8.

Upon the Owner’s selection of a definite scheme, the Consultant shall develop preliminary drawings and outline specifications which shall clearly define the design concept in terms of siting, functional planning, layouts, elevations, appearance and character, construction and materials as well as structural, mechanical and electrical systems.

Upon completion of the preliminary functional plans and routine specification, the Consultant will provide the Owner with a Class ‘C’ elemental cost estimate. An Approved Construction Cost Budget for future expenditure on the Project will be developed by the Consultant and based on this estimate and provided to the Owner for its review and approval in writing if acceptable.

The Consultant will prepare from the foregoing a "Design Development Package" and will submit five (5) copies to the Owner for approval in writing.

3.9 Construction Contract Documents

Where Construction Contract Documents is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall provide such Services in accordance with this Section 3.9.

The Consultant shall not proceed to prepare construction Contract Documents until it has received written authorization from the Owner. Upon receipt of the Owner’s written notification to proceed, the Consultant shall prepare working drawings and specifications providing details required for tendering, construction and completion of the Project.

The Consultant shall keep the Owner informed, at all times, of any conditions or changes affecting the general process, the schedule or the cost of the Project and provide progress drawings when requested.

The Consultant shall find solutions and make all changes to ensure completion of the Project within the requirements of the Approved Construction Cost Budget and as expressed in this Agreement.

The Consultant shall submit 90% complete Contract Documents with a Class 'B' estimate to the Owner for review.

Space layouts will be prepared for all areas, based on the University Space Standards and Guidelines.

The Consultant shall submit to the Owner, for its written approval, the final working drawings and specifications and the pre-tender report which shall include the Consultant's final, Class 'A' estimate, all desirable applications for review of drawings by governmental and regulatory agencies, as well as all other items customarily included in a pre-tender report.

3.10 Bidding and Construction Contract Award

Where Bidding and Construction Contract Award is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall provide such Services in accordance with this Section 3.10.

The Consultant will prepare a draft of the tender call documents in accordance with the Owner's requirements, including without limitation instructions to bidders and general conditions. The Owner will provide the form of contract which is to be included as the Contract with the tender call documents.

The Consultant shall provide a draft of the tender call documents to the Owner for approval in writing. The Owner will advertise the tender call for the Project and will convene and administer a tender opening board.

The Consultant will provide the Owner with up to five (5) sets of plans and specifications for up to four (4) tender packages which are included within the Fee. Any required reproductions above this amount will be reimbursed by the Owner at cost. The Consultant will dispense plans and specifications and addenda thereto and will administer the Project during the tender period. The Consultant will prepare such addenda as is necessary during the tender period. The Consultant will advise the Owner on all requests for "alternate approvals" of equipment and materials.

Addenda to the tender call documents will be issued by the Consultant to reach bidders prior to the tender closing.

The Consultant will analyse the bids received from all bidders in response to the tender call and provide the Owner with a written recommendation based on its review within one (1) week of the tender opening.

It shall remain within the Owner's discretion to either accept or reject a bid.

3.11 Construction Contract Administration

Where Construction Contract Administration is indicated on the Cover Pages or in the RFP as one of the Services provided by the Consultant, the Consultant shall:

(a) Provide for the administration and supervision of the Contract in the Consultant's office and at the location of the Project (the "Contract Site");

(b) Keep detailed records of all aspects of the Project relating to the administration and supervision of the Project;

(c) Prepare, within two (2) weeks prior to tender call, detailed administrative instructions to be submitted to the Owner for approval. Such administrative instructions, when approved in writing by the Owner, will be issued by the Consultant to all persons required to follow or be aware of such administrative instructions, and such procedures will be followed by such persons until the completion of the Project. The procedures will cover, but will not necessarily be limited to, correspondence, progress claims, final acceptance certificates, job meetings, as built drawings, etc.;

(d) Provide general review and inspection of the Project to determine that its construction is in accordance with the working drawings and specifications. Such general review shall require that:

   (i) The Consultant must have on its staff suitable and experienced field supervisory personnel who will be designated as responsible for the contract administration of the Project. Such staff will be subject to the prior written approval of the Owner;

   (ii) The Consultant's designated field representatives shall make regular visits to the Contract Site to determine if the Project is proceeding in general accordance with the Contract Documents. The frequency of such visits shall be determined by the Owner; however, in no case shall it be less than two (2) weeks even where there is constant representation at the Contract Site;

   (iii) During such visits, the Consultant will prepare a site visit report that includes notification of any non-conforming work observed for the

Project and will determine whether all deficiencies have been addressed in accordance with the Contract Documents. Copies of such lists will be forwarded to the Owner indicating what action has been taken.

(e) Submit monthly reports to the Owner in narrative form, summarizing the progress of the Project construction and such other information as the Owner may require from time to time and will include digital photographs taken during the course of the scheduled site reviews demonstrating issues or non-conformances with the Work and digital photographs used specifically to demonstrate progress of the Project;

(f) Review (or shall cause the review by its approved sub-consultants) all testing results called for under the Contract Documents and work with the Owner to identify the groups within the Owner who may be impacted by such testing and shall ensure that such groups are notified at least one (1) week in advance of any such tests;

(g) Prepare and issue change orders as approved by the Owner;

(h) Recommend to the Owner the amounts owing to the Contractor under the Contract based on the Consultant's observations and evaluation of the Contractor's application for payment;

(i) Transcribe "as-built" information from the Project, as provided by the Contractor, to the original drawings, provide a set of such documents to the Owner in a form suitable for reproduction, and provide as-built information in electronic format acceptable to the Owner with workable file formats preserved and provided where possible. The cost of the Consultant's staff in the preparation of the as-built reproducible information will be part of the Fee;

(j) Organize, through the Contractor, a complete commissioning of all of the components of the Project to determine that the various parts are operating in the manner as intended by the Contract Documents. The Substantial Performance Certificate will not be issued until the final commissioning of the work has been successfully completed and so certified by the Consultant;

(k) Upon achievement of Substantial Performance by the Contractor, prepare, sign and deliver to the Owner the Substantial Performance Certificate. Prior to the issuance of such Substantial Performance Certificate, the Consultant shall ensure that the Owner has been provided with all Deliverables related to the Contract and shall provide any remaining Deliverables forthwith including, without limitation, a complete set of the contract drawings revised to record all changes "as-builts";

(l) Upon achievement of Total Performance by the Contractor (including the rectification of any deficiencies), prepare a Total Performance Certificate for issuance to the Contractor. The Total Performance Certificate, in order to be valid, will require the signature of the Consultant, the Contractor and the Owner;

(m) Carry out visual inspections at the request of the Owner during the Warranty Period to determine whether the Contractor has remedied all defects and failures and, when satisfied, to certify in writing to this effect. For greater certainty, any inspection which is recommended by the Consultant which involves imaging, demolition or other non-visual inspection work will be reviewed with the Owner and subject to the Owner’s written approval prior to being undertaken. No fees will be charged by the Consultant for its time spent in respect of such inspections; however, any disbursements by the Consultant shall be reimbursed by the Owner in accordance with the Reimbursement Requirements;

(n) Provide the Owner with a post-construction evaluation of the Project, including all buildings, building services and cost analysis, which will include a final cost of construction review, including all changes and amendments, and a report on the performance on the building which would include a guide for the Owner as well as a program or formula for use by the Owner in future years to determine the performance of the designed building. In addition, the Consultant will perform a post-occupancy evaluation of the completed building within one (1) year of its completion and occupancy. The post-occupancy evaluation will include:

    (i) An analysis of energy performance over baseline, provided that the Owner releases all necessary energy consumption information to the Consultant required for such analysis;

    (ii) A review of material selections for durability and condition;

    (iii) A workshop with the Owner to discuss lessons learned from process and feedback received from users of the building, including the Owner’s staff;

    (iv) A review by the Owner and Consultant of any warranty issues that have arisen; and

    (v) A review of control systems (building automation) to verify performance of control systems to design intent.

3.12 Resident Services (Additional Services)

Where requested in writing by the Owner, the Consultant shall provide resident services as Additional Services in accordance with this Section 3.12.

Particular aspects of the Project will require additional on-site services, e.g., review and inspection of structural components, mechanical systems and electrical systems.

The Owner will require a residential, full-time representative on the Project in order to ensure that the Project is constructed in accordance with the terms and conditions of the Contract Documents. Resident services do not take the place of any professional responsibilities of the Consultant to witness tests, review work, review submittals and comment on the work of the Contractor.

Resident staff is required to compile and preserve up-to-date records of execution of the Project including measurement of qualities/quantities of material used showing also the mode and location of use and inspect the Project continuously while the construction is in progress. Such residential staff must be experienced and qualified and acceptable to the Owner.

Resident staff will arrange for and witness all tests and evaluations of Project materials and equipment, maintain and keep available for examination by the Owner a continuous daily record showing the number of persons and items of equipment from time to time employed in connection with the Project by the Contractor, provide all other information and advice necessary to assess the progress, determine the causes of any delays, perform all required inspections and verify the claims and examine and verify any payment claims due to the Contractor for the progress of the construction on the Project.

An Owner’s Coordinator acceptable to both the Owner and the Consultant may be engaged by either the Owner or Consultant at the discretion of the Owner, in which case the Owner shall approve the salary or fee to be paid for such services in advance and shall establish the duties to be carried out by the Owner’s Coordinator.

3.13 Insurance

In performing the Services, the Consultant will obtain and maintain insurance as described below:

(a) All insurance required to be maintained by the Consultant shall be primary with respect to other similar or complementary insurance maintained by Owner;

(b) Prior to commencement of the Services, the Consultant shall provide evidence of insurance policies required to be procured by the Consultant hereunder in the form of a Certificate of Insurance. Similar evidence of renewals shall be provided to Owner upon request;

(c) All amounts of claims, losses or damages otherwise covered but not recoverable from the Consultant's insurers by reason of: (i) application of deductible clauses pertaining to Consultant furnished insurance; or (ii) any breach by the Consultant of the terms of its insurance policies, shall be for the account of and paid by the Consultant;

(d) Consultant purchased policies shall contain clauses which require notification to the Owner in writing at least thirty (30) days prior to any cancellation of such policies. Consultant shall notify the Owner in writing at least thirty days prior to any material change in such policies;

(e) Insurance to be provided by the Consultant shall include, as a minimum, the following:

(i) Workplace compensation and/or employer's liability coverage to the full extent required by all laws (including, if applicable, maritime and international law) or $5,000,000, whichever is the greater, applicable wherever the Services is to be performed under this Agreement and/or contracts of employment for Consultant's employees are made or expressed to be made;

(ii) Comprehensive general liability insurance for personal injury to or death of third parties and loss of or damage to property of third parties, including Consultant’s contingent liability with respect to the operations of sub-consultants, and contractual liability assumed by the Consultant under this Agreement, arising out of or in any way connected with the performance of the Services, subject to a limit of not less than $5,000,000 per occurrence and in the aggregate;

(iii) Comprehensive automobile liability insurance which complies with all applicable governmental requirements including coverage for all automotive equipment owned, hired or otherwise procured by the Consultant for the Services, subject to a limit of not less than $5,000,000 per occurrence. In respect of vehicles not owned by the Consultant, it shall maintain and keep in force non-owned automobile liability insurance protecting its liability, including that assumed under this Agreement, subject to a limit of not less than $5,000,000 per occurrence and in the aggregate;

(iv) Professional liability insurance covering negligent acts, errors and omissions arising out of the performance of design and engineering

Services under this Agreement. The professional liability insurance shall be continued to be maintained by the Consultant for a period at least equal to the Warranty Period, subject to a limit of not less than $2,000,000 per occurrence and in the aggregate unless otherwise stated in Table 1 - Details; and

(v) Any other insurance which it is required by law to provide.

(f) Each Party shall afford the other all reasonable assistance as may be required for prompt notice to insurers and for preparation and negotiation of insurance claim;

(g) The Consultant shall give to the Owner prompt notification, in any event no more than twenty-four (24) hours after the time of the incident, of any accident or incident occurring during the progress of the Services, whether or not it may result in a claim against the Owner's or the Consultant's insurance policies;

(h) All such insurance shall be maintained by the Consultant during the term of this Agreement and up to the expiry of the Warranty Period;

(i) All insurance shall be placed with insurers authorized to do business in the Province of Newfoundland and Labrador.

4. CONSULTANT’S ACTIONS AND DECISIONS

4.1 The Consultant acknowledges that it has had adequate discussion and access to sufficient information to enable them to undertake the Services contracted for the Fee.

4.2 The Consultant agrees to act promptly on all matters requiring an action or decision on its part affecting the provision of the Services.

4.3 The Consultant acknowledges that regulatory codes and standards applicable to the Services will be met and that it will obtain any required approvals from the regulatory authorities for the provision of the Services.

The Consultant acknowledges that the integration of capital work into existing mechanical, electrical, controls, data, space management, building services and equipment management systems is of paramount importance to the Owner, and the Consultant shall consult with the Owner’s technical services, operations and maintenance and engineering groups to ensure that the Consultant meets existing standards and practices related to the Services. The Consultant must request from the Owner all University Guidelines, Policies and Specifications which relate to or inform the Services being provided. Throughout the term of the Agreement, the Consultant must request from the Owner any updates or revisions to the University Guidelines, Policies and Specifications before using or relying on such documents in the Services.

Without limiting the generality of the foregoing, if applicable to the Services, all engineering drawings, plans and calculations shall be properly signed and stamped in accordance with the Engineers and Geoscientists Act (Newfoundland and Labrador) and any successor or replacement legislation thereto, the regulations thereunder and the guidelines from time to time established by the Professional Engineers and Geoscientists of Newfoundland and Labrador (PEGNL) (or its successor from time to time). If applicable to the Services, the Consultant (or an approved sub-consultant) will stamp and approve all design calculations, drawings and other documents essential to the execution of the Services.

4.4 No acceptance or approval by the Owner, whether expressed or implied, shall be deemed to relieve the Consultant of its contractual, professional or technical responsibility for the Services.

4.5 If applicable to the provision of the Services, the Consultant is encouraged to specify local materials when the materials are available, of satisfactory quality and competitive in cost.

4.6 The Consultant hereby represents and warrants to the Owner as follows and acknowledges that the Owner is relying upon such representations and warranties in connection with entering into this Agreement and making payments due hereunder:

(a) The Consultant has all necessary corporate power and authority to enter into this Agreement and perform its obligations hereunder;

(b) All necessary corporate action and other action has been taken by the Consultant to authorize the execution and delivery of this Agreement by the Consultant and the performance by the Consultant of its obligations under this Agreement, and this Agreement has been duly executed and delivered by the Consultant and constitutes a legal, valid and binding obligation of the Consultant, enforceable against the Consultant in accordance with its terms;

(c) Neither the execution and delivery of this Agreement by the Consultant nor the performance by the Consultant of its obligations under this Agreement will conflict with or result in the violation of any of the terms and provisions of the constating documents or by-laws of the Consultant or of any agreement, obligation, contract, commitment, law or regulation to which the Consultant is a party or by which it is bound; and

(d) The Consultant is a resident of Canada for the purpose of Canadian income tax legislation. If the Consultant is or becomes a non resident, the Owner may withhold from any payment otherwise due and owing under the terms of this Agreement any percentage of any such payment as may be required by such legislation. The Consultant shall inform the Owner forthwith of any change in its residency status for income tax purposes and in any event the Consultant shall indemnify the Owner for any payment not withheld, but required to be paid pursuant to such legislation, including any interest and penalty assessed thereon.

4.7 The Consultant acknowledges that timely performance of the Services is of paramount importance to the Owner. Unless otherwise directed by the Owner in writing, the Consultant shall work diligently to reach completion of the Services and achieve any required milestones in accordance with the Services Schedule.

4.8 The Consultant shall use its best efforts to avoid and mitigate any delay in the performance or provision of the Services.

5. STAFF

5.1 If applicable to the Services, the Consultant shall retain or employ professional staff licensed to practice in the Province of Newfoundland and Labrador by its respective professional associations for the conduct of the Services.

5.2 The Consultant shall assign to the performance of the Services, those personnel identified in the Consultant Proposal. The Consultant shall not replace such key personnel unless replacement becomes unavoidable, and in such case, the Consultant shall provide the Owner with the résumés and qualifications of potential candidates for such position(s). The Owner shall have the right to first approve any proposed replacement personnel.

5.3 At the request of the Owner, the Consultant will provide the Owner with a list of its employees and those of its sub-consultants who will be assigned to the provision of the Services. The list will include the classification of each employee and typical hourly rates to be paid. The purpose of such lists will be to assess the Consultant's staff for the Services and to establish rates for payments should the Services be abandoned or postponed by the Owner. The Consultant will notify the Owner's Representative of any additions or changes.

6. PROJECT MANAGEMENT/CONSTRUCTION MANAGEMENT

The Owner may elect to retain a project manager or construction manger to carry out the work of this Project and, if such appointment occurs, the Owner (in its sole discretion) shall specify the scope of such services. On this basis, the Owner reserves the right to renegotiate the duties of the Consultant and the commensurate fee. The fees and expenses of a project manager will not be included as part of the Consultant's Fee.

7. REIMBURSABLE EXPENSES

The Consultant shall be reimbursed at cost for certain reimbursable expenses incurred in relation to the performance of this Agreement in accordance with the Reimbursement Requirements.

8. FEES

8.1 Services

The Consultant agrees that its total compensation for the performance of the Services, other than the Additional Services, shall be the Fee, which does not include Harmonized Sales Tax, and which is earned as set out in Section 8.3.

It is agreed by the Parties hereto that accounts payable under this Agreement shall be payable only when the Services has been performed to the satisfaction of the Owner within the cost limit established by the Agreement, and any payment in respect of a phase or part of a phase shall not be deemed a waiver of the Owner's rights of set-off at law or under this Agreement for costs or expenses arising from default or negligence of the Consultant or its sub-consultants.

8.2 Additional Services

Additional Services shall be provided at the rates described in the Consultant Proposal. If any of the Additional Services require services for which a rate is not included in the Consultant Proposal, then rates shall be negotiated between the Consultant and the Owner, and agreed upon in writing, before the commencement of any Additional Services. Payment shall be made in accordance with this Article 8.

8.3 Payments

The Fee shall be broken down and payments made in a manner hereinafter outlined:

(a) Upon written approval by the Owner, up to the completion of the Concept Design Stage:

.15 x Fee

(b) Upon written approval of the Owner, up to the completion of the Design Development Stage:

.15 x Fee

(c) Upon written approval of the Owner, up to the completion of approved Construction Contract Documents suitable for tendering purposes and pre-tender estimate:

.40 x Fee

(d) Upon written approval of the Owner, up to the completion of the bidding and completion of written recommendation for construction contract award:

.05 x Fee

(e) During Construction Contract Administration upon written approval of the Owner, up to the completion of Construction Contract Administration:

.25 x Fee

8.4 Holdbacks

As set out in Subsection 8.5 (b), the Owner shall retain the Holdback (as well as the other items referenced in Subsection 8.5 (b)) from each payment due to the Consultant hereunder upon:

a) Achievement of Total Performance by the Consultant;

b) The delivery to the Owner of a sworn Declaration (in the form provided by the Owner) signed by the Consultant and declaring that all payments have been made by the Consultant to its suppliers and sub-consultants with the exception of monies that are being withheld in accordance with the Mechanics’ Lien Act or to satisfy deficiencies; and

c) Confirmation from the Consultant to the Owner that the Owner has been provided with all Deliverables related to the Agreement, the Owner will prepare and issue to the Consultant a Total Performance Certificate. Upon issuance of the Total Performance Certificate, the Owner shall make all remaining payments to the Consultant out of the Holdback as are permitted by the Mechanics' Lien Act and the terms of this Agreement.

8.5 Invoicing/Payment/Disputed Amounts

(a) Invoicing

The Consultant shall invoice the Owner for the total amount payable as determined in accordance with Article 8. The invoice shall provide, at minimum, an arithmetic calculation of fees payable and a detailed list of expenses including copies of receipts, documentation and time sheets. All invoices shall clearly identify any amounts paid or charged in respect of Canadian import duties, sales taxes and Goods and Services Tax (GST) or Harmonized Sales Tax (HST). In addition, the Consultant’s GST/HST registration number shall be quoted on all invoices. Invoices shall be submitted to the Owner along with all reasonably necessary back-up documentation, and payment of the invoice by the Owner shall be as provided in Subsection 8.5 (b).

The Consultant may issue invoices monthly or at such other times which are agreed between the Owner and the Consultant in writing. Amounts for Additional Services may also be invoiced monthly or at such other times which are agreed between the Owner and the Consultant in writing.

(b) Payment

The invoice and all back-up documentation required hereunder shall be submitted for payment as indicated on the Cover Pages hereof.

The Consultant agrees that no payment made by the Owner under the terms of this Agreement shall constitute, or shall be construed to constitute, the acceptance of the accuracy of any invoice, the acceptance of the validity of any charge, or the waiver of any right to claim repayment, unless and until the Owner's audit rights with respect thereto, as set forth in Article 11 hereof, shall have expired and such invoice, charge or payment shall not have been challenged. The Consultant further agrees that no payment made by the Consultant under the terms of this Agreement shall constitute, or shall be construed to constitute, the acceptance of any faulty or defective Services.

The Owner shall pay the Consultant within forty-five (45) days of receiving a properly documented invoice from the Consultant the amount due on the invoice less:

(i) The Holdback;

(ii) All amounts of credit then owning to the Owner;

(iii) Any withholding amounts required by any governmental authority, including any Holdback;

(iv) Any disputed amounts; and

(v) Any amounts not payable to the Consultant under Sections 8.1 or 8.2 hereof.

(c) Disputed Amounts

In the event of dispute, of any nature or kind, over any item or items in an invoice, the disputed amount shall be left unpaid until such time as the

Parties reach agreement regarding the disputed amount and failing such agreement thereon, the Owner and the Consultant shall:

(i) Use their best efforts in good faith to reach a reasonable and equitable resolution of the dispute; or

(ii) Proceed with good faith negotiations between managers of the Parties with decision making powers. If the Parties still fail to reach an agreement, the dispute shall be resolved in accordance with Article 10. The disputed amount, if payable, shall be paid within fifteen (15) days from the date resolution is reached regarding the disputed amount. Undisputed amounts, whether appearing on the same invoice or a different invoice as the disputed amount, shall be paid in accordance with Subsection 8.5 (b).

9. SPECIAL CONDITIONS

9.1 Force Majeure

(a) For the purposes of this Article, “Force Majeure” means an occurrence beyond the reasonable control of the Party claiming suspension of an obligation hereunder, which has not been caused by such Party's negligence and which such Party was unable to prevent or provide against by the exercise of reasonable diligence at a reasonable cost and includes, without limiting the generality of the foregoing, an act of God, war, revolution, insurrection, blockage, riot, strike, a lockout or other industrial disturbance, fire, lightning, unusually severe weather, storms, floods, explosion, accident, government restraint, action, delay or inaction.

(b) If any Party is prevented by Force Majeure from fulfilling any obligation hereunder, the obligations of the Party, in so far only as its obligations are affected by the force majeure, shall be suspended while the Force Majeure continues to prevent the performance of such obligation and for that time thereafter as that Party may reasonably require to commence to fulfil such obligation. A Party prevented from fulfilling any obligation by Force Majeure shall promptly give the other Party notice of the Force Majeure and the affected obligations, including reasonably full particulars in respect thereof.

(c) The Party claiming suspension of an obligation, as aforesaid, shall promptly remedy the cause and effect of the applicable Force Majeure, in so far as it is reasonably able so to do, and such Party shall promptly give the other Party notice when the Force Majeure ceases to prevent the performance of the applicable obligation. The terms of settlement of any strike, lockout or other industrial disturbance shall be wholly in the discretion of such Party, notwithstanding this Section, and that Party shall not be required to accede to the demands of its opponents in any strike, lockout or industrial disturbance solely to remedy promptly the Force Majeure thereby constituted.

If, within a reasonable time after a Force Majeure occurrence which has caused the Consultant to suspend or delay performance of the Services, the Consultant has failed to take such action as the Consultant could lawfully initiate to remove or relieve either the Force Majeure occurrence or its direct or indirect effects, the Owner may, in its sole discretion and after written notice to the Consultant, at Consultant's expense, initiate such measures, including but not limited to, the hiring of third parties designed to remove or relieve such Force Majeure occurrence or its direct or indirect effects and thereafter require the Consultant to resume full or partial performance of the Services. Alternatively, the Owner, in its sole discretion, may decide to terminate this Agreement without any liability whatsoever.

(d) Notwithstanding anything contained in this Section, lack of finances shall not be considered a Force Majeure nor shall any Force Majeure suspend any obligation for the payment of money due hereunder.

9.2 Confidentiality

It is acknowledged by the Consultant that in the performance of this Agreement there will be disclosed to the Consultant information of the Owner (including without limitation all intellectual property, drawings, specifications, dies, patterns and the like supplied by the Owner or prepared or constructed by the Consultant in connection with the Services), which has not been generally disclosed to the public (the “Confidential Information”). It is acknowledged that it is necessary to the proper and efficient performance of the Agreement that disclosure of Confidential Information may need to be made to the employees of the Consultant (“Permitted Purposes”).

The term “Confidential Information” does not include information which becomes:

a) Generally available to the public other than as a result of a disclosure by the Consultant or its agents or employees;

b) Available to the Consultant on a non-confidential basis from a source other than the Owner or its employees, provided that such source is not bound by a confidentiality agreement with the Owner. It is further agreed by each Party that money damages would not be sufficient remedy for any breach of this Section by the Consultant or its employees, and in addition to all other remedies, the Owner shall be entitled to specific performance and injunctive or other equitable relief as a remedy for any such breach, and the Consultant further agrees to waive and to use its best efforts to cause its employees to waive any requirement for the securing or posting of any bond in connection with such remedy.

It is agreed that the Confidential Information will not be used by the Consultant in any manner that may be detrimental, commercially or otherwise, to the Owner and that the Confidential Information will be kept confidential by the Consultant provided, however, that such Confidential Information may be disclosed to employees of the Consultant who need to know such information for the Permitted Purposes. It shall be the responsibility of the Consultant to inform such of its employees who have access to Confidential Information of the confidential nature of such information and to cause them to treat such information in the strictest of confidence and only for the Permitted Purposes.

Except as provided herein, the Confidential Information shall not be disclosed to others without prior written approval of the Owner, and upon completion of Services or upon termination of the Agreement, the Confidential Information shall be returned to the Owner.

In the event that the Consultant is requested in any proceeding to disclose any Confidential Information, the Consultant shall provide immediate notice of such request to the Owner so that it may seek an appropriate protective order. It is further agreed that, if in the absence of a protective order the Consultant is nonetheless compelled to disclose Confidential Information, such information may be disclosed without liability hereunder provided that the Consultant give written notice to the Owner of all information to be disclosed at the earliest possible time as is practicable and that the Consultant utilize its best efforts to obtain assurances that confidential treatment will be accorded to such information. The Consultant will be responsible for any breach of this Agreement by its employees. It is further agreed that upon request the Consultant will promptly redeliver to the Owner all copies of the Confidential Information and, furthermore, will destroy all memoranda, notes and other writings prepared by the Consultant or its employees based on the Confidential Information.

Failure or delay by the Owner in exercising any right, power or privilege under this Section shall not operate as a waiver thereof, nor shall any single or partial exercise thereof preclude any other further exercise thereof or the exercise of any right, power or privilege thereunder.

The Consultant acknowledges that the Owner is a public body subject to the *Access to Information and Protection of Privacy Act*, SNL 2002 Ch. A-1.1 and that this Agreement, the records of the Consultant supplied to the Owner and all related records in the custody or control of the Owner may be subject to a request for access under such legislation.

9.3 Default

(a) The Consultant shall be in default (“Default”) if any one of the following occur:

(i) If the Consultant becomes insolvent or if insolvency, receivership or bankruptcy proceedings are commenced by or against the Consultant;

(ii) If the Consultant assigns, subcontracts or transfers this Agreement or any right or interest therein, except as expressly permitted hereunder;

(iii) If the interest of the Consultant under this Agreement is devolved to any person or corporation other than as specifically permitted herein;

(iv) If the Consultant fails to make prompt payment for labour or materials or to its sub-consultants, unless such failure of the Consultant to pay is as a result of a bona fide dispute as to amounts payable by the Consultant for labour or materials or to its sub-consultants (as the case may be) and provided that any undisputed amounts are promptly paid;

(v) If the Consultant breaches applicable laws or ordinances or the lawful requirements of any competent authority or instructions of the Owner or if, except for any of the reasons of Force Majeure (as defined herein), the Consultant fails, neglects, refuses or is unable at any time during the course of the Services to provide ample material, equipment, services or labour to perform the Services at a rate or in a manner deemed sufficient by the Owner to give reasonable assurance that the Consultant shall complete the Services in accordance with this Agreement;

(vi) If the Consultant fails to prosecute the Services in such a manner as to complete the Services in accordance with the Services Schedule, provided, however, that the Owner first provides the Consultant with thirty (30) days’ notice of its intention to terminate their Agreement for default of this Subsection and a reasonable opportunity to cure such Default; or

(vii) If the Consultant defaults in its performance of a representation, warranty or guarantee or other provision of this Agreement provided, however, that the Owner first provides the Consultant with thirty (30) days’ notice of its intention to terminate this Agreement for default of this Subsection and a reasonable opportunity to cure such Default.

If the Consultant is in Default, then the Owner, without prejudice to any other rights or remedies available to it under this Agreement or at law, may terminate this Agreement forthwith by giving written notice of termination to the Consultant, and/or the Owner shall have the right to finish the Services either directly or by using the services of other Consultants or the services of the Consultant's employees.

(b) In the case of Default:

(i) The Consultant shall execute all papers and take all other steps which may be required to vest in the Owner all rights, title, set offs and other benefits held by the Consultant in connection with the performance of the Services;

(ii) The Consultant shall be liable for actual Losses incurred by the Owner on account of the Consultant's Default, which actual Losses may be set-off against amounts due to the Consultant hereunder; and

(iii) The Owner shall be entitled to suspend payments to the Consultant until such time as 1) it has been determined by written agreement between Owner and the Consultant that amounts are due to the Consultant, 2) the Consultant cures the Default, or 3) it has been determined in accordance with Article 10 that amounts are due to the Consultant, in all cases taking into account the Owner's rights of set-off against any such payments.

9.4 <u>Suspension of Services or Termination without Default</u>

(a) The Owner may, in its sole discretion and without or without reason, suspend the Services or any portion thereof at any time by providing twenty (20) days' written notice to the Consultant. Upon receipt of such written notice, the Consultant shall:

(i) Stop all suspended Services and place no further sub-consultants or orders in relation to the suspended Services;

(ii) Forward to the Owner all complete or incomplete reports, data and other documents pertaining to such suspended Services or portion thereof;

(iii) If requested by the Owner, assign or suspend sub-consultants and orders to the extent they relate to the suspended portion of the Services;

(iv) Complete the performance of any unsuspended portions of the Services in accordance with this Agreement;

(v) Cooperate and assist the Owner in respect of the best methods of mitigating any delays, costs or Losses arising from the suspended Services; and

(vi) Maintain the key personnel identified in the Consultant Proposal for up to thirty (30) days from the Notice of Suspension as required by the Owner.

In the event of such suspension, the Consultant shall be paid by the Owner in accordance with Subsection 9.4 (c) hereof.

If the Owner requests the Consultant proceed with the Services within sixty (60) days or less from the date that the Owner requested the Services be suspended, the Consultant shall, upon the cessation of such suspension, and may, at its option if requested by the Owner when such suspension is longer than sixty (60) days, resume performance of the Services, and the Owner shall reimburse the Consultant in accordance with Subsection 9.4 (d) hereof.

If on or after sixty-one (61) days of suspension the Owner requests resumption of the Services, the Consultant may refuse to resume the Services.

(b) In addition, the Owner, may in its sole discretion and without cause, terminate all or any part of the Services at any time upon ten (10) days’ written notice to the Consultant. Upon receipt of such notice, the Consultant shall stop the Services, or portion thereof, and forward to the Owner all complete or incomplete reports, data and other documents pertaining to such cancelled Services, or portion thereof, and shall assign any subcontracts to the Owner if the Owner so requests.

(c) In the event of suspension or termination of any part of the Services in accordance with the provisions of this Section 9.4, the Consultant shall be entitled to full payment for that part of the Services performed by the Consultant under the terms and conditions of this Agreement up to the effective date of such termination or suspension.

If this Agreement provides for the payment for Services upon the completion of milestones, then the following provision shall apply:

Should this Agreement be suspended or terminated by the Owner in accordance with the provisions of this Section prior to the completion of any or all of milestones for payment, the payment for any Services completed in addition to an approved milestone will be on the basis of hourly rates for the classification involved as set out in the Consultant Proposal.

The Owner shall not pay any cancellation fees or expenses related to cancellation, termination or suspension (unless the Consultant is entitled to payment of fees or expenses on resumption of the Services under Subsection 9.4 (a)) by the Owner under this Section 9.4 and shall not be liable for any Losses of the Consultant including, without limitation, loss of anticipated profits on account of such suspension or termination.

(d) In the event of a resumption of suspended Services under Subsection 9.4 (a), the Consultant shall be paid:

(i) Disbursements incurred in relation to the suspension of the Services;

(ii) Third party cancellation charges incurred by the Consultant to the date of the suspension; and

(iii) Any demobilization costs and remobilization costs.

9.5 Provision of Materials on Termination

Upon suspension and/or termination of this Agreement, irrespective of the time, manner or cause of the said suspension and/or termination, the Consultant must provide the Owner with all Deliverables, including, without limitation, drawings, reports, specifications, bills of quantities, calculations, computer generated files and other documents and/or records related to the Services, including all copies except for one copy which the Consultant shall be entitled to retain subject to the confidentiality provisions of this Agreement.

9.6 Survival of Agreement

The rights and obligations of the Owner and the Consultant, which by their nature survive termination or completion of this Agreement, including but not limited to those relating to confidentiality, liability, indemnification, warranty and other remedies, settlement of accounts, audit, taxes and disputes, shall survive any termination or suspension of the Services and expiration of this Agreement and remain enforceable thereafter, anything in this Agreement to the contrary notwithstanding.

9.7 Suspension or Termination by Consultant

Failure by the Owner to make payments, other than those payments which may be delayed or withheld by the Owner pursuant to Sections 8.4 and 8.5 hereof, is substantial non-performance and cause for either termination or suspension of the Agreement. If the Owner fails to make timely payments to the Consultant of amounts due to the Consultant, other than those payments which may be delayed or withheld by the Owner pursuant to Sections 8.4 and 8.5 hereof, the

Consultant may upon forty-five (45) days' prior written notice to the Owner suspend performance of the Services under this Agreement.

10. DISPUTE RESOLUTION

In the event of disagreement between the Parties as to the performance of the Services or the interpretation, application or administration of the Agreement, the Consultant shall continue to perform the Services as per the terms and conditions of the Agreement. All differences between the Parties not resolved by negotiation and all disputes and claims of either Party arising out of this Agreement and its performance shall be settled in accordance with this Article.

In the event of any dispute arising out of or in connection with this Agreement, the Parties shall make all best efforts to resolve all disputes and claims by negotiation and agree to provide, without prejudice, open and timely written disclosure of relevant facts, information and documents to facilitate these negotiations.

In the event that negotiation does not succeed in resolving the dispute, or if either one of the Parties refuses or chooses to opt out of the negotiation, the dispute will be resolved through confidential final and binding arbitration to be held in St. John's, Newfoundland and Labrador excluding any further legal procedure. Such arbitration will be governed by the rules of the *Arbitration Act* (Newfoundland and Labrador) by one arbitrator. The arbitrator shall be appointed in accordance with the said rules. The arbitration shall be conducted and all related communications shall be in the English language.

11. RIGHT OF AUDIT

The Consultant will keep and maintain accurate time sheets and cost invoice records of its services performed under this Agreement including services performed on its behalf by a sub-consultant (if permitted) and, when required, make such material available for inspection and audit by the Owner.

The Consultant shall be responsible for ensuring that all of its records and its permitted sub-consultants' records specified above are preserved and made available at any time for audit, without additional compensation therefore, for a period of seven (7) years after the expiry of the Warranty Period. The Owner's right to audit such records shall continue for the period of time in which the Consultant is required to retain such records.

12. COPYRIGHT

All surveys, reports, drawings, calculations, design, plans, specifications and other digital or hard copy data compiled and collected in connection with the Services are the property of the Owner and the copyright therein vests in the Owner. The Consultant may retain one (1) complete set of the above-described material for its records. The Owner will make available its originals to the Consultant for all proper and reasonable purposes for a period of five (5) years following the completion or termination of the Consultant's services under this Agreement.

13. WARRANTY AND INDEMNITY

13.1 Warranty

The Consultant hereby warrants to the Owner as follows and acknowledges that the Owner is relying upon such warranties in connection with entering into this Agreement and making payments due hereunder:

(a) The Services will meet all of the requirements set forth in this Agreement. If errors and omissions arise in respect of the performance of the Services under this Agreement, Section 13.2 shall apply;

(b) The Consultant has all of the required skills, facilities, equipment and capacity to perform the Services and will perform the Services with all due diligence and in a manner and to a standard which would normally be employed by a recognized reputable professional Consultant performing Services of a comparable nature; and

(c) All deliverables including, if applicable to the Services, all design, engineering, drawings and specifications prepared or supplied by the Consultant will be accurate to the standards of skill, care and diligence referred to in Subsection 13.1 (b).

13.2 Warranty Period and Remedy for Non-Performance

The Warranty Period with regard to this Agreement is from the date on which the Services are performed by the Consultant up to where:

(a) The Consultant has been engaged to provide construction contract administration services pursuant to Section 3.11 hereof, the date which is one (1) year from the issuance of the Substantial Performance Certificate; or

(b) The Consultant has not been engaged to provide construction contract administration services as part of the Services, the date which is one (1) year from the issuance of the Total Performance Certificate to the Consultant for the Services provided hereunder.

(the applicable period, referred to herein as the "Warranty Period").

The Consultant shall, upon notice by the Owner, correct by re-performing the Services in which the deficiency or defect appeared or performing additional Services of the same nature as the Services at its own cost and expense, any deficiencies or defect in its Services or any defect caused by the performance, purported performance or non-performance of the Services, which appear prior to or during the Warranty Period (the “Corrective Services”) and for which the Owner has provided such notice to the Consultant no later than thirty (30) days after the end of the Warranty Period.

The Warranty Period is extended for an additional one (1) year period from the later of 1) the completion of the Corrective Services or 2) the end of the original Warranty Period in respect of any deficiencies caused by the performance, purported performance or non-performance of the Corrective Services.

13.3 Owner’s Right to Complete

In the event the Consultant fails or refuses to correct such deficiencies or defect in a timely manner, the Consultant shall be in Default under this Agreement in which case the Owner reserves the right to complete any required remedial Services itself, or by others, and Section 9.3 shall apply.

13.4 Owner’s Other Rights

The Owner's right to require the Consultant to re-perform the Services set forth in this Article 13 shall be in addition to, and not a waiver, reduction or restriction of, the Owner's other rights and remedies at law or in equity. Nothing contained in this Article 13 shall reduce or limit the otherwise applicable statutes of limitation for any action based upon the Consultant's breach of any representation, warranty or guarantee.

13.5 Consultant’s Liability and Indemnity

(a) The Consultant shall be liable to the Owner for and shall indemnify, defend and save harmless the Owner from and against all Losses which the Owner may suffer, pay or incur as a result of the Consultant’s failure to comply with the terms of this Agreement and any negligence, negligent omission or wilful misconduct of the Consultant in connection with, related to or arising out of this Agreement.

(b) Without limiting the generality of the foregoing, the Consultant shall be liable to the Owner for and shall indemnify, defend and save harmless the Owner from and against all Losses which the Owner may suffer, pay or incur in respect of:

(i) Any Lien placed by the Consultant or any sub-consultant or supplier or other person arising from the performance of the Services; and

(ii) The actual or alleged infringement of any rights under patent, copyright or any other intellectual property right or any litigation based thereon, arising from the Services.

The Consultant’s liability to indemnify or reimburse the Owner under this Agreement shall not limit or prejudice the Owner from relying on the provisions of applicable legislation.

For greater certainty, the indemnity survives the end of the Warranty Period.

14. AGREEMENT

14.1. This Agreement shall enure to the benefit of and be binding upon the Parties hereto, their successors and permitted assigns.

14.2 This Agreement may not be assigned in whole or in part without the prior written consent of the Owner.

14.3 This Agreement shall be governed by and construed in accordance with the laws of the Province of Newfoundland and Labrador and the federal laws of Canada applicable therein. The Parties irrevocably submit to the exclusive jurisdiction of the courts of the Province of Newfoundland and Labrador, as applicable, with respect to any matter arising hereunder or related hereto.

14.4 Any notice or communication required or permitted to be given under this Agreement must be in writing and shall be served either personally, by facsimile (with adequate proof of delivery), by deposit with an overnight courier with charges prepaid, or by prepaid registered post addressed 1) to the Owner at the address and facsimile number provided on the Cover Pages hereof, and 2) to the Consultant at the address and facsimile number provided on the Cover Pages hereof, or 3) such other address as either Party may give the other by written notice.

Any such notices shall be deemed to have been given 1) upon delivery in the case of personal delivery, 2) upon the first business day following facsimile receipt, 3) one (1) business day after deposit with an overnight courier, or 4) three (3) business days after deposit in the mail, provided that if such mail service shall be interrupted by strike or other irregularity before the deemed receipt of such notice as aforesaid, then such notice shall not be effective unless delivered or transmitted via facsimile.

14.5 This Agreement, together with any documents incorporated by reference herein, constitutes the entire agreement between the Consultant and the Owner in connection with the subject matter hereof and there are no other representations, warranties, undertakings, promises, covenants, conditions, terms, agreements or inducements by or between the parties hereto relating to the subject matter of this Agreement not embodied or contained in this Agreement.

In the process of selecting the Consultant, the Owner relied upon the Consultant Proposal. Notwithstanding the foregoing, for the purpose of clarification or interpretation, the Owner may rely upon the Consultant Proposal and any other documents and submissions made by the Consultant.

In the event of any conflict in the documents comprising this Agreement, the following shall apply:

(a) The Cover Pages together with Appendix 1 – Terms and Conditions (without reference to the other Appendices) shall govern over all other Appendices; and

(b) The RFP shall take precedence over the Consultant Proposal.

If any of the terms of the Consultant Proposal violate any of the terms, provisions or context of the RFP or a provision or context of the Cover Pages together with Appendix 1 – Terms and Conditions (without reference to the other Appendices), the parties agree that the terms, provisions or context of the RFP or the provision or context of the Cover Pages together with Appendix 1 – Terms and Conditions (without reference to the other Appendices) shall prevail, and the Consultant Proposal will be construed as having been altered to conform with such terms, provisions or context. If any of the terms of the Cover Pages together with Appendix 1 – Terms and Conditions (without reference to the other Appendices) conflict with the terms of the RFP, the terms and provisions of the Cover Pages together with Appendix 1 – Terms and Conditions (without reference to the other Appendices) prevail.

14.6 Headings used in this Agreement are provided for convenience only and shall not be used to construe meaning or intent.

14.7 This Agreement shall be interpreted according to the ordinary and usual meaning of the words herein, including any usage or custom in the industry which is relevant to the provisions of the Services.

14.8 Words importing the singular include the plural and vice versa, and words importing gender include all genders.

14.9 This Agreement may be amended only by written instrument executed by both Parties. No modification or change to this Agreement shall be binding upon any Party unless contained in writing signed by the other Party. No course of dealing, course of performance, or trade usage, and no parol evidence of any nature, shall be used to supplement or modify such agreement and understanding.

(a) No waiver or course of dealing shall extend to, or constitute a waiver of, any subsequent or other defaults or impair any right consequent thereon.

(b) No failure or delay on the part of any Party in exercising any right, power, or privilege hereunder and no course of dealing between the parties shall operate as a waiver of any default or any such right, power or privilege.

(c) No waiver to this Agreement shall be binding unless in writing signed by the waiving Party.

If any term or provision of this Agreement or the application thereof to any persons or circumstances shall to any extent or for any reason be invalid or unenforceable, the remainder of this Agreement and the application of such terms or provisions to persons or circumstances other than those as to which it is held invalid or unenforceable shall not be affected thereby, and each such remaining term or provision of this Agreement shall be valid and enforced to the fullest extent permitted by law.

14.10 This Agreement may be executed in one or more counterparts, each of which so executed will constitute an original and all of which together will constitute one and the same agreement. This Agreement may be executed and delivered by fax or email (pdf) and shall upon such execution and delivery be fully enforceable.

APPENDIX 2

RFP

APPENDIX 3

CONSULTANT PROPOSAL

APPENDIX 4

PROTECTION OF PRIVACY

PROTECTION OF PRIVACY

This Appendix forms part of the agreement between:

MEMORIAL UNIVERSITY OF NEWFOUNDLAND (the "University")

and

the Consultant (as defined on the Cover Pages of this Agreement)

Respecting a Consultant's Agreement between the Owner and the Consultant dated as of the date hereof (the "Agreement").

Definitions

1. In this Appendix,

   (a) "Act" means the Access to Information and Protection of Privacy Act of Newfoundland and Labrador, as amended from time to time;

   (b) "Contact Information" means information to enable an individual at a place of business to be contacted and includes the name, position name or title, business telephone number, business address, business email or business fax number of the individual;

   (c) "Personal Information" means recorded information about an identifiable individual, other than Contact Information, collected or created by the Consultant as a result of the Agreement or any previous agreement between the University and the Consultant dealing with the same subject matter as the Agreement.

Purpose

2. The purpose of this Appendix is to:

   (a) Enable the University to comply with its statutory obligations under the Act with respect to Personal Information; and

   (b) Ensure that, as a service provider, the Consultant is aware of and complies with its statutory obligations under the Act with respect to Personal Information.

Collection of Personal Information

3. Unless the Agreement otherwise specifies or the University otherwise directs in writing, the Consultant may only collect or create Personal Information that is necessary for the performance of the Consultant's obligations, or the exercise of the Consultant's rights, under the Agreement.

4. Unless the Agreement otherwise specifies or the University otherwise directs in writing, the Consultant must collect Personal Information directly from the individual the information is about.

5. Unless the Agreement otherwise specifies or the University otherwise directs in writing, the Consultant must tell an individual from whom the Consultant collects Personal Information:

   (a) the purpose for collecting it;

   (b) the legal authority for collecting it; and

   (c) the title, business address and business telephone number of the person designated by the University to answer questions about the Consultant's collection of Personal Information.

Accuracy of Personal Information

6. The Consultant must make every reasonable effort to ensure the accuracy and completeness of any Personal Information to be used by the Consultant or the University to make a decision that directly affects the individual the information is about.

Requests for access to Personal Information

7. If the Consultant receives a request for access to Personal Information from a person other than the University, the Consultant must promptly advise the person to make the request to the University unless the Agreement expressly requires the Consultant to provide such access and, if the University has advised the Consultant of the name or title and Contact Information of an official of the University to whom such requests are to be made, the Consultant must also promptly provide that official's name or title and Contact Information to the person making the request.

Correction of Personal Information

8. Within 5 business days of receiving a written direction from the University to correct or annotate any Personal Information, the Consultant must annotate or correct the information in accordance with the direction.

9. When issuing a written direction under section 8, the University must advise the Consultant of the date the correction request to which the direction relates was received by the University in order that the Consultant may comply with section 10.

10. Within 5 business days of correcting or annotating any Personal Information under section 8, the Consultant must provide the corrected or annotated information to any party to whom, within one year prior to the date the correction request was made to the University, the Consultant disclosed the information being corrected or annotated.

11. If the Consultant receives a request for correction of Personal Information from a person other than the University, the Consultant must promptly advise the person to make the request to the University and, if the University has advised the Consultant of the name or title and Contact Information of an official of the University to whom such requests are to be made, the Consultant must also promptly provide that official's name or title and Contact Information to the person making the request.

Protection of Personal Information

12. The Consultant must protect Personal Information by making reasonable security arrangements against such risks as unauthorized access, collection, use, disclosure or disposal, including any expressly set out in the Agreement.

Retention of Personal Information

13. Unless the Agreement otherwise specifies, the Consultant must retain Personal Information until directed by the University in writing to dispose of it or deliver it as specified in the direction.

Use of Personal Information

14. Unless the University otherwise directs in writing, the Consultant may only use Personal Information if that use is:

    (a) for the performance of the Consultant's obligations, or the exercise of the Consultant's rights, under the Agreement; and

    (b) in accordance with section 13.

Disclosure of Personal Information

15. Unless the University otherwise directs in writing, the Consultant may only disclose Personal Information inside Canada to any person other than the University if the disclosure is for the performance of the Consultant's obligations, or the exercise of the Consultant's rights, under the Agreement.

Inspection of Personal Information

16. In addition to any other rights of inspection the University may have under the Agreement or under statute, the University may, at any reasonable time and on reasonable notice to the Consultant, enter on the Consultant's premises to inspect any Personal Information in the possession of the Consultant or any of the Consultant's information management policies or practices relevant to its management of Personal Information or its compliance with this Schedule and the Consultant must permit, and provide reasonable assistance to, any such inspection.

Compliance with the Act and directions

17. The Consultant must in relation to Personal Information comply with:

    (a) the requirements of the Act applicable to the Consultant as a service provider, and

    (b) any direction given by the University under this Appendix.

18. The Consultant acknowledges that it is familiar with the requirements of the Act governing Personal Information that are applicable to it as a service provider.

Notice of non-compliance

19. If for any reason the Consultant does not comply, or anticipates that it will be unable to comply, with a provision in this Appendix in any respect, the Consultant must promptly notify the University of the particulars of the non-compliance or anticipated non-compliance and what steps it proposes to take to address, or prevent recurrence of, the non-compliance or anticipated non-compliance.

Termination of Agreement

20. In addition to any other rights of termination which the University may have under the Agreement or otherwise at law, the University may, subject to any provisions in the Agreement establishing mandatory cure periods for defaults by the Consultant, terminate the Agreement by giving written notice of such termination to the Consultant, upon any failure of the Consultant to comply with this Appendix in a material respect.

Interpretation

21. In this Appendix, references to sections by number are to sections of this Appendix unless otherwise specified in this Appendix.

22. Any reference to the “Consultant” in this Appendix includes any sub-consultant or agent retained by the Consultant to perform obligations under the Agreement and the Consultant must ensure that any such sub-consultants and agents comply with this Appendix.

23. The obligations of the Consultant in this Appendix will survive the termination of the Agreement.

24. If a provision of the Agreement (including any direction given by the University under this Appendix) conflicts with a requirement of the Act or an applicable order of the Commissioner under the Act, the conflicting provision of the Agreement (or direction) will be inoperative to the extent of the conflict.

25. The Consultant must comply with the provisions of this Appendix despite any conflicting provision of this Agreement or the law of any jurisdiction outside Canada.

APPENDIX 5

INITIAL SERVICES SCHEDULE

APPENDIX 6

REIMBURSEMENT REQUIREMENTS

Department of Facilities Management
Consultant Reimbursable Expenses Guidelines

Direct Expenses

Expenses incurred by the Consultant on behalf of the Memorial University related to the provision of the Consultant's services and the production of instruments of services, such as computer models, drawings and specifications, as a result of designing, documenting, bidding and constructing a building shall be reimbursed at cost and not covered by professional fees. All reimbursable expenses shall be supported by copies of invoices for said costs.

Reimbursable expenses shall include, but are not limited to:

- Communication and shipping costs (long distance charges, courier, postage, dedicated web hosting, etc.);
- Reproduction costs for plans, sketches, drawings, graphic representations and other documents;
- Renderings, models, prints of computer-generated drawings, mock-ups specifically requested by the University;
- Special computer modeling and documentation;
- Certification and documentation costs for third party certification such as LEED;
- Fees, levies, duties or taxes for permits, licences, or approvals for Authorities Having Jurisdiction.

Travel

All travel at University expense must occur by the most economical mode of transportation that is available and practical, while considering the purpose and the urgency of the trip. Reasonable expenses will be reimbursed at cost. No markup or overhead charge will be paid. Consultants will be expected to follow the University policy Travel–General as applicable unless agreed otherwise. The policy is available at http://www.mun.ca/policy/site/policy.php?id=232. In addition the following shall apply:

1. Air travel should not exceed full economy fare. Business class (or equivalent) will not be reimbursed.
2. Meal per diems shall be as set out in the policy for Per Diem Allowances.
3. Alcohol will be not be reimbursed.
4. Hosting expenses or other entertainment expenses will not be reimbursed. These are considered the consultants' cost if incurred.
5. Mileage within a 25 kilometer radius of the Consultant's office is not considered a reimbursable expense. Mileage will only be reimbursed for travel beyond this 25 kilometer radius.

APPENDIX H – HEALTH AND SAFETY ORIENTATION

Health and Safety Orientation

MAY 2022

MEMORIAL UNIVERSITY

www.mun.ca

Welcome to Memorial University

Memorial is committed to developing, maintaining, implementing and continuously improving a safe and healthy work, teaching and learning environment. Prior to starting work at Memorial it is important that you are aware of the following health and safety information.

Health and Safety Information

Emergency Response

- To report an emergency (dialed from a campus phone, otherwise dial 864-XXXX):
  - St. John's Campus – 4100
  - Health Sciences Centre - 4100
  - Ocean Sciences Centre – 9-911*
  - Marine Institute – 9-911*
  - Grenfell – 2888

*when utilizing 911, a follow up call should be made to St. John's Campus Enforcement and Patrol (CEP) 4100.

Incident Reporting and MUN Safe

- <u>All</u> health and safety incidents must be reported to your Memorial Representative and an incident report completed
- Download the MUN Safe app to quickly access campus resources 24/7 such as emergency push notifications, emergency procedures, incident reporting and more.
  - Report hazard observations and near misses via MUN Safe

First Aid and AEDs

- In case of an injury, first aid kits are located in all office suites and laboratories
- All workplaces have AEDs as well as trained first aid responders, names posted throughout the buildings.

Emergency Evacuations

- Ensure you are aware of the primary and secondary.
- The building fire alarm system can be activated at the nearest fire alarm pull station.
- Emergency evacuation and location plans are posted on each in each building. Exit the building immediately upon activation of the alarm and proceed to the building's assembly point.
  - Mobility impaired individuals must proceed to the nearest stairwell and inform an emergency warden of their location

Working Alone

- If activities involve lone work then a check-in process must be developed in consultation with your Memorial Representative.

Communicable Disease

- Practice good hand hygiene and cough/sneeze into your arm
- Do not come to campus if feeling unwell

Other

- Memorial is a smoke-free campus
- Speed limit on Memorial road is 30 km/hr, be mindful of the many pedestrians on campus
- Obey all posted signage

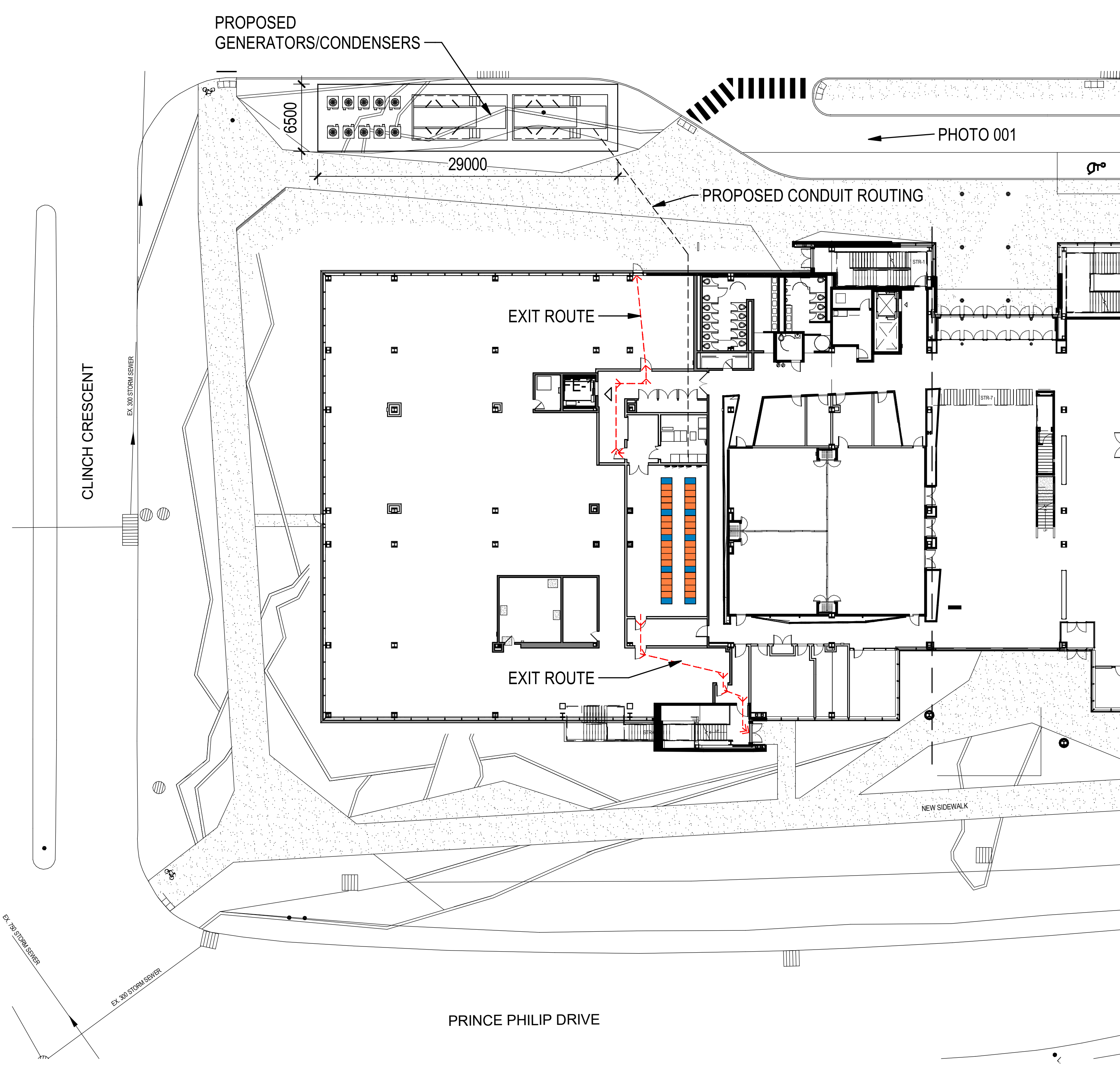
Contact us

Environmental Health and Safety
Office of the Chief Risk Officer
E: health.safety@mun.ca
www. mun.ca

This is one in a series of informational fact sheets highlighting Environmental Health and Safety.

APPENDIX I – CONCEPT DESIGN REPORT SKETCHES & ELECTRCIAL RISER DIAGRAM

PHOTO 001



CONCEPT SITE PLAN - OPTION 2

1 / A-102

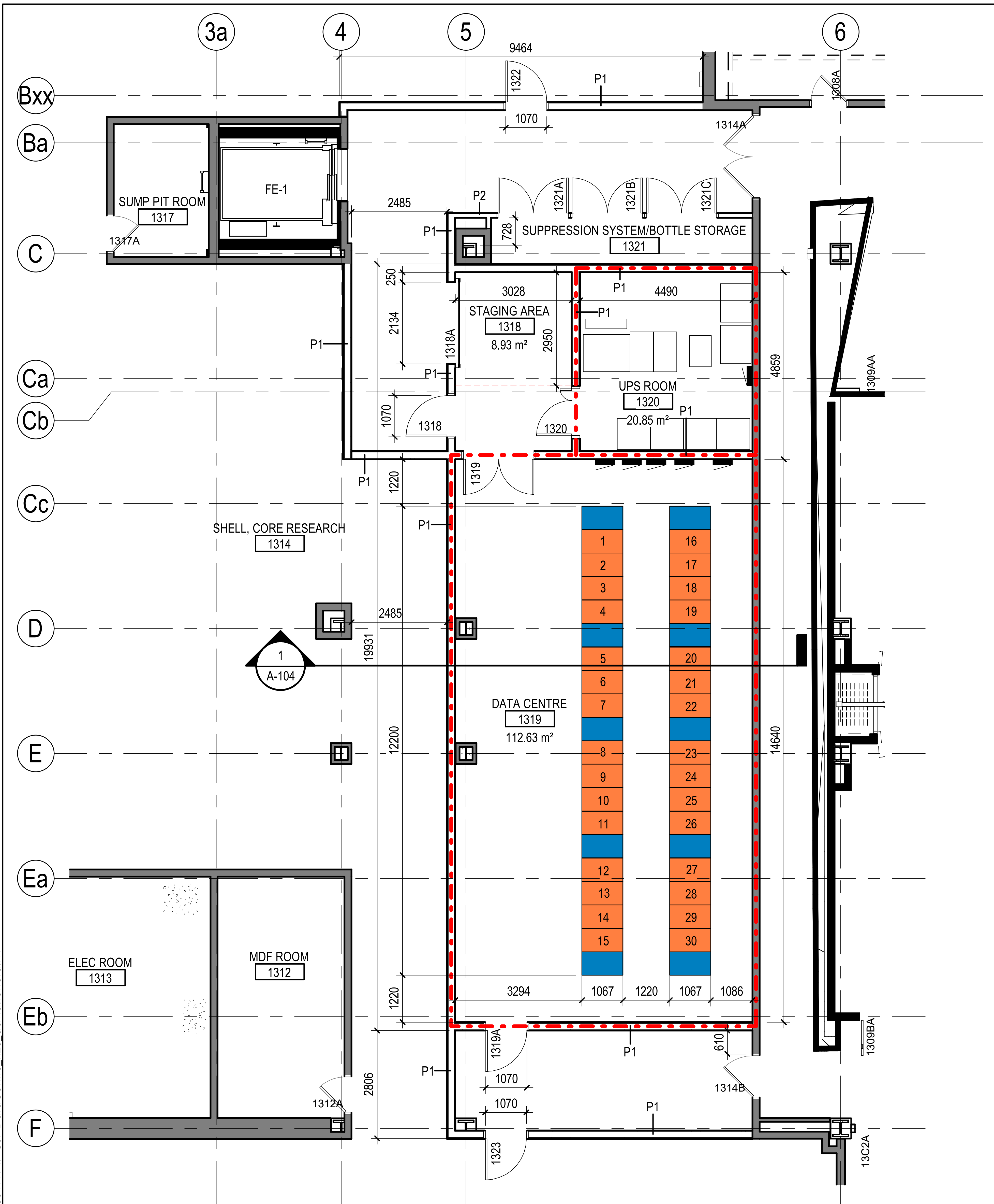
1 : 500

4/25/2024 10:11:56 AM C:\Users\Public\Documents\Local_Revit_Files\133411747-CSF-DataCentre_R23_david.tetford.rvt

Stantec

OFFICE ADDRESS LINE 1 / OFFICE ADDRESS LINE 2
OFFICE CITY, XX XXX XXX
www.stantec.com

Client/Project	MUN CSF DATA CENTRE
Revision	REVISED CONCEPT
YYYY.MM.DD	2024.04.25
Title	CONCEPT SITE PLAN - OPTION 2 REVISED
Project No.	133411747
Reference Sheet	
Figure No.	A-102



1 A-103 PARTIAL PLAN - LEVEL 1

1 : 100

SYMBOLS LEGEND

DATA RACK 43u
610x1067x1867H

COOLING RACK
610x1067x1867H

ILLUSTRATED RAISED
ACCESS FLOOR FOR
PLANNING PURPOSES

60 MIN FIRE SEPARATION

WE HAVE ILLUSTRATED A RAISED ACCESS FLOOR PURELY FOR PLANNING PURPOSES. CURRENTLY, IT IS ENVISAGED THAT RACKS WILL BE FED FROM ABOVE. A RAISED ACCESS FLOOR COULD BE PROVIDED BUT THIS WILL REQUIRE FURTHER STUDIES REGARDING RAMP ACCESS AND LOCATION OF ENTRANCE DOOR.

PARTITION TYPES:

P1 16mm TYPE 'X' GYPSUM BOARD
152mm METAL STUD @ 400 c/c
BATT INSULATION TO FILL CAVITIES
16mm TYPE 'X' GYPSUM BOARD

P2 16mm TYPE 'X' GYPSUM BOARD
152mm METAL STUD @ 400 c/c
16mm TYPE 'X' GYPSUM BOARD

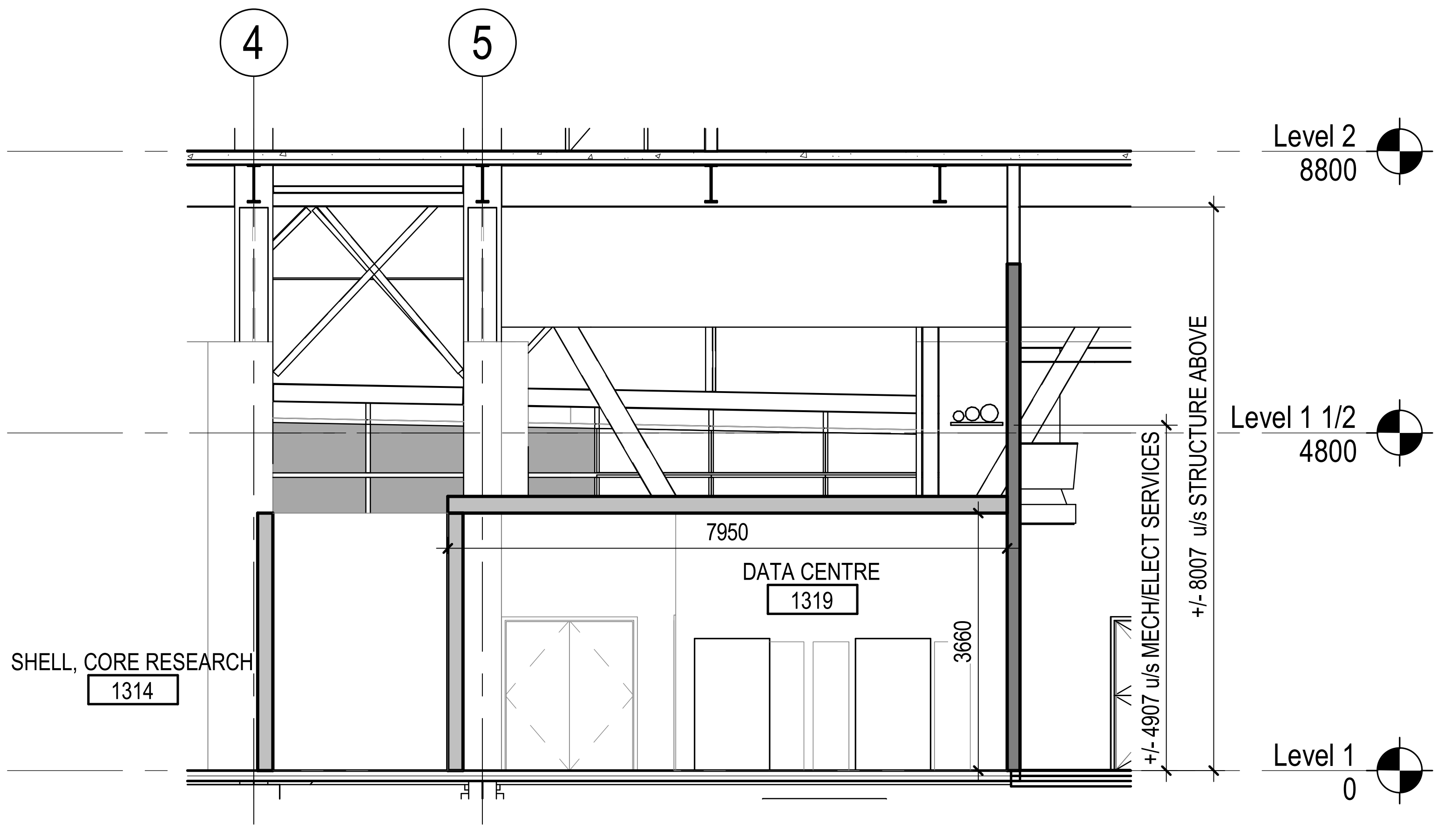
Stantec
OFFICE ADDRESS LINE 1 / OFFICE ADDRESS LINE 2
OFFICE CITY, XX XXX XXX
www.stantec.com

Client/Project
MUN
CSF DATA CENTRE

REVISED CONCEPT — 2024.04.25
Revision — YYYY.MM.DD

Title
PARTIAL FLOOR PLAN - OPTION 2 - REVISED

Project No. 133411747
Reference Sheet
Figure No. A-103



1
A-104

PARTIAL BUILDING SECTION

1 : 100

Stantec
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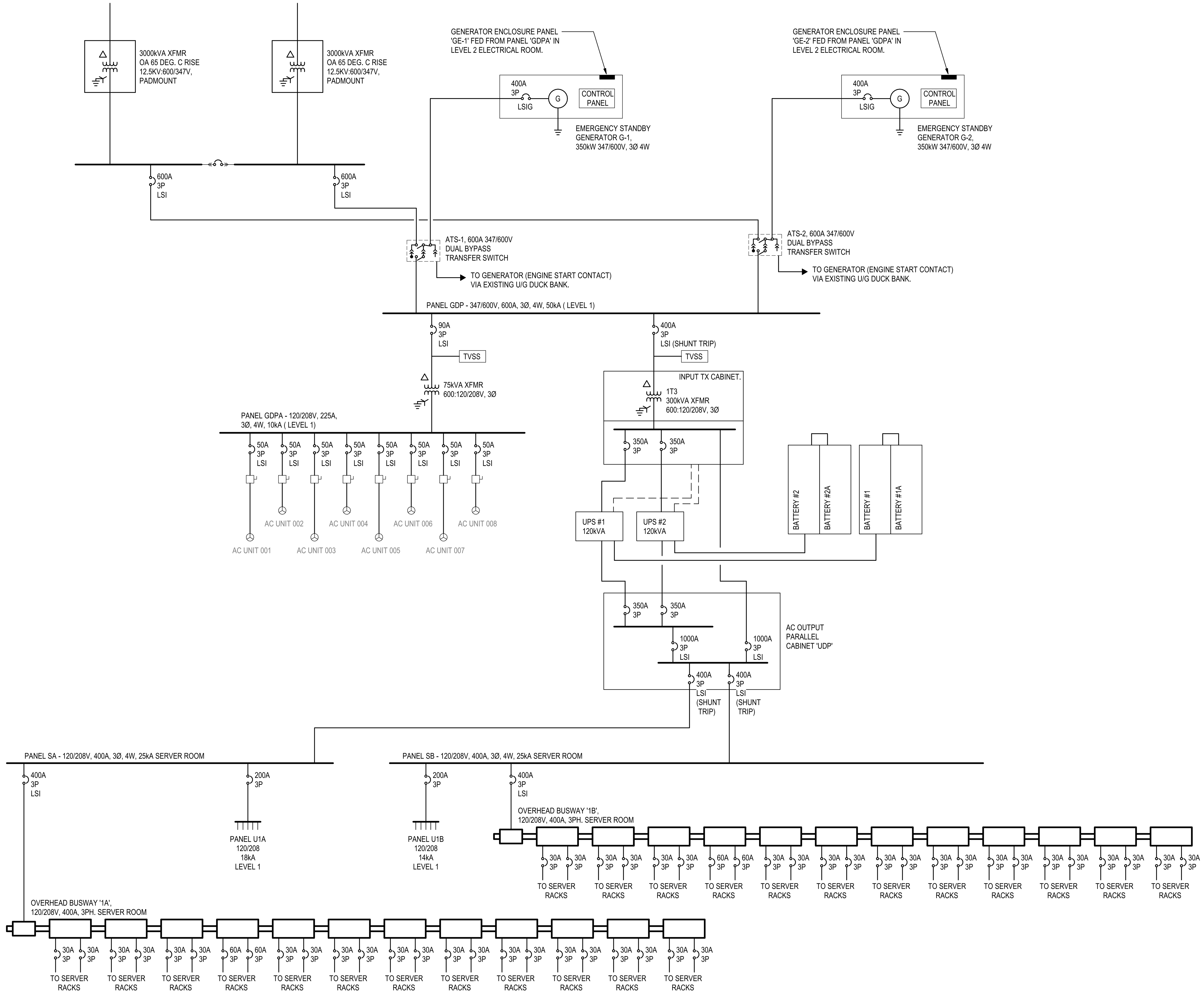
OFFICE CITY, XX XXX XXX
www.stantec.com

Client/Project
MUN
CSF DATA CENTRE

Revision
YYYY.MM.DD

Title
PARTIAL BUILDING SECTION

Project No.	Reference Sheet	Figure No.
133411747		A-104



1 E001 PARTIAL ELECTRICAL RISER DIAGRAM - CSF DATA CENTRE

N.T.S.

Stantec

Prime Consultant /
Architectural Consultants
Stantec Architecture Ltd.
141 Kelsey Drive
St. John's, NL A1B 0L2
Tel. (709) 576-1458 Fax.(709) 576-2126
stantec.com

Consultants

Legend

Revision

		By	Appd	YYYY.MM.DD
A	ISSUED FOR CONCEPT REVIEW	JD	BR	2024.04.24

Issued

Permit-Seal

PRELIMINARY
NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes.
This document has not been completed or checked and is for general information or comment only.

Client/Project

DATA CENTRE CONCEPT REPORT

CORE SCIENCE FACILITY

Title

PARTIAL ELECTRICAL RISER DIAGRAM

Project No. 133347974

Scale N.T.S.

Drawing No. E001

Revision

APPENDIX J – UPTIME INSTITUTE TIER STANDARD SUMMARY TABLES

Tier Requirements Summary

A summary of the preceding requirements defining the four distinct Tier classification levels is in Table 1. In the table, Crtitical Power Distribution is defined as the power from the UPS output to the IT assets.

	Tier I	Tier II	Tier III	Tier IV
Minimum Capacity Components to Support the IT Load	N	N+1	N+1	N After any Failure
Distribution Paths - Electrical Power Backbone	1	1	1 Active and 1 Alternate	2 Simultaneously Active
Critical Power Distribution	1	1	2 Simultaneously Active	2 Simultaneously Active
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	No	Yes
Continuous Cooling	No	No	No	Yes

Table 1: Tier Requirements Summary

APPENDIX K – RJ BARTLETT ENGINEERING LTD. CSF DESIGN DEVELOPMENT BUILDING CODE ANALYSIS

- Fire Protection Engineering
- Building and Fire Code Consulting

RJB Forensic

- Investigative Engineering

1133 Regent Street
Suite 113
Fredericton, NB
E3B 3Z2
Canada
Tel: (506) 459-3070
Fax: (506) 450-3731

1046 Barrington Street
2nd Floor
Halifax, NS
B3H 2R1
Canada
Tel: (902) 496-3070
Fax: (902) 468-1150

rjbel@rjbartlett.com

www.rjbartlett.com

HOK

MUN Core Science Building
St. John's, NL

Design Development Building Code Analysis

REGISTERED PROFESSIONAL ENGINEER
PEG Newfoundland and Labrador
BENJAMIN COLES
SIGNATURE
2017/01/19
DATE
NEWFOUNDLAND & LABRADOR

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEG Newfoundland and Labrador
PERMIT HOLDER
This Permit Allows
R.J. BARTLETT ENGINEERING LTD.
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEG D0114 which is valid for the year 2016.

14024 Sealed Design Development Building Code Analysis R170119

QUALITY REVIEW FORM

RJ Bartlett Engineering Ltd

Document Verification
Page 1 of 1

Project Title	Design Development Building Code Analysis for MUN Core Science Building, St. John's, NL	Project Number 14024

Revision	Date	Issued to	14024 Sealed Design Development Building Code Analysis R170119		
			Prepared By:	Checked By:	Approved By:
Sealed	January 19, 2017	Client	Kevin McCarthy, EIT	Christian Oickle, M.E., P.Eng.(NL) Fire Protection Engineer	Ben Coles, M.Sc.E., MBA, P.Eng. (NL), PE Fire Protection Engineer
			Admin Staff	Heather Cameron	

Technical Calculation Review:
Yes ☑ **N/A** ☐

Peer Review:
Yes ☑ **N/A** ☐

Table of Contents

1 Introduction

This project involves the construction of a new educational facility having a building footprint of approximately 8,600 m^2 on the Memorial University of Newfoundland (MUN) campus in St. John's, NL.

This building code analysis report identifies the major fire protection and life safety requirements of the 2010 National Building Code of Canada (NBC). NFPA 101, "*Life Safety Code*" (LSC) has been referenced for requirements specific to egress and exiting as mandated by the Consolidated Newfoundland and Labrador Regulations 9/96, Fire Prevention Regulations.

The major requirements that have been presented include the following:

- Construction requirements,
- Exposures/limiting distances to adjacent properties,
- Fire separations,
- Egress and exiting,
- Storage and handling of dangerous goods,
- Interconnected floor spaces,
- Active fire protection systems,
- Fire department access, and
- Fire safety planning.

This review has not considered the barrier-free and accessibility requirements governed by the NBC/CSA as amended by the Consolidated Newfoundland and Labrador Regulation 1140/96. Refer to Appendix A.

2 Applicable Codes and Standards

The Codes and Standards considered as part of this review include, but are not limited to, the following:

- 2010 National Building Code of Canada (NBC).
- 2010 National Fire Code of Canada (NFC).
- Consolidated Newfoundland and Labrador Regulations, "*Fire Prevention Regulations*", 9/96.
- Consolidated Newfoundland and Labrador Regulations, "*Building Accessibility Regulations*", 1140/96.
- Consolidated Newfoundland and Labrador Regulations, "*Fire Protection Services Regulations*", 45/12.
- CSA C22.1-12, "*Canadian Electrical Code, Part I*".
- National Fire Protection Association, "*Standard for the Installation of Sprinkler Systems"*, 2013 Edition (NFPA 13).
- National Fire Protection Association, *"Standard for the Installation of Standpipe and Hose Systems",* 2013 Edition (NFPA 14).
- National Fire Protection Association, *"Standard for the Installation of Stationary Pumps for Fire Protection",* 2013 Edition (NFPA 20).
- National Fire Protection Association, "*Flammable and Combustible Liquids Code",* 2015 Edition (NFPA 30).
- National Fire Protection Association, "*Standard on Fire Protection for Laboratories Using Chemicals",* 2015 Edition (NFPA 45).
- National Fire Protection Association, "*Venting of Deflagrations"*, 2013 Edition (NFPA 68).
- National Fire Protection Association, "*Explosion Prevention Systems",* 2014 Edition (NFPA 69).
- National Fire Protection Association, "*Standard for the Installation of Fire Doors and Fire Windows*", 2013 Edition (NFPA 80).
- National Fire Protection Association, "*Ventilation Control and Fire Protection of Commercial Cooking Operations*", 2014 Edition (NFPA 96).

- National Fire Protection Association, "*Life Safety Code*", 2015 Edition (NFPA 101).
- CAN4-S106-M, "*Fire Tests of Window and Glass Block Assemblies*".
- CAN/ULC-S524, *"Installation of Fire Alarm Systems".*
- CAN/ULC-S537, *"Verification of Fire Alarm Systems".*
- ULC/ORD-C263.1-99, *"Window Systems – Sprinkler Protected".*

3 Project Description

The new MUN Core Science (MCS) building will have a building area (footprint) of approximately 8,600 m^2. The building height is to be six storeys, including both a Service Level above Level 1 (Level 1.5), and a mechanical penthouse. A pedway/link will connect the adjacent University Centre (UC) building with Level 2 of the MCS building on the east face.

The building does not qualify as a high building by Subsection 3.2.6. of the NBC as the height measured between grade and the floor level of Level 5 is approximately 25 m with the penthouse floor at a height of approximately 30 m from grade. The building is not a high building by way of the cumulative occupant load measurement as shown in Table 1 below, which indicates the 300 person limit is not exceeded.

Level	Occupant Load (on or above)	Exit Minimum Aggregate Width (mm)	Cumulative Occupant Load Factor
5	800 persons	10,350	43
4	1,439 persons	10,350	78
3	2,069 persons	10,350	112
2	2,999 persons	10,350	161
1	3,632 persons	10,350	195

Table 1: Cumulative Load Factor Calculation

A site plan is provided in Figure 1 with the building sited on the MUN Campus such that it is bounded by:

- Arctic Avenue to the north,
- Parking and the University Centre to the east,
- Prince Philip Drive to the south, and
- Westerland Road to the west.

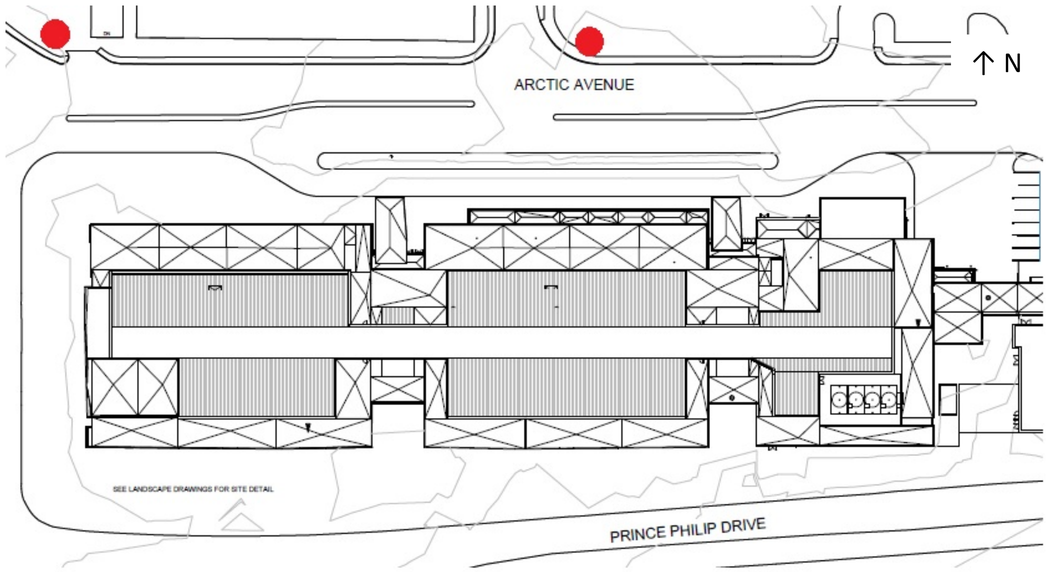


Figure 1: MCS Facility Site Plan

The building will be served by sprinkler, fire alarm and detection, and standpipe systems. A single interlock preaction system is to be provided within areas containing high value equipment, located on Level 1. Refer to associated commentary in Appendix B.

General occupancy use will involve a combination of research and teaching laboratories, with approximately 1,645 m^2 of Level 1, as well as portions of Level 5 (sixth storey) being reserved as shell space for future expansion.

Level 1 is served by exit doors which discharge directly to the exterior. Upper levels are served by two fire rated exit stairs for each of the three pavilions, which typically discharge to the exterior on the first level. A pedway to the UC building is located along the east face at the second level and provides additional horizontal exiting.

Interconnected floor spaces have been proposed via openings in the floor assemblies. Special protection measures such as protected floor areas, draft stops, and mechanical exhaust are required by the acceptable solution requirements. These aspects are being specifically analyzed by RJBEL and the design team in the context of a performance-based alternative solution. Other alternatives that have been incorporated into the building design include the use of window sprinklers as a means of achieving rated fire separations and the application of NFPA 30/45 for lab areas in lieu of the NFC. These alternatives are discussed further in their corresponding report sections.

4 Fire Protection and Life Safety Requirements

4.1 Building Construction

The various functional uses of the MCS building can be divided into three major NBC occupancy classifications as per below.

- Group A, Division 2 – Assembly
- Group D - Business and Personal Services
- Group F, Division 3 – Low-Hazard, Industrial

Table 2 identifies the associated occupancies and uses by floor level. F2 occupancies may be present to account for areas such as chemical storage and handling. The Client has acknowledged that there will be no combustible fuel loading greater than 50 kg/m^2. NFPA 101 is the applicable Code in terms of egress for the building and the classifications provided from this Code have been used as they will affect the occupant load and exit capacity. It is noted that teaching laboratories (instructional laboratories serving less than 50 persons) have been identified as a business use in accordance with NFPA 45/101. Research laboratories are to be considered as a general industrial occupancy use per NFPA 45 Section 4.2.2. and NFPA 101 Section 6.1.11. Refer to Section 4.11 of this report for additional requirements regarding maximum allowable quantities in these labs.

Level	NBC Occupancy Classification	NFPA 45/101 Classification	Functional Use of Space
1	A2, D, and F3	Assembly, High-Hazard and General-Hazard Industrial, Business	Shell Space, Research Labs, Offices, Loading/Receiving/Stock Area, Assembly Space, and Building Services
1.5	D and F3	Business and General-Hazard Industrial	Offices and Building Services
2	F3	Business	Teaching Labs
3	F3	Business	Teaching Labs
4	F3	Business and General-Hazard Industrial	Teaching and Research Labs
5	D and F3	Business and General-Hazard Industrial	Shell Space, Teaching, and Research Labs
Penthouse	F3	General-Hazard Industrial	Building Services

Table 2: Occupancies by Floor Level

It is noted that any lab/classroom or meeting area which contains an occupant load greater than 50 persons is to be regarded as an assembly use (NFPA 101 Article 6.1.2.1).

The most restrictive construction requirements applicable to the various major occupancy classifications present are to be implemented in this building (NBC Articles 3.2.2.24., 3.2.2.54. and 3.2.2.78.). These requirements include the following:

- Noncombustible construction throughout.
- Automatic sprinkler protection throughout.
- Floor assemblies constructed as fire separations having not less than a 2 h fire-resistance rating.
- Mezzanines constructed with a fire-resistance rating not less than 1 h.
- Load-bearing members constructed with a fire-resistance rating not less than that of the assembly being supported.

The meeting rooms and Lounge present within Levels 1.5 and 2 in the east atrium and within Levels 3 and 4 in the west atrium are to be constructed as mezzanines having a fire-resistance rating of 1 h. The aggregate floor area of these rooms do not exceed the 10% criterion on any of the levels in relation to their respective floor area (NBC Article 3.2.1.1).

4.2 Spatial Separation and Limiting Distance

The exterior wall construction (materials, fire-resistance rating, and quantity of unprotected openings) is primarily a function of the following variables:

- The area of the exterior wall in a fire compartment (exposing building face).
- The limiting distance measured to a property line, a centre line of a public street, or a line established between two buildings on the same property.
- The NBC occupancy classification of the fire compartment.

Spatial separation calculations for the building have been completed to determine the maximum allowable area of unprotected openings for each exposing building face. With the exception of the classroom adjacent the UC pedway/link on Level 2, the limiting distance from the building is greater than 9 m for all other building faces, which would allow 100% unprotected openings (NBC Table 3.2.3.1.D.). The classroom and UC pedway/link limiting distances are presented below in Table 3.

Room/Area Description	Limiting Distance (approx.)	% Unprotected openings	Fire-Resistance Rating	Construction/Cladding
Classroom adjacent UC link east face	4 m[a]	62 %	45 min	Combustible or noncombustible

a) 3 m allocated to UC stair per NBC Sentence 3.2.3.13.(2).

Table 3: Spatial Separation Calculations

4.3 Fire Separations

4.3.1 Room Separations

Rooms and areas are to be separated from the remainder of the building as indicated in Table 4.

Room/Area Description	Fire-Resistance Rating	NBC Reference
Major Occupancy separation from A2 to D and A2 to F3	1 h	Table 3.1.3.1.
Janitors' rooms	0 h	Article 3.3.1.21.
Exit stairs	2 h	Sentence 3.4.4.1.(1)
Elevator hoistways[a]	2 h	Sentence 3.5.3.1.(1)
Elevator machine rooms	2 h	Sentence 3.5.3.3.(1)
Emergency generator room	2 h	Article 3.6.2.8.
Service rooms[b]	1 h	Sentence 3.6.2.1.(1)
Electrical rooms[c]	1 h	Sentence 3.6.2.1.(6)
Vestibules[d,e]	0 h	Sentence 3.2.8.5.(1)
Electrical equipment vaults	2 h	Sentence 3.6.2.7.(2)
Protected floor spaces[e]	2 h	Article 3.2.8.6.
Combustible refuse or recycling room	1 h	Sentence 3.6.2.5.(1)
Vertical service spaces	1 h	Sentence 3.6.3.1.(1)
Penthouse floor[f]	1 h	Sentence 3.6.3.1.(2)
Central stores on L1 (bulk solvent, cylinder storage, multi-hazard room and flammable liquid storage room)	2 h	NFPA 30 Table 9.9.1.
Cryogenic area on L1[g]	0 h	NFPA 55
Electrical Vault[h]	2 h	NBC Article 3.6.2.7.
Pedway/Link between buildings	45 min at each end	Articles 3.2.3.19./20
Loading/receiving area	1.5 h	Article 3.3.5.6.
Teaching laboratory units	0 h	NFPA 45 Article 5.1.1.
Research laboratory units	L1/L2/L3 – 0 h L4/L5 – 1 h	NFPA 45 Article 5.1.1.

Room/Area Description	Fire-Resistance Rating	NBC Reference
Central stores within lab units on upper levels	1 h/2 h	NFPA 30 Table 9.9.1.
Tenant suites on L1/L5 (Shell Space)	1 h	Article 3.3.1.1.
Storage of Class 2.1 gases[i]	0 h	Sentence 3.3.6.3.(1)

a) Passenger elevators are permitted within an interconnected floor space without being enclosed in a hoistway separated from the remainder of the building.
b) Service rooms containing fuel-fired appliances such as boilers.
c) Electrical rooms containing electrical equipment that is required to be located in a service room according to CSA C22.1.
d) Specifically required for exit stair/protected floor areas.
e) Refer to Section 4.5 regarding interconnected floor space.
f) Where considered horizontal extension of the vertical shaft system (i.e. shafts open to the mechanical penthouse portions).
g) Assumes inert cryogenics stored within the space.
h) Assuming sprinkler protection. No sprinkler protection would require a 3 h fire-resistance rating.
i) Cylinders are permitted to be stored outside of dedicated storage rooms provided the aggregate capacity per fire compartment is not greater than 170 m^2.

Table 4: Room/Area Fire Separations

A laboratory unit requiring a fire separation, as established in Table 4, is defined as an enclosed space used for experiments or tests. This can include offices, lavatories, and other incidental contiguous rooms maintained for or used by laboratory personnel, and corridors within the unit (NFPA 45 Subsection 3.3.37.).

4.3.2 Closure Ratings

Openings in fire separations are to be protected by listed closures having fire protection ratings as indicated in Table 5 (NBC Sentence 3.1.8.4.(2)).

Fire Separation Fire-Resistance Rating	Closure Fire-Protection Rating
45 min	45 min/20 min
1 h	45 min
1.5 h	1 h
2 h	1.5 h

Table 5: Closure Fire-Protection Ratings

A door assembly having a fire-protection rating of 20 min is permitted to be used as a closure in a fire separation not required to have a fire-resistance rating more than 45 min and in a fire separation located between a corridor and adjacent classrooms in a fire separation not required to be more than 1 h (NBC Article 3.1.8.10).

The glazing restrictions and maximum temperature rise on the opaque portion of the unexposed side of a door used as a closure in a fire separation is to conform to Table 3.1.8.15. of the NBC (i.e. 250°C after 1 h).

Ventilation ducts penetrating fire separations are to be equipped with fire dampers having a fire-protection rating as noted in Table 5 with the following exceptions (NBC Articles 3.1.8.7. and 3.1.8.8.):

- Ventilation ducts penetrating a vertical fire separation not required to have a fire-resistance rating are not required to be equipped with a fire damper at the fire separation,

- Noncombustible ventilation ducts penetrating a horizontal fire separation not required to have a fire-resistance rating are not required to be equipped with a fire damper, and

- A noncombustible duct that penetrates a fire separation that separates a vertical service space from the remainder of the building need not be equipped with a fire damper at the fire separation provided:
  - The duct has a melting point above 760°C, and
  - Each individual duct exhausts directly to the outside at the top of the vertical service space.

Note: NFPA 45 ventilation requirements set forth in Section 4.10 of this report are for use in lab units and the systems serving them; the requirements of NFPA 45 supersede the requirements above. The requirements above are applicable throughout the balance of the building.

Doors in fire separations are required to be equipped with:

- Self-closing devices designed to return the door to the closed position after each use (NBC Sentence 3.1.8.11.(1)).

- Positive-latching mechanisms designed to hold the door in the closed position after each use (NBC Sentence 3.1.8.13.(1)).

A hold-open device is permitted on a door in a required fire separation, other than an exit stair door, provided it is designed to release upon a signal from the building fire alarm system and a smoke detector located as described in CAN/ULC-S524 (NBC Article 3.1.8.12.).

Penetrations of a fire separation or membrane forming part of an assembly that is required to have a fire-resistance rating are to be sealed by a fire stop that, when subjected to the fire test method in CAN/ULC-S115, “*Fire Tests of Firestop Systems*”, has an F-rating not less than the fire protection rating require for closures in the fire separation, or cast in place (NBC Sentence 3.1.9.1.(1)).

Concealed spaces in interior wall, ceiling and crawl spaces are to be separated from concealed spaces in exterior walls and attic or roof spaces by fire blocks conforming to Article 3.1.11.7. as indicated below (NBC Article 3.1.11.1.)

Fire blocks conforming to Article 3.1.11.7. are to be provided to block off concealed spaces within a wall assembly at every floor level, every ceiling level where the ceiling forms part of an assembly required to have a fire-resistance rating, and so that the maximum horizontal dimension is not more than 20 m and the maximum vertical dimension is not more than 3 m (NBC Sentence 3.1.11.2.(1)).

Fire blocks described in the above paragraph are not required, provided (NBC Sentence 3.1.11.2.(2)):

- The wall space is filled with insulation,
- The exposed construction materials and any insulation within the wall space are noncombustible,
- The exposed materials within the space, including insulation but not including wiring, piping or similar services, have a flame-spread rating not more than 25 on any exposed surface, or on any surface that would be exposed by cutting through the material in any direction, and fire blocks are installed so that the vertical distance between them is not more than 10 m, or
- The insulated wall assembly contains not more than one concealed air space, and the horizontal thickness of that air space is not more than 25 mm.

Horizontal concealed spaces within a floor or roof assembly are to be separated by construction conforming to Article 3.1.11.7. of the NBC, into compartments not more than (NBC Sentence 3.1.11.5.(1)):

- 600 m^2 in area with no dimensions more than 60 m, if the exposed construction materials within the space have a flame spread rating not more than 25, and
- 300 m^2 in area with no dimensions more than 20 m, as the exposed construction materials within the space have a flame spread rating more than 25

The following materials are permitted to be used for the construction of the fire blocks (NBC Article 3.1.11.7.):

- Gypsum board not less than 12.7 mm thick,
- Sheet metal not less than 0.38 mm,
- Solid lumber not less than 0.38 mm thick,
- Phenolic bonded plywood, waferboard, or strandboard not less than 12.5 mm thick with joints supported, or
- Two thickness of lumber, each not less than 19 mm thick with joints staggered, where the width or height of the concealed space requires more than one piece of lumber not less than 38 mm thick to block off the space.

Where materials are penetrated by construction elements or by service equipment, a fire stop is to be used to seal the penetration (NBC Sentence 3.1.11.7.(6)).

4.4 Egress and Exiting

4.4.1 Occupant Load and Exit Capacity

An occupant load analysis has been completed for this building using factors representative of the use of space as follows (LSC Table 7.3.1.2.):

- Teaching laboratories as business use (4.6 m^2/person net),
- Research laboratories as general industrial use (9.3 m^2/person),
- Building services areas and storage as storage in other than storage and mercantile occupancies (46.5 m^2/person),
- Business use for offices (9.3 m^2/person),
- Less concentrated assembly use without fixed seating for meeting/seminar rooms and lounges (1.4 m^2/person net).

The LSC determines occupant load using either gross or net values. The definition of gross area is the floor area within the inside perimeter of the outside walls of the building under consideration with no deductions for hallways, stairs, closets, thickness of interior walls, columns, elevator and building services shafts, or other features. An occupant load factor having a net designation is limited to the interior room use only and can be calculated without including fixed equipment, workstations and tables in the space. For the MCS the occupant load per level is as follows:

- Level 1 will be calculated with gross area values using a factor of 9.3 m^2/person for General Industrial/Concentrated Business which is the predominant space within this area.
- Levels 2, 3, and 4 are to be calculated using net areas with the basis being that these three levels are used primarily as educational levels (which carry a net factor) with subsidiary offices to the space. Fixed equipment in these spaces is permitted to be removed from the occupant load calculations.
- Level 5 – The gross area will be used for this level and the occupant load factor of 9.3 m^2/person has been applied to ensure conservatism for additional use of the space.

The occupant load calculations are based on dimensions identified on design drawings dated December 9, 2016. It is noted that these values will be refined as the project progresses in conjunction with the updated drawings. The design team is preparing drawings which will indicate the calculated occupant load per room or space.

Level	Room Description	Area (m^2)	LSC Occupant Load Factor (m^2/person)	LSC Occupant Load (persons)
1	Gross Area – Shell Core Research Labs	1,555	9.3	167
	Vending/Food Kiosk	24	2.8	9
	Research Labs	1,010	9.3	109
	Gross Area – Equipment Rooms	1,757	46.5	38
	Meeting/Seminar Rooms	309	1.4 net	221
	Storage	701	46.5	15
	Chapel	18	1.4 net	13
	Quiet Room	13	9.3	2
			Total Floor Level Occupant Load	***574***
1.5	Offices	206	9.3	23
	Meeting Room (Low occupancy)	73	9.3	8
	Gross Area – Equipment Rooms	1,294	46.5	28
			Total Floor Level Occupant Load	***59***
2	Offices	748	9.3	81
	Teaching Labs	1,896	4.6 net	412
	Storage	394	46.5	9
	Clerical Workstations	60	9.3	7
	Workstations	134	4.6 net	30
	Junior/Senior Des. Stud.	542	4.6 net	118
	Comp Lab, Stud. Proj. Lab and MASCE HMRM	282	4.6 net	62
	Classroom	83	1.9	44
	Meeting/Seminar Rooms (Low occupancy)	26	9.3	3
	Learning Commons	136	1.4 net	98

Level	Room Description	Area (m^2)	LSC Occupant Load Factor (m^2/person)	LSC Occupant Load (persons)
2 (Continued)	Informal Learning	103	4.6 net	23
	Help Centre	139	4.6 net	31
	Lounge	111	9.3	12
			Total Floor Level Occupant Load	***930***
3	Offices	578	9.3	62
	RES/PD Offices	61	9.3	7
	Research Labs	265	9.3	29
	Teaching Labs	2,036	4.6 net	443
	Storage	290	46.5	7
	Workstations	377	4.6 net	82
			Total Floor Level Occupant Load	***630***
4	Offices	637	9.3	69
	Research Labs	366	9.3	40
	Teaching Labs	1,748	4.6 net	380
	Storage	954	46.5	21
	Workstations	502	4.6 net	110
	Help Centre	18	1.4 net	13
	Lounge	55	9.3	6
			Total Floor Level Occupant Load	***639***
5	Gross Area – Offices and General Industrial	7,059	9.3	759
	Teaching Labs	59	4.6	13
	Research Labs	62	9.3	7
	Workstations	89	4.6	20
	Storage	50	46.5	1
			Total Floor Level Occupant Load	***800***

Table 6: Occupant Load Calculations

The exit capacity calculations are based on the widths measured from the design drawings dated December 9, 2015. The exiting capacity provided by each exit stairwell is calculated using the stair width as the limiting factor and assumes a sufficient door width is provided for the stair location. The doors leading into the stairwell are sized to accommodate this capacity. Refer to Table 7 for exit capacity calculations.

Level	Exit	Exit Width (mm)	LSC Exit Capacity Factor (mm/person)	LSC Exit Capacity (persons)
1	North double doors (5)	9,100	5	1,820
	West double doors (5)	9,100	5	1,820
	South door (West Pavilion)	910	5	182
	South door (Centre Pavilion)	910	5	182
	North double doors	1,820	5	364
	Northeast door	910	5	182
	East door (East Pavilion)	910	5	182
	West door (Centre Pavilion)	910	5	182
	South double doors (Whale Atrium)	1,820	5	364
	East door (Centre Pavilion)	910	5	182
			Total Floor Level Exit Capacity	***5,460***
			Total Exit Door Width	***27,300 mm***
			Required Exit Door Width based on Occupant Load (574 persons x 5 mm/person)	***2,870 mm***
1.5	East Pavilion North Exit Stair	1,400	7.6	185
	East Pavilion South Exit Stair	1,400	7.6	185
	East Pavilion East Exit Stair	1,400	7.6	185
			Total Floor Level Exit Capacity	***555***
			Total Exit Stair Width	***4,200 mm***
			Required Exit Door Width based on Occupant Load (59 persons x 7.6 mm/person)	***449 mm***
2	Exit Stairs 1 and 6	3,300	7.6	434
	Exit Stair 5	1,650	7.6	217
	Exit Stair 2	2,100	7.6	276
	Exit Stairs 3 and 4	3,300	7.6	434
	Link to UC	5,460	5	1,092
			Total Floor Level Exit Capacity	***2,453***
			Total Exit Door/Stair Width	***15,810 mm***
			Required Exit Door Width based on Occupant Load (930 persons x 7.6 mm/person)	***7,068 mm***

Table 7: Exit Capacity Summary

Level	Exit	Exit Width (mm)	LSC Exit Capacity Factor (mm/person)	LSC Exit Capacity (persons)
3 through 5	Exit Stairs 1 and 6	3,300	7.6	434
	Exit Stair 5	1,650	7.6	217
	Exit Stair 2	2,100	7.6	276
	Exit Stairs 3 and 4	3,300	7.6	434
			Total Floor Level Exit Capacity	***1,361***
			Total Exit Stair Width	***10,350 mm***
			Required Exit Door Width based on Occupant Load (800 persons x 7.6 mm/person)	***6,080 mm***
Penthouse	West Pavilion Exit Stair	1,000	7.6	131
	Centre Pavilion North Exit Stair	1,000	7.6	131
	East Pavilion Exit Stairs	1,000	7.6	131
			Total Floor Level Exit Capacity	***393***
			Total Exit Stair Width	***3,000 mm***
			Required Exit Door Width based on Occupant Load	***0***

Table 7: Exit Capacity Summary

4.4.2 Egress Analysis

The travel distance is to be not more than 76 m to an exit in assembly and general (Low-Hazard, Industrial) industrial occupancies, and 91 m to an exit in business occupancies (NFPA 101 Articles 12.2.6.3., 38.2.6.3., and 40.2.6.1.).

A minimum of three means of egress are to be provided from every storey (NFPA 101 Article 7.4.1.1.2).

In business occupancies, a single exit is permitted from a room or area where the total travel distance, including travel to an exit, does not exceed 30 m (NFPA 101 Sentence 38.2.4.3.(3)). A single means of egress is permitted in (Low-Hazard, Industrial) occupancies, provided that the exit can be reached within 30 m (NFPA Sentence 40.2.4.1.2.).

Not less than two means of egress are required from areas deemed to contain high-hazard contents (i.e. central stores dispensing/storage) unless the following criteria are met (NFPA 101 Article 7.11.4.):

- Rooms do not exceed 18.6 m^2,
- Rooms have an occupant load not exceeding three persons, and
- Rooms have a travel distance to the room door not exceeding 7.6 m.

A second means of access to an exit is to be provided from any laboratory unit work area that exceeds 93 m^2, and from any room where a compressed gas cylinder/cryogenic container is located such that it could prevent safe egress in the event of accidental release of contents (NFPA 45 Subsection 5.4.1.).

Mezzanines having an occupant load not exceeding 50 persons are permitted to be served by a single means of egress, and such means of egress are permitted to lead to the floor below (NFPA 101 Article 12.2.4.5.).

Exits, exit accesses, or exit discharges are to be located at a distance from one another not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served, measured in a straight line between the nearest edge of the exits, exit accesses, or exit discharges (NFPA 101 Sentence 7.5.1.3.(3)).

All exit doors, and egress doors from a room that is intended for an occupant load of more than 50 persons are to swing in the direction of travel to an exit and on a vertical axis (NFPA 101 Sentence 7.2.1.4.2.(1)).

All exit doors, and all egress doors serving a room or floor area of assembly occupancy having an occupant load more than 100 persons, are to be equipped with panic hardware (NFPA 101 Article 12.2.2.2.3).

A dead-end corridor is not to be more than 6.1 m in assembly occupancies and 15 m in business and industrial occupancies (NFPA 101 Article 12.2.5.2., 38.2.5.2., and 40.2.5.1.).

A common path of travel in an assembly occupancy is permitted for the first 6.1 m from any point where the common path serves any number of occupants, and for the first 23 m from any point where the common path serves not more than 50 occupants (NFPA 101 Section 12.2.5.1.2.). Industrial and business occupancies permit a 30 m common path of travel (NFPA 101 38.2.5.3.1. and 40.2.5.1.).

The minimum required width of exit components serving the building as per the LSC is outlined below in Table 8. The minimum height of risers is of 100 mm and the minimum tread depth is 280 mm (NFPA Clause 7.2.2.2.1.2 and 7.2.1.2.3.2.).

Description	Minimum Clear Opening Width (mm)
Doorways	810
Corridors	1120
Exit Stairs	1120

Table 8: Minimum Required Width of Exit Components

It is noted as part of the interconnected floor alternative solution, exit stairs on the upper storey pavilions have been increased to 1,650 mm as an enhanced measure to expedite evacuation. Doors serving these stairs are increased accordingly to not restrict flow.

Industrial equipment access doors, walkways, platforms, ramps and stairs that serve as a component of the means of egress from the involved equipment are modified by Table 40.2.5.3.1. of the LSC. The minimum door, corridor, stair and tread width is 560 mm and the minimum tread depth is 255 mm.

A service room containing service equipment subject to possible explosion, such as boilers operating in excess of 100 kPa (gauge) and transformers, are not to be located directly under a required exit (NBC Article 3.6.2.2.).

Illuminated exit signs are to be installed above or adjacent to every exit door and are to be located throughout floor areas to indicate the direction of travel to exits (NBC Article 3.4.5.1. and LSC Article 7.10.1.2.).

Each exit sign is to consist of a green pictogram and a white or lightly tinted graphical symbol meeting the color specifications referred to in ISO 3864-1, "*Graphical symbols – Safety colors and safety signs – Part 1: Design principles for safety signs in workplaces and public areas*," and conform to the dimensions indicated in ISO 7010, "*Graphical symbols – Safety colors and safety signs – Safety signs in workplaces and public areas"* for the directional symbols (NBC Article 3.4.5.1.).

4.5 Interconnected Floor Space

The MCS will be provided with two central atrium spaces, which effectively creates three distinct pavilions. Floor interconnection has been proposed via openings in the floor assemblies. Per the NBC acceptable solutions requirements, these interconnected floor spaces are required to be provided with the following measures of additional protection (NBC Subsection 3.2.8.):

- Exit stairs which open into the interconnected floor space are required to have non-rated vestibules that have doorways not less than 1.8 m apart. The vestibules are to be designed to limit the passage of smoke so that the exit shaft does not contain more than 1% by volume of contaminated air from the fire floor.

- Elevator hoistways opening into an interconnected floor space and into storeys above the interconnected floor space are to be protected by vestibules as above.

- Exits serving the interconnected floor space are required to be cumulative unless:
  - Not less than 0.3 m^2 of area of treads and landings is provided for each occupant of the interconnected floor space, or
  - Not less than 0.5 m^2 of protected floor space is provided for each occupant of the interconnected floor space.

- Draft stops having a depth of not less than 500 mm are required to be provided around the perimeter of atrium floor openings on each level.

- A manually activated mechanical exhaust system is required to remove air from the interconnected floor space at a rate of four air changes per hour.

- Combustible contents, excluding interior finishes, in the interconnected floor space in areas where the ceiling is more than 8 m above floor level is required to be limited to 16 g of combustible material for each cubic meter of interconnected floor space volume.

A performance-based alternative solution has been undertaken to facilitate a greater degree of interconnection for the upper atrium levels. The alternative solution report has been included in Appendix D.

Following the successful presentation of the preliminary analysis and findings to the Authority Having Jurisdiction (AHJ); *Fire Emergency Services Newfoundland and Labrador*, our office proceeded with a series of fire modeling and occupant egress simulations to support this initiative. Several key assumptions that support this approach include:

- L4 and L5 pavilion neighbourhoods are fire separated from the atrium spaces by no less than 1 h fire separations. The two exit stairs serving each of the neighbourhoods are located within the protected floor spaces and not the atrium proper.

- L3 pavilion neighbourhoods are fire separated from the atrium spaces by no less than a 0 h fire separation. Exit stairs serving the neighbourhoods are located within the protected floor spaces and not the atrium proper.

  Exit stairs serving each of the three pavilions are designed with stair widths of 1,650 mm.

- Make up air will be provided along the MCS north face via approximately 235 m^2 of operable exterior façade in the locations noted in HOK correspondence dated November 6, 2015. This includes a portion of the UC pedway/link. Refer to the alternative solution report for a drawing showing locations.

- Each atrium will be equipped with four exhaust fans to provide a capacity of no less than 200,000 cfm per atrium. Exhaust will occur at the L5/Penthouse interface.

- Multiple fire department connections will be provided along the north face and forming a looped system.

- The performance based analysis and report is to be reviewed by an independent third party fire protection engineer prior to final submission to the AHJ.

- Primary fire department response will occur at the east atrium along the north face and include the provision of a CACF in accordance with NBC Article 3.2.6.7. Secondary fire department response will occur at the west atrium and include the provision of an annunciator.

- Air-aspirating and beam type smoke detection systems are to be provided in the open atrium portions of the building,

- 2 h emergency power in accordance with NBC Article 3.2.7.9. is to be provided for smoke control equipment,

- A comprehensive fire safety planning/pre-planning strategy is to be developed and implemented prior to occupancy.

- A firefighter’s elevator in accordance with NBC Article 3.2.6.5. is to be provided within the vicinity of each of the two fire department response points.

4.6 Automatic Sprinkler and Standpipe Systems

The building is required to be protected throughout by an automatic sprinkler system designed, constructed, installed, and tested in accordance with NFPA 13 with consideration for the sequencing requirements of the atrium smoke system (NBC Article 3.2.5.12.). A single interlock pre-action system is to be provided within areas containing high value equipment, located on the first level (CREAIT lab areas). Refer to associated commentary in Appendix B.

A standpipe system is required to be installed throughout and designed, constructed, installed, and tested in accordance with NFPA 14 (NBC Articles 3.2.5.8. and 3.2.5.9.).

Every standpipe riser is required to be equipped with 64 mm hose connections, located in exits (NBC Article 3.2.5.10.). The hose connections are to be provided at the main floor landing in exit stairways and at the highest landing of stairways with stairway access to a roof (NFPA 14 Article 7.3.2.5.).

The commissioning of the life safety and fire protection systems must be performed as a whole to ensure the proper operation and inter-relationship between these integrated systems (NBC Article 3.2.4.6.).

Portable fire extinguishers are to be selected and installed in accordance with NFPA 10 (NFC Article 2.1.5.1.).

4.7 Fire Alarm and Detection System

The MCS building will be served by a two-stage fire alarm system as permitted by NBC Articles 3.2.4.1. and 3.2.4.3.

The fire alarm system is required to provide notification to the local fire department in conformance with CAN/ULC-S561 upon activation of a water-flow indicating device or initiation of an alarm/alert signal (NBC Article 3.2.4.8.). It has been the practice for all campus buildings to provide monitoring via campus security. The acceptability of such continued approach for this project is at the discretion of the Building Owner, Emergency Responders and AHJ.

The fire alarm system is required to be installed in conformance with CAN/ULC-S524 and verified in conformance with CAN/ULC-S537 (NBC Article 3.2.4.5.).

A voice communication system will be provided throughout the building and is to consist of (NBC Sentences 3.2.4.22.(7) and (8)):

- A two-way means of communication with the central alarm and control facility and to the mechanical control centre from each floor area, and

- Loudspeakers operated from the central alarm and control facility that are designed and located so that transmitted messages are audible and intelligible in all parts of the building, except in elevator cars.

The fire alarm system is required to be zoned such that separate indication is provided for the following (NBC Article 3.2.4.9.):

- Each shaft required to be equipped with a smoke detector.

- Each ventilation system required to be equipped with a smoke detector.

- Each level or area as specified by NFPA 13.

The sprinkler system and fire alarm zoning is required to be consistent based on the most stringent requirements. As part of the enhanced measures to facilitate the atrium alternative solution, the main fire alarm panel will be located in the CACF at the east atrium main entrance, with an additional annunciator at the secondary response point located at the west atrium main entrance.

The automatic sprinkler system is required to be electrically supervised to indicate a supervisory signal on the building fire alarm system annunciator for each of the following. Indication of a supervisory signal is to be transmitted to the fire department in conformance with CAN/ULC-S561 (NBC Sentences 3.2.4.10.(3) and 3.2.4.10.(5)) for the following:

- Movement of a valve handle that controls the supply of water to sprinklers,

- Loss of excess water pressure required to prevent false alarms in a wet pipe system,

- Loss of air pressure in a dry pipe system,

- Loss of air pressure in a pressure tank, and

- A temperature approaching the freezing point in any dry pipe valve enclosure or water storage container used for firefighting purposes.

Detection is required to be provided via the following with consideration for the sequencing requirements of the atrium smoke control system:

- Water flow detection devices installed on the automatic sprinkler system (NBC Article 3.2.4.16.), and
- Smoke detectors installed at the top of each exit stair, in the vicinity of draft stops, in elevator machine rooms, near the entrance of walkways to adjacent buildings, in air-handling systems serving more than one storey (duct-type) and as required by the atria alternative solution (NBC Articles 3.2.4.12. and 3.2.4.13.).

Manual pull stations are required to be installed near every exit and principal entrances (NBC Sentence 3.2.4.17.(1)).

Signaling is to be provided by the following:

- Audible signal devices installed throughout with the sound pressure level not less than 10 dBA above the ambient noise level without being less than 65 dBA (NBC Article 3.2.4.19.), and
- Visual signal devices installed in assembly floor areas in which music and other sounds associated with performances could exceed 100 dBA and in any floor area in which the ambient noise level is more than 87 dBA, or in areas intended for persons with hearing impairments (NBC Article 3.2.4.20.).

4.8 Window Sprinkler Systems

The use of window sprinkler systems in lieu of fire-rated construction is required to be accepted by the AHJ in the context of an alternative solution to the prescriptive requirements for fire separations. Final locations showing the extent of proposed use are to be confirmed by the design team.

The Underwriters Laboratory of Canada (ULC) has developed and published a Test Standard that outlines requirements for providing sprinkler-protected window assemblies in lieu of traditional fire-resistive assemblies and closures. This Standard, ULC/ORD C263.1-99, "*Sprinkler-Protected Window Systems*", requires that physical testing be performed to assess the performance, under controlled fire exposure conditions, of a sprinkler-protected window system. The fire exposure used in the test is such that the temperature measured in the test room, under nonsprinklered conditions, follows the standard time temperature curve defined in CAN/ULC-S101, "*Fire Endurance Tests of Building Construction and Materials*". The term "listed" window sprinkler is intended to refer to a product tested in accordance with ULC/ORD C263.1.

General guidelines to be considered when specifying such a system are as follows and should be revisited as the design progresses:

- The sprinkler system shall be installed and tested in accordance with NFPA 13 as a wet pipe system and maintained in accordance with the NFC.

- Listed window sprinklers (i.e. Tyco model WS or similar), installed in accordance with the manufacturer's requirements developed based on ULC/ORD C263.1 full scale fire testing based on *"Glazing in Fire Resistant Wall Assemblies",* published by the National Research Council of Canada.

- The interior glazing shall consist of fixed non-operable tempered or heat strengthened glass installed in a hollow metal steel frame per the sprinkler manufacturer's listing.

- This window sprinkler system may be used to protect non-operable window openings to a maximum of 2 h fire-resistance rating provided:
    - In a exposing building face or exterior spatial separation the window sprinkler is installed on the interior side of the window, or
    - In an interior fire separation the window sprinkler is installed on both sides of the window in the fire separation.

- Should the system be located in a loadbearing wall, all loadbearing components shall be protected independently of this window sprinkler assembly system.

- This window sprinkler system shall not be used in more than 50% of required exits.

This window sprinkler system shall be zoned separately from the building's floor area.

4.9 Emergency Lighting and Power

Emergency lighting is to be provided with a minimum level of illumination not less than 1 lx, and an average illumination level of 10 lx at the floor level in the following areas (NBC Article 3.2.7.3. and LSC Subsection 7.9):

- Exits,

- Principal routes providing access to exit in open floor areas and service rooms,

- Laboratory units,

- Corridors serving lab spaces and/or the public, and

- All floor areas where the public may congregate.

The following systems are to be provided with an emergency power supply via a generator, batteries, or a combination of both:

- All emergency lighting and exit signs for a period of 90 min (NFPA 101 Article 7.9.2.1.), and
- The building's fire alarm and detection system for a period of 24 h of supervisory operation immediately followed by 90 min of operation under full load (NBC Article 3.2.7.8. and NFPA 101 Article 7.9.2.1.).

It is noted that as part of the alternative solution, these systems are required to operate under full load for a period of 2 h.

Two elevators for use by firefighters will be provided in the building as part of the atria alternative and the emergency power generator is required to be capable of operating one of the firefighter's elevators plus one additional elevator simultaneously (NBC Sentence 3.2.7.9.(2).).

Emergency conductors serving Firefighter elevators, smoke control equipment, and the fire alarm and detection systems are to conform to ULC-S139, *"Fire Test for Evaluation of Integrity of Electrical Cables",* including the hose stream application, to provide a circuit integrity of 1 h, or be located in a service space that is separated from the remainder of the building by a fire separation that has a fire-resistance rating not less than 1 h. The service space is not to contain any combustible materials other than the cables being protected (NBC Article 3.2.7.10.).

4.10 Fire Department Access

A fire department connection serving the sprinkler and standpipe systems is to be located near the primary fire department response point and not more than 45 m, unobstructed, from a fire hydrant (NBC Article 3.2.5.15.). As part of the enhanced measures to facilitate the atria alternative solution, multiple siamese connections will be provided and form a looped system (i.e. one at each of the two designated fire department response points). NFPA 24 mandates that fire hydrants be located not less than 12.2 m from the building.

When the collective individual storage areas used for the storage of Dangerous Goods, as defined by the NBC, exceed 10 m^2, buildings are to be accessible by fire department vehicles on a minimum of two sides for the purposes of firefighting (NFC Sentence 3.2.7.12.(2)).

Fire department access routes are required to be provided for each building face having a principal entrance. The access route is to be located such that the principal entrance is not less than 3 m and not more than 15 m from the closest portion of the fire department access route, measured horizontally from the face of the building (NBC Sentence 3.2.5.5.(1)).

Fire department access routes are to (NBC Article 3.2.5.6.):

- Be not less than 6 m in width,
- Have a centerline radius not less than 12 m,
- Have an overhead clearance not less than 5 m,
- Have a gradient not exceeding 1 in 12.5 over a minimum distance of 15 m,
- Be designed to support the expected loads imposed by firefighting and be surfaced with concrete, asphalt, or other material designed to permit accessibility under all climatic conditions,
- Have turnaround facilities for any dead-end portion of the access route more than 90 m long, and
- Be connected to a public thoroughfare.

Where the slope of the roof of the MCS is less than 1 in 4, all main roof areas are required to provide direct access from the floor areas immediately below, either by a stairway or a hatch not less than 550 mm by 900 mm with a fixed ladder (NBC Article 3.2.5.3.).

4.11 Storage and Handling of Dangerous Goods

The AHJ has accepted the application of NFPA 30 and 45 for the central stores and laboratory spaces, respectively, and in their entirety in lieu of the NFC. Refer to RJBEL "*Minutes of Meeting No. 1",* dated December 11, 2014 in Appendix E. While this may result in some relative relaxations for select areas, the overall approach is one that reflects contemporary best engineering practices through a measured approach to fire safety.

Compressed gases and cryogenics have been subjected to the more stringent of the requirements of the NBC/NFC and NFPA 55, respectively as a conservative measure.

4.11.1 Laboratories

A laboratory unit, is defined as an enclosed space used for experiments or tests. This can include offices, lavatories, and other incidental contiguous rooms maintained for or used by laboratory personnel, and corridors within the unit (NFPA 45 Subsection 3.3.36.).

The units located in the building have been assigned a classification of Class C (Low Fire Hazard) or Class D (Minimal Fire Hazard) based on their use as instructional and research type laboratories (NFPA 45 Subsection 4.2.2.). Research labs are defined as being Class C and instructional/teaching labs as either Class C or Class D; the associated occupancy classifications are Industrial and Business, respectively.

This approach is applicable to lab work areas with an occupant load less than 50 persons. Lab areas having an occupant load greater than 50 persons have been regarded as assembly spaces in terms of egress and exiting requirements (NFPA 101 Sentence 6.1.2.1.).

A second means of access to an exit is required in all laboratory work areas exceeding 93 m^2 (NFPA 45 Subsection 5.4.1.).

The laboratory units for instructional/teaching labs (Class D) are not required to be fire separated, while the research labs (Class C) are required to have a 1 h fire separation on Levels 4 and 5 and no fire separation on Levels 1 through 3 (NFPA 45 Table 5.1.1.). Where no fire separation is required, a 0 h fire separation will be maintained to define the extents of individual laboratory units.

The maximum quantities of flammable and combustible liquids in Laboratory Units can be found below in Table 9. For Levels 4 and 5, the values indicated are reduced by 25% (NFPA 45 Table 9.1.1.(a)). All lab units are to conform to these limitations for use and storage; this has been deemed acceptable by the project architect through their discussions with the end user.

Laboratory Unit Fire Hazard Class	**Applicable Floor Level**	**Flammable and Combustible Liquid Class**	**Quantities in Use**		**Quantities in Use and Storage**	
			Maximum Quantity per 9.3 m^2 of Laboratory Unit (L)	**Maximum Quantity per Laboratory Unit (L)**	**Maximum Quantity per 9.3 m^2 of Laboratory Unit (L)**	**Maximum Quantity per Laboratory Unit (L)**
C (Low Fire Hazard)	Levels 1 to 3	I	7.5	570	15	1,136
		I, II, and IIIA	15	757	30	1,515
	Levels 4 & 5	I	5.6	427	11	852
		I, II, and IIIA	11.3	567	22	1,136
D (Minimal Fire Hazard)	Levels 1 to 3	I	4	284	7.5	570
		I, II, and IIIA	4	284	7.5	570
	Levels 4 & 5	I	3	213	5.6	427
		I, II, and IIIA	3	213	5.6	427

Table 9: Summary of Flammable and Combustible Liquids in Laboratory Units

Class I flammable liquids and Class II combustible liquids that are not in use inside of laboratory units are to be stored in safety cans; in storage cabinets, or in an inside liquid storage area (NFPA 45 Article 9.2.3.3.).

Dispensing of Class I liquids to or from containers less than 20 L in capacity are to be performed in either a chemical fume hood, a well ventilated area (less than 25% lower explosive limit), or an inside liquid storage area designed and protected in conformance with NFPA 30. Except for pressurized liquid containers, dispensing of Class I liquids to or from containers greater than 20 L is to be performed inside liquid storage areas (central stores) specifically designed and protected for dispensing Class I flammable liquids in conformance with the requirements of NFPA 30. See Section 4.10.2 of this report (NFPA 45 Subsections 9.3.1. and 9.3.2.).

Compressed and liquefied gas cylinders that are not intended for daily laboratory usage are to be stored outside the laboratory. The quantity of compressed and liquefied gases are to be in accordance with NFPA 55 Table 6.3.1.1. located in Appendix F of this report. Class D laboratory units are limited to 50% of the value indicated in the Table 9 mentioned above (NFPA 45 Article 10.1.6.7.).

Cylinders of Class 2.1 flammable gases stored indoors are to be located in a room separated to the remainder of the building by a gas-tight fire separation having a fire-resistance rating of at least 2 h, located on an exterior wall of the building that can be entered from the exterior, and whose closures leading to the interior of the building are equipped with self-closing devices and prevent the migration of gases from the room (NBC Sentence 3.3.6.3.(1)). Cylinders of Class 2.1 flammable, lighter-than-air gases are permitted to be stored outside of dedicated storage rooms provided the aggregate capacity of expanded gas outside of the room per 1 h fire compartment is not greater than 170 m^3 (NFC Article 3.2.8.2.).

Floors, floor openings, floor penetrations, and floor fire stop systems are to be sealed to prevent liquid leakage to lower floors (NFPA 45 Subsection 5.1.5.).

Laboratory ventilation systems are to be designed to ensure that fire hazards are minimized. A summary of major requirements is as follows (NFPA 45 Chapter 7):

- Laboratory units and hoods in which chemicals are present are to be continuously ventilated under normal operating conditions.

- Chemical fume hoods are not to be relied upon to provide explosion (blast) protection unless specifically designed to do so.

- Exhaust and supply systems are to be designed to prevent a pressure differential that would impede egress or ingress when either system fails or during a fire or emergency scenario. This design includes reduced operational modes of shutdown of either the supply or the exhaust ventilation system.

- The release of chemical vapors into the laboratory are to be controlled by enclosures or captured to prevent any flammable/combustible concentrations of vapors from reaching any source of ignition.

- Supply systems and exhaust air are to be designed to ensure that chemical fumes, vapors, or gases originating from the laboratory are not to be re-circulated.

Where wiring or electrical equipment is located in areas in which flammable gases/vapors, combustible dusts, or combustible fibers are present in quantities sufficient to create a hazard, such wiring and electrical equipment shall conform to CSA C22.1 for hazardous locations (NFC Article 3.1.4.1.). The use of the NFC in this instance is to redirect from application of NFPA 70, which is otherwise referenced in NFPA 45, Section 5.6.

Automatic fire dampers are not to be used in chemical fume hood exhaust systems and the fire detection and alarm systems are not to be interlocked to automatically shut down chemical fume hood exhaust systems (NFPA 45, Article 7.10.3.1.).

Perchloric acid heated above ambient temperatures is only to be used in a chemical fume hood specifically designed for its use and identified as "FOR PERCHLORIC ACID OPERATIONS". The hoods and exhaust ductwork are to be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid. The exhaust fan is to be acid and spark resistant and its motor is not to be located within the ductwork (NFPA Section 7.12).

Portable fire extinguishers are to be provided in accordance with NFPA 10 and rated as Ordinary Hazard (NFPA 45 Subsection 6.3.1.).

Automatic sprinkler systems with quick-response type sprinklers are to be provided in accordance with NFPA 13 and designed with Ordinary Group 1 Hazard classification (NFPA 45 Subsections 6.1.1. and 6.2.1.).

4.11.2 Central Stores

The Level 1 central stores are to be considered as inside liquid storage rooms in accordance with NFPA 30. Local chemical storage within lab units may also be required to be designed as inside liquid storage rooms, depending on end user requirements.

The liquid storage rooms are not to exceed 46 m^2 and are required to be fire separated by 1 h for a floor area of less than 14 m^2 and 2 h for floor areas greater than 14 m^2. The quantity limitations for liquid storage rooms are of 204 L/m^2 and 408 L/m^2 depending on the fire-resistance rating (NFPA 30, Subsections 9.9.1 and 12.6.1).

Two liquid storage rooms and a single dispensing room are located in the L1 East Pavilion and each room has less than a 46 m^2 area. The storage rooms and dispensing room are to be separated from each other and the remainder of the building by a 2 h fire separation. All storage of liquids not in use, with the exception of the dispensing room, are required to be in closed containers. Reported quantities based on current storage configurations have been included in Appendix G.

Where Class IA liquids are stored in containers exceeding 4 L in capacity, the room is to be designed with a means of explosion control that meets the requirements of NFPA 69, "*Standard on Explosion Prevention Systems"* (NFPA 30, Subsection 9.16.1.). It is our understanding that the custom dispensing system currently under review by the end user for the existing chemical stores on campus, is intended to be installed within this room.

Where wiring or electrical equipment is located in areas in which flammable gases/vapors, combustible dusts, or combustible fibers are present in quantities sufficient to create a hazard, such wiring and electrical equipment shall conform to CSA C22.1 for hazardous locations (NFC Article 3.1.4.1.). The use of the NFC in this instance is to re-direct from application of NFPA 70, which is otherwise referenced in NFPA 45, Section 5.6.

Spill control in areas storing flammable liquids, combustible liquids and other Dangerous Goods is to conform to NFPA 30, Section 9.13 (NFPA 30; Section 12.13) and is summarized as follows:

- Storage areas are to be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property, unless such a discharge has been specifically approved.
- Where the drainage system discharges to private or public sewers or waterways, the drainage system are to be equipped with traps and separators.
- Where individual containers exceed 38 L, curbs, scuppers, drains, or other suitable means are to be provided to prevent flow of liquids under emergency conditions into adjacent building areas.
- Containment or drainage to an approved location is to be provided.
- Where a drainage system is used, it is to have sufficient capacity to carry the expected discharge of water from fire protection systems.

Liquid storage areas where dispensing is conducted is to be provided with either a gravity system or a continuous mechanical exhaust ventilation system. Mechanical ventilation is to be used if Class I liquids are dispensed within the room. A summary of the requirements are as follows (NFPA 30, Section 18.6):

- Exhaust air is to be taken from a point near a wall on one side of the room and within 300 mm of the floor, with one or more makeup inlets located on the opposite side of the room within 300 mm of the floor.

- The location of both exhaust and inlet air openings is to be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors.

- Exhaust ventilation discharge is to be to a safe location outside the building.

- Recirculation of the exhaust air is permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures in concentrations over one-fourth of the lower flammable limit are detected.

- If ducts are used, they are not to be used for any other purpose and are to comply with NFPA 91.

- If make-up air to a mechanical system is taken from within the building, the opening is to be equipped with a fire door or damper, as required by NFPA 91.

- For gravity systems, the makeup air is to be supplied from outside the building.

- Mechanical ventilation systems are to provide at least 0.02832 m^3/min of exhaust air for each 0.3 m^3/min per floor area, but not less than 4 m^3/min.

- The mechanical ventilation system for dispensing areas is to be equipped with an airflow switch or other equally reliable method that is interlocked to sound an audible alarm upon failure of the ventilation system.

Exterior walls are to be constructed to provide ready access for fire-fighting operations by means of access openings, windows, or lightweight, noncombustible wall panels (NFPA 30 Subsection 9.9.3).

Portable fire extinguishers are to be provided in accordance with NFPA 10 (NFPA 30 Article 9.10.2.1.). Automatic sprinkler systems and standpipe connections are to be provided in accordance with NFPA 13 and NFPA 14, respectively (NFPA 30 Subsection 6.7.6.).

In terms of separation of incompatibles, both NFPA 30 and 45 are relatively vague with direction in comparison to the NFC. Incompatible materials shall be segregated to prevent accidental contact with one another (NFPA 45-9.2.3.2.).

NFPA 30-9.17 requires spatial separation or the use of a noncombustible barrier and listed cabinets.

It is recommended that NFC Article 3.2.7.6. be considered in development of an approach to separation of incompatibles. Refer to Table 10 below.

Class		2.1	2.2	2.3	3	4.1	4.2	4.3	5.1	5.2	6	8
2.1	Flammable gas	-	P	X	P	P	A	DS	X	X	X	X
2.2	Non-flammable and non-toxic gas	P	-	P	P	P	P	P	P	P	P	P
2.3	Toxic or corrosive gas	X	P	-	X	A	A	DS	A	X	DS	A
3	Flammable Liquids and Combustible Liquids	P	P	X	-	P	A	A	X	X	DS	A
4.1	Flammable solids	P	P	A	P	-	A	DS	X	X	DS	A
4.2	Subject to spontaneous ignition	A	P	A	A	A	-	DS	X	X	DS	A
4.3	Reactive with water	DS	P	DS	A	DS	DS	-	X	X	DS	X
5.1	Oxidizers	X	P	A	X	X	X	X	-	X	A	X
5.2	Organic peroxides	X	P	X	X	X	X	X	X	-	X	X
6	Poisonous and infectious substances	X	P	DS	DS	DS	DS	DS	A	X	-	A
8	Corrosive substances	X	P	A	A	A	A	X	X	X	A	-

X=Incompatible goods: do not store goods together in the same *fire compartment.*
A=Incompatible goods: separate goods by a horizontal distance of not less than 1 m.
P=Permitted: goods are permitted to be stored together.
DS=Refer to Material Safety Data Sheet.

Table 10: Separation of Incompatibles Storage Chart

4.12 Aboveground Horizontal Propane Tank and Diesel Generator Tank

The location requirements for the horizontal (1,000 Gal) above-ground propane tank currently located under the pedestrian link to the University Centre are illustrated in Table 7.4 of the Canadian Standards Association's "*Propane storage and Handling Code"* CAN/CSA-B149.2-10 and Section 4.3.2. of the NFC. The tank must conform to the following requirements:

- Certified to a recognized Canadian tank standard.
- Equipped with an overfill protection device (ULC-S661 "*Overfill Protection Devices for Flammable and Combustible Liquid Storage Tanks*").

- The minimum distance between the propane tank and the property line, between adjacent concrete or masonry building wall with no building openings and the distance from sources of ignition is to be not less than 3 m.

- The minimum distance between the propane tank and building walls of other than concrete or masonry construction is to be not less than 3 m.

- The minimum distance between the propane tank and any building opening is to be not less than 3 m,

- The minimum distance between the propane tank and an adjacent tank is to be not less than 1 m, and

- The minimum separation between a flammable liquid or combustible storage tank and a liquefied petroleum tank gas cylinder or tank is to be not less than 6 m.

There is no allowance for such a tank to be located directly beneath a building and the existing tank will be relocated in accordance with these requirements.

The diesel generator tank that will be provided to the building is proposed to be double contained and concrete encased in accordance with ULC-S655 which will permit the tank to have a 0 m limiting distance to the building. Additional provisions for the tank include:

- Fire Department access routes to permit the approach of fire department vehicles to within 60 m travelling distance of any storage tank (NFC 4.3.2.4.)

- Foundation and supports, where the clearance below the base of the tank exceeds 300 mm, tank supports are to have a minimum 2 hour fire-resistance rating (NFC 4.3.3.1.).

- Vent piping outlet location as per NFC 4.3.5.2.

5 Fire Safety Planning

The MCS building is required to have a fire safety plan developed in accordance with the requirements of Section 2.8. of the NFC. Development of the fire safety plan should be reviewed and approved by the AHJ and the St. John's Regional Fire Department prior to occupancy. The fire safety plan is required to include, at a minimum, the following (NFC Article 2.8.2.1.):

- Specific procedures for the evacuation of building occupants in the event of a fire emergency.

- Fire safety plan drawings showing the location of fire safety system components related to emergency evacuation.

- Training of supervisory staff.
- Maintenance drawings showing the location of all fire safety system components.
- A description of required test and inspection tasks for maintaining fire and life safety equipment.
- Implementation of a maintenance log book to document completion of maintenance tasks.

Additional fire safety planning criteria may be required as part of the alternative solution being developed for the interconnected floor space. Any such requirements will be documented in the alternative solution report.

6 Reliance

This report has been prepared for the sole benefit of HOK. This report may not be used by any other person without the expressed written consent of HOK and RJ Bartlett Engineering Ltd. Any use which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. RJ Bartlett Engineering Ltd accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix A

Consolidated Newfoundland and Labrador Regulation 1140/96

Table of Regulations | Main Site | How current is this regulation?

CONSOLIDATED NEWFOUNDLAND AND LABRADOR REGULATION 1140/96

Buildings Accessibility Regulations
under the
Buildings Accessibility Act
(O.C. 96-865)

Amended by:

66/06
8/12

CONSOLIDATED NEWFOUNDLAND AND LABRADOR REGULATION 1140/96

Buildings Accessibility Regulations
under the
Buildings Accessibility Act
(O.C. 96-865)

Under the authority of section 30 of the *Buildings Accessibility Act* and the *Subordinate Legislation Revision and Consolidation Act*, the Lieutenant-Governor in Council makes the following regulations.

REGULATIONS

Analysis

Short title

1. These regulations may be cited as the *Buildings Accessibility Regulations.*

176/92 s1

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Definitions

2. In these regulations

(a) "Act" means the *Buildings Accessibility Act* ;

(b) "architect" means an architect registered in accordance with the *Architects Act* ;

(c) "assembly occupancy" means the occupancy or the use of a building or part of it by a gathering of persons for civic, political, travel, religious, social, educational, recreational or like purposes, or for the consumption of food or drink;

(d) "barrier-free" means that a building and its facilities can be approached, entered and used by persons with physical or sensory disabilities;

(e) "building addition" means an increase in the size of the building;

(f) "curb ramp" means a ramp cut in the sidewall having flared sides with the lower edge of the ramp blending to the common surface of the finished grade;

(g) "existing building" means a completed building or partially completed or proposed building for which plans have been approved and a permit issued before December 24, 1981 ;

(h) "exit" means that part of a means of egress, including doorways, that leads from the floor area it serves to a separate building, an open public thoroughfare or an exterior open space protected from fire exposure from the building and having access to an open public thoroughfare;

(i) "firewall" means a type of fire separation of noncombustible construction which subdivides a building or separates adjoining buildings to resist the spread of fire and which has a fire-resistance rating as prescribed in the National Building Code of Canada 1990 and has structural stability to remain intact under fire conditions for the required fire-rated time;

(j) "first storey" means the uppermost storey having its floor level not more than 2 metres above grade;

(k) "floor area" means the space on a storey of a building between exterior walls and firewalls if provided including the space occupied by interior walls, partitions, shaftways and stairways;

(l) "guard" means a protective barrier around openings in floors or at the open sides of stairs, landing, balconies, mezzanines, galleries, raised walkways or other locations to prevent accidental falls from one level to another and that barrier may or may not have openings through it;

(m) "industrial occupation" means the occupancy or use of a building or part of it for the assembling, fabricating, manufacturing, processing, repairing or storing of goods and materials;

(n) "inspection agency" means an inspection agency prescribed in accordance with paragraph 30(1)(i) of the Act;

(o) "major occupancy" means the principal occupancy for which a building or part of it is used or intended to be used and shall be considered to include the subsidiary occupancies which are an integral part of the principal occupancy;

(p) "mercantile occupancy" means the occupancy or use of a building or part of it for the displaying or selling of retail goods, wares or merchandise;

(q) "occupancy" means the use or intended use of a building or part of it for the shelter or support of persons, animals or property;

(r) "permit" means a permit issued by the permit issuing authority;

(s) "principal entrance" means an entrance in a building which is intended for general use by the public or employees or both the public and employees, and there may be more than one principal entrance;

(t) "professional engineer" means an engineer registered in accordance with the *Engineers and Geoscientists Act* ;

(u) "public corridor" means a corridor that provides access to an exit from more than one suite;

(v) "residential occupancy" means the occupancy or use of a building or part of it by persons for whom sleeping accommodation is provided but who are not harboured or detained to receive medical care or treatment or are not involuntarily detained;

(w) "sprinklered" means that the building or part of it is equipped with an automatic sprinkler system;

(x) "storey" means that portion of a building which is situated between the top of a floor and the top of the floor next above it and if there is not a floor above it, that portion between the top of the floor and the ceiling above it; and

(y) "suite" means a single room or series of rooms of complementary use operated under a single tenancy and includes dwelling units, individual guest rooms in motels, hotels, boarding houses, rooming houses and dormitories as well as individual stores and individual or complementary rooms for business and personal services occupancies.

176/92 s2; 66/06 s1

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Codes and standards

3. The following codes and all revisions and amendments as are made are adopted as modified and amended in Schedule A:

(a) N.R.C.C. the National Building Code of Canada , 1990; and

(b) Canadian Standards Association Can/CSA -B651-M90 Barrier-Free Design.

66/06 s2

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Building requirements

4. (1) A public building having a total floor area, incorporating all storeys, between the exterior walls of greater than 600 square metres measured from and including the lowest floor to which the public and employees employed in the building have access shall

(a) from an entrance that is ordinarily used by the public and employees employed in the building and capable of accommodating persons with disabilities provide an acceptable means of making accessible to persons with disabilities all floors to which the public and employees employed in the building have lawful access; and

(b) in respect of floors that are required to be accessible to persons with disabilities, have those floors at the same level throughout or have any levels of those floors connected by a ramp.

(2) An apartment type building that contains 15 or more residential units shall

(a) from an entrance that is ordinarily used by the public and occupants and capable of accommodating persons with disabilities, provide an acceptable means of making accessible to persons with disabilities all floors to which the public and occupants have lawful access;

(b) in respect of floors that are required to be accessible to persons with disabilities, have those floors at the same level throughout or have any levels of those floors connected by a ramp; and

(c) have at least one residential unit which is accessible to persons with disabilities.

(3) An apartment-type building that contains more than 4 and less than 15 residential units shall have at least one residential unit in which all rooms are on the same level or which are connected by a ramp.

(4) A hotel shall have at least one accessible suite, but not less than one accessible suite in every 20 suites.

(5) A lodging house, boarding house or bed and breakfast which accommodates more than 10 boarders, lodgers or guests shall have

(a) at least one room with sleeping accommodations that are accessible to physically disabled persons; and

(b) the entrance and facilities normally used by the boarders, lodgers or guests shall be accessible to physically disabled persons.

176/92 s4; 66/06 s3

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Subdivision of building

5. (1) Where a building is subdivided or divided by fire walls and where there is no physical connection between the subdivisions, each portion of the building so divided or subdivided shall be considered a separate building.

(2) Where a connection is made between the 2 separate subdivisions or divisions after the final inspection, those subdivisions or divisions shall then be considered to be one building.

176/92 s5

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Exemption

6. (1) A public building classified as Group F, Division 1 under subsection 1(3) of the Schedule is exempt from the requirements of the Act and regulations.

(2) Where a building contains multiple occupancies and one of those occupancies is exempted by subsection (1), only that portion of the building in the exempted category is excluded from the determination of the 600 square metres calculation for access to floors other than the entry level.

176/92 s6

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Principal entrance

7. Where a building has a total floor area of less than 600 square metres, a principal entrance shall provide barrier free access to the storey which, in the opinion of the director, constitutes the major occupancy.

176/92 s7

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Parking

8. In a parking area provided for a building there shall be at least one lot or 4% of the total lots, whichever is the greater, designed and designated for use by physically disabled persons.

176/92 s8; 66/06 s4

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Reconstructions and additions

9. (1) The Act and these regulations shall apply to the reconstruction of an existing building where the cost of reconstruction of the building is equal to or exceeds 50% of the cost of erecting a new building of the same character and dimensions, that cost being calculated without including the cost of reconstructing basements, cellars or chimneys or the cost of site alterations.

(2) Where building additions take place at the same time as reconstruction, those building additions will be included in the 50% calculation.

(3) The Act and these regulations shall apply to the addition to a building where

(a) the building addition contains a principal entrance;

(a.1) the building addition affects other areas of the buildings where the building addition is greater than 300 square metres; or

(b) the building addition changes or reclassifies a building or section of it from the previously exempted occupancy.

(4) Where a building addition is covered by the regulations there shall be an available and accessible washroom.

(5) Each building addition and reconstruction of a building shall be considered cumulative and shall comply with the provisions of the Act and regulations.

(6) Reconstruction or additions to a building shall be registered with the department.

176/92 s9; 66/06 5

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Exemption

10. An existing building is exempt from the provisions of the Act and regulations.

176/92 s10

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Non-application

11. These regulations do not apply to

(a) service rooms;

(b) elevator machine rooms;

(c) service spaces, which may include limited commercial storage space;

(d) catwalks;

(e) loading docks; and

(f) raised or lowered portions of floor areas within a single area of use provided that the inaccessible area is

(i) for security or security observation and not more than 12 square metres, or

(ii) minor in proportion to the area and provided the function or service available in the inaccessible portion is equally available in the adjacent accessible area.

176/92 s11; 66/06 s6

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Elevating devices

12. Where an elevating device is provided, independent operation shall be possible without the assistance of keys or personnel.

66/06 s7

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Public telephones

13. Where public telephones are provided

(a) at least one telephone in each bank of telephones shall be accessible to persons using a wheelchair and as in subsection 34(1) of the Schedule; and

(b) at least one telephone in each area where telephones are provided shall be accessible for use by deaf and hard of hearing persons as in subsection 34(2) of the Schedule.

66/06 s8

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Drawings and specifications

14. (1) Three copies of drawings and specifications of design shall be submitted by the owner to the director for all buildings and reconstruction of or additions to which the Act applies.

(1.1) The copies of drawings and specifications of design required under subsection (1) shall be submitted prior to any construction contemplated by those drawings and specification of design taking place.

(2) The drawings and specifications in relation to a building shall include

(a) the classifications of major occupancies as in section 1 of the Schedule;

(b) the number of storeys;

(c) the total floor area and, where applicable, the number of residential units;

(d) the location of the building on the site, indicating its relationship to sidewalks, parking and other ancillary service areas;

(e) the location of stairways, ramps, elevating devices, washrooms, lights, switches and telephones within the building as applicable;

(f) the details of all other facilities required to ensure compliance with the requirements of the Act and regulations;

(g) the name and address of the permit issuing authority for the area where the building is intended to be constructed, added to or reconstructed;

(h) the height of the entrance level above the grade; and

(i) the division of the building by firewalls.

(3) Where the building and facilities are designed by a professional engineer or architect, the drawings, specifications and information referred to in subsection (2) shall bear the signature and seal of the person responsible for the design.

(4) Drawings and specifications submitted with the application for registration shall be provided with a 10.2 centimetre by 10.2 centimetre blank space on which an official registration stamp may be placed.

(5) Drawings shall be drawn to scale and shall indicate the nature and extent of the work or proposed occupancy in sufficient detail to establish that the design is in conformance with the regulations.

176/92 s14; 66/06 s9

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Compliance of drawings and specifications

15. (1) The director shall examine the drawings and specifications submitted to him or her under subsection 14(1) and determine whether they comply with the Act and regulations.

(2) Where the director determines that drawings and specifications submitted under subsection 14(1) comply with the Act and regulations, he or she shall register them and return a stamped copy to the owner.

(3) Where the director determines that drawings and specifications submitted under subsection 14(1) do not conform to the requirements of the Act and regulations, he or she shall notify the owner that they do not so conform and that new or amended drawings and specifications are required.

(4) Where the director registers drawings and specifications submitted to him or her under subsection 14(1), he or she shall notify the permit issuing authority for the area where the building is located that the drawings and specifications have been so registered and that permits required to be issued by the permit issuing authority for the area may now be issued.

(5) Registration of drawings and specifications does not relieve the owner of responsibility for ensuring that the building is constructed, added to, or reconstructed in accordance with the requirements of the Act and regulations.

176/92 s15

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Inspectors

16. In addition to inspectors employed by the department, the following, if appointed as an inspector or employing inspectors appointed under section 9 of the Act, may function as inspection agencies for the purpose of the Act and regulations:

(a) the City of St. John's ;

(b) the City of Corner Brook ;

(c) the City of Mount Pearl ;

(d) a municipality as defined in the *Municipalities Act* ; or

(e) a legal entity.

176/92 s16

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Eligibility

17. To be eligible for appointment as an inspector a person shall satisfy the minister that he or she is qualified to so act by appropriate

(a) technical training; or

(b) work experience.

176/92 s17

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Building construction, additions or reconstruction

18. (1) An inspector shall during the construction of, addition to, or reconstruction of a building make periodic inspections for the purpose of ensuring that the requirements of the Act and regulations are being complied with.

(2) Where the director receives notification under section 15 of the Act that the construction of, addition to, or reconstruction of a building has been completed, he or she shall order a final inspection to be made.

(3) Upon completion of a final inspection, the inspector shall issue, in a form prescribed by the director, an inspection report and provide the owner, the director and the appropriate permit issuing authority with copies.

176/92 s18

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Liability

19. An inspection carried out under the Act and regulations does not relieve an owner of responsibility for ensuring that a building is constructed, reconstructed or enlarged in accordance with the requirements of the Act and regulations.

176/92 s19

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Fees

20. (1) Every application made to the director for registration of the design for the construction of, addition to, or reconstruction of a building shall be accompanied by a fee for registration as prescribed by the minister.

(2) A fee paid under subsection (1) is not refundable if the drawings and specifications required under subsection 15(1) are rejected for registration.

176/92 s20

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Repeal

21. The Buildings Accessibility Regulations, 1992, Newfoundland Regulation 176/92, are repealed.

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Schedule

Classification of buildings

1. (1) Except as provided in subsections (3) to (6), every building or part of it shall be classified according to its major occupancy as belonging to one of the groups or divisions described in Table 1.

Table 1

Group	Division	Description of Major Occupancies
A	1	Assembly occupancies intended for the production and viewing performing arts
A	2	Assembly occupancies not elsewhere classified in Group A
A	3	Assembly occupancies of the arena type
A	4	Assembly occupancies in which provision is made for the congregation or gathering of persons for the purpose of participating in or viewing open air activities
B	1	Institutional occupancies in which persons are under restraint or are incapable of self-preservation because of security measures not under their control
B	2	Institutional occupancies which persons because of mental or physical limitations require special care or treatment
C	-	Residential occupancies
D	-	Business and personal services occupancies
E	-	Mercantile occupancies

(2) A building intended for use by more than one major occupancy shall be classified according to all major occupancies for which it is used or intended to be used.

(3) For the purpose of the Act and regulations, the following "buildings" are considered to be classified as Group F, Division I.

Bulk plants for flammable liquids	Aircraft hangers

Bulk storage warehouse for hazardous substances	Detention quarters in penitentiaries, jails and police stations
Cereal mills	Cold storage plants
Chemical manufacturing or processing plants	Electrical substations
Distilleries	Freight depots
Dry cleaning plants	Helicopter landing areas on roofs
Feed mills	Laundries, except self-service
Flour mills	Planning mills
Grain elevators	Repair garages
Lacquer factories	Storage rooms
Mattress factories	Creameries
Paint, varnish and pyroxylin product factories	Power plants
Rubber processing plants	Automatic telephone exchanges
Spray painting operations	Pumphouses
Waste paper processing plants	

(4) An arena type building intended for occasional use for trade shows and similar exhibition purposed shall be classified as Group A, Division 3 occupancy.

(5) Police stations with detention quarters are permitted to be classified as Group B, Division 2 major occupancies provided those stations are not more than one storey in building height and 600 square millimetres in floor area.

(6) Convalescent homes and children's custodial homes are permitted to be classified as Group C major occupancies provided that occupants are ambulatory and live as a single housekeeping unit in a dwelling unit with sleeping accommodation for not more than 10 persons.

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Occupancies of same classifications

2. A building is considered to be occupied by a single major occupancy, notwithstanding its use for more than one major occupancy, provided that those occupancies are classified as belonging to the same group classification or, where the group is divided into division, as belonging to the same division classification in Table 1.

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Entrances

3. (1) Except as required in subsection (2), every building shall have at least one entrance intended for general use by the public, occupants or employees employed in the building designed in conformance with and opening to the outdoors at sidewall level or to a ramp leading to a sidewall.

(2) Where a suite is located in a storey to which a barrier-free path of travel is provided and

is completely separate from the remainder of the building so that there is no access to the remainder of the building, such suites shall have at least one barrier-free entrance in conformance with subsection (1).

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Barrier-free path

4. Where a barrier-free path of travel is provided above or below the first storey in a building that is not sprinklered, every floor area having a barrier-free path of travel shall conform to the requirements of Article 3.3.1.7. of the National Building Code of Canada 1990.

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Corridors

5. (1) The minimum unobstructed width of every public corridor shall be 1100 millimetres.

(2) Except as provided in subsection (3), obstructions located within 1980 millimetres of the floor shall not project more than 100 millimetres horizontally into exit passageways, public corridors, corridors used by the public or corridors serving classrooms or patients' sleeping rooms in a manner that would create a hazard for visually impaired persons travelling adjacent to walls.

(3) The horizontal projection of an obstruction described in subsection (2) is permitted to be more than 100 millimetres where it extends to less than 680 millimetres above the floor.

(4) A dead end corridor exceeding 3000 millimetres in length shall have an area measuring 1500 millimetres by 1500 millimetres located at the dead end of the corridor.

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Post or turnstiles

6. Post or turnstiles shall not restrict the barrier-free path of travel to less than 750 millimetres into or throughout a building unless an alternative means of access is provided adjacent to and is plainly visible from the restricted access.

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Interior barrier-free path of travel

7. (1) Except as permitted in sections 18, 19, 24, 27 and 30 of this Schedule, every barrier-free path of travel shall provide an unobstructed width of not less than 920 millimetres for the passage of wheelchairs.

(2) Floor surfaces along a barrier-free path of travel shall have no opening that will permit the passage of sphere more than 13 millimetres diameter.

(3) A barrier-free path of travel is permitted to include ramps, elevators or other platform elevating devices where there exists a difference in elevation.

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Exterior barrier free path of travel

8. All exterior paths of travel shall

(a) be a continuous plane, uninterrupted by steps or abrupt changes in elevation, with a gradient not exceeding one in 20;

(b) be at least 1100 millimetres in width;

(c) where an accessible route has less than 1500 millimetres clear width, have passing spaces 1500 millimetres by 1500 millimetres located at intervals not to exceed 60 metres;

(d) where 2 routes intersect have a passing space 1500 millimetres by 1500 millimetres;

(e) have a level area adjacent to the entrance doorway at least 1500 millimetres by 1500 millimetres that extends at least 600 millimetres beyond the latch side of the door opening;

(f) have a stable, firm and slip-resistant surface;

(g) have a minimum 1100 millimetres wide walk of a different texture to that surrounding it where the line of travel is level and even with adjacent walking surfaces;

(h) be free from obstructions from the full width of the walks to a minimum height of 1980 millimetres, except that handrails are permitted to project not more than 100 millimetres from either side or both sides into the clear area;

(i) avoid the use of gratings wherever possible and when used, gratings must have no space greater than 13 millimetres wide in one direction and elongated openings must be placed at right angles to the direction of travel;

(j) when precast units such as brick paver, concrete slabs or tiles are used all joints shall be approximately flush with a tolerance limit of 6 millimetres;

(k) have changes in elevation between 6 millimetres and 13 millimetres bevelled with a slope not greater than one in 2;

(l) have changes in elevation greater than 13 millimetres accomplished by means of a ramp.

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Curb ramps

9. (1) Curb ramps located in a barrier-free path of travel shall

(a) have a width of not less than 1200 millimetres exclusive of flared sides;

(b) have a gradient of not more than one in 10;

(c) have flared sides with a slope not more than one in 10;

(d) have a level walking space at the top of the ramp of 920 millimetres to the nearest obstruction;

(e) have the surfaces of the ramp slip-resistant with a detectable warning surface that is colour and texture contrasted with the adjacent surfaces.

(2) Built up type curb ramps projecting into the roadway or parking lot are not permitted.

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Storeys served by escalators

10. Where escalators provide access to storeys above or below the first storey, a barrier-free path of travel shall be provided to those storeys serviced by the escalators.

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Controls

11. Except as provided in section 24 of this Schedule for elevators controls for the operations of building services or safety devices located in a barrier-free path of travel and intended to be operated by an occupant or employee, including electrical switches, thermostats and intercom switches, shall be accessible to persons using a wheelchair and shall be mounted not more than 1400 millimetres above the floor.

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Areas requiring barrier-free path of travel

12. (1) Barrier-free path of travel shall be provided in the entrance storey and in each storey serviced by a passenger elevator or other platform equipped passenger elevating device from the entrance described in section 3 of this Schedule

(a) throughout each suite;

(b) throughout rooms or areas that serve the public and employees employed in the building or are designated for use by visitors, including areas in assembly occupancies with fixed seats, display areas and merchandising departments;

(c) throughout rooms or areas for student use in assembly occupancies;

(d) throughout general work areas including office areas;

(e) throughout general use or general service areas, including shared laundry areas in residential occupancies, recreational areas, cafeterias, lounge rooms and lunch rooms;

(f) throughout patient's or resident's bedrooms;

(g) into at least one passenger elevator or platform-equipped passenger elevating device if the building is equipped with one or more passenger elevator or elevating device;

(h) throughout a facility required to accommodate persons with physical disabilities;

(i) onto a balcony installed to satisfy the requirements for fire protection for floor areas with barrier-free access;

(j) to ticket counters, refreshment stands, drinking fountains, public telephones, banking machines and checkout counters;

(k) through turnstiles or post restrictions;

(l) into at least one change room;

(m) to patios and court yards; and

(n) into at least one washroom designated for adults.

(2) The number of spaces designated for wheelchair use in the rooms and areas referred to in paragraph (1)(b) shall conform to Table II.

Table II

Designated Wheelchair Spaces

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Number of Fixed Seats in Seating Area	Number of Spaces Required for Wheelchairs
2-100	2
101-200	3
201-300	4
301-400	5
401-500	6
501-900	7
901-1300	8
1301-1700	9
each increment of up to 400 seats in excess of 1700	one additional space

Access to parking areas

13. A barrier-free path of travel shall be provided from the entrance described in section 3 of this Schedule to

(a) an exterior parking area where exterior parking is provided; and

(b) at least one parking level where a passenger elevator serves an indoor parking level.

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Parking spaces

14. Parking spaces designated for persons with disabilities

(a) that service a specific building shall be located on the shortest possible accessible route to the principal entrances of the building;

(b) in separate parking structures or lots that do not serve a particular building shall be located on the shortest possible circulation route to an accessible pedestrian entrance of the parking facility;

(c) may have 2 accessible parking spaces sharing a common access aisle and colour;

(d) shall have the access aisle(s) marked as a "no parking" area and meet the criteria for an exterior path of travel;

(e) shall be at least 2400 millimetres wide and shall have an adjacent access aisle that is at least 1500 millimetres wide adjacent and parallel to the vehicle parking space.

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Parking space signs

15. (1) Accessible parking spaces shall be designated as reserved for use by persons with disabilities by the

(a) uniform traffic control sign mounted vertically; and

(b) international symbol of access on the pavement of the space.

(2) Vertical signs shall be

(a) at least 300 millimetres by 600 millimetres;

(b) permanently installed on a permanent post, building or structure at a height of 1500 millimetres from the ground or floor surface to the centre of the sign;

(c) visible to the public; and

(d) maintained in a state of good repair.

(3) Symbol on the pavement shall be

(a) at least 1000 millimetres long;

(b) located in the centre of the space; and

(c) in a colour strongly contrasting with the background pavement.

(4) All designated parking stalls and access aisles shall be painted the international colour of access on the pavement of the spaces and aisles.

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Washrooms required to be barrier-free

16. (1) Where washrooms are provided in a storey to which a barrier-free path of travel is required, these washrooms shall be barrier-free in conformance with the appropriate requirements in sections 27 to 32 of this Schedule.

(2) Notwithstanding subsection (1), washrooms need not conform to the requirements in that subsection if other barrier-free washrooms are provided on the same floor area within 45 metres.

(3) In a building where a washroom is required, a barrier-free washroom shall be provided in the entrance storey except if a barrier-free path of travel is provided to a barrier-free washroom in another storey.

(4) The number of accessible toilet stalls for washrooms of each sex shall be as follows:

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Number of Toilet Stalls	Number of Accessible Toilet Stalls
1-10	1

11-20	2
Over 20	3

17. Accessibility signs

(1) A building entrance that is required to accommodate persons with disabilities shall have signs incorporating the international symbol of accessibility for persons with disabilities installed where necessary to indicate the location of that entrance.

(2) Where a washroom, elevator or parking area is required to accommodate persons with disabilities, it shall be identified by a sign consisting of the international symbol of accessibility for persons with disabilities and other graphic or written directions that are needed to indicate clearly the type of facility available.

(3) Where a washroom is not designed to accommodate persons with disabilities in a storey to which a barrier-free path of travel is required, signs shall be provided to indicate the location of barrier-free facilities.

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Doorway and doors

18. (1) Every doorway that is located in a barrier-free path of travel shall have a clear width of not less than 800 millimetres when the door is in the open position.

(2) The doorway to at least one bathroom within a suite of residential occupancy shall have a clear width of not less than 760 millimetres when the door is in the open position.

(3) Door operating devices shall be of a design which does not require tight grasping and twisting of the wrist as the only means of operation.

(4) Thresholds for doorways referred to in subsections (1) and (2) shall be not more than 13 millimetres higher than the finished floor surface and shall be bevelled to facilitate the passage of wheelchairs.

(5) Except as permitted in subsection (6) the door for the entrance described in section 3 of this Schedule shall be equipped with a power door operator in

(a) hotels;

(b) buildings of Group B, Division 2 major occupancy; and

(c) buildings of Group A, D or E major occupancy of more than 500 square metres in building area.

(6) The requirements in subsection (5) do not apply to an individual suite having an area of less than 500 square metres in buildings having only suites of Group A, D or E occupancy where that suite is completely separated from the remainder of the building so that there is no access to the remainder of the building.

(7) Except for doors with power operators, closers for doors in a barrier-free path of travel shall be designed to permit doors to open when a force of not more than 38 N is applied to the handles, push plates or latch-releasing devices in the case of exterior doors and 22 N in the case of interior doors.

(8) Closers for the interior doors in a barrier-free path of travel shall have a closing period of not less than 3 seconds measured from when the door is in an open position of 70° to the doorway to when the door reaches a point 75 millimetres from the closed position measured from the leading edge of the latch side of the door.

(9) Every door in a barrier-free path of travel, except power operated, shall have a clear space beyond the latch side of not less than

(a) 600 millimetres where the door swings towards the approach side; and

(b) 300 millimetres where the door swings away from the approach side.

(10) On power operated doors, the operating controls shall be located outside the swing of the door unless the clearances in subsection (9) are provided.

(11) Vestibules located in a barrier-free path of travel shall be arranged to allow the movement of wheelchairs between doors and shall provide a distance between 2 doors in series of not less than 1200 millimetres plus the width of a door that swings into the space in the path of travel from one door to another.

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Ramps

19. (1) Ramps located in a barrier-free path of travel shall

(a) have a width of not less than 870 millimetres between handrails;

(b) have a gradient of not more than one in 12;

(c) have a level area not less than 1500 millimetres by 1500 millimetres at the top and bottom and at intermediate levels of a ramp leading to a door so that the level area extends not less than 600 millimetres beyond the latch side of the door opening except that where the door opens away from the ramp, the area extending beyond the latch side of the door opening may be reduced to 300 millimetres;

(d) if the door swings towards the top of the ramp, the ramp shall be located outside of the swing of the door and have the level area in front of the ramp extend 920 millimetres outside the swing of the door, or provide a level area not less than 1200 millimetres long at the top of the ramp, outside the swing of the door;

(e) have a level area not less than 1200 millimetres long and at least the same width as the ramp,

(i) at intervals of not more than 9 metres along its length, and

(ii) where there is an abrupt change in the direction of the ramp; and

(f) except as provided in subsection (2), be equipped with handrails and guards conforming to sections 22 and 23 of this Schedule.

(2) Where a ramp services as an aisleway for fixed seating, the requirement for handrails in paragraph (1)(f) need not apply.

(3) Floors or walks in barrier-free path of travel having a slope steeper than one in 20 shall be designed as ramps.

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Slip resistance

20. Treads and landings of stairs and ramps shall have slip resistant strips of contrasting colors which extend not more than one millimetre above the surface of the tread landing or ramp.

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Stair treads and risers

21. (1) Treads in every stair stall have a run of not less than 230 millimetres and not more than 355 millimetres exclusive of nosing and have a rise between successive treads of not less than 125 millimetres and not more than 200 millimetres.

(2) Treads and risers shall have a uniform run and rise in any one flight and shall not alter significantly in run and rise in successive flights in a stair system.

(3) Where the run of a tread in a stair is less than 250 millimetres, a nosing of not less than 25 millimetres shall be provided beyond the face of the riser or an equivalent back slope on the riser shall be provided.

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Handrails

22. (1) Every ramp or stairway shall have a handrail on at least one side and where 1100 millimetres or more in width shall have handrails on both sides.

(2) Where the required width of a ramp or flight of stairs is more than 2200 millimetres, one or more intermediate handrails continuous between landings shall be provided and the number and position of these intermediate handrails shall be such that there will not be more than 1650 millimetres between handrails.

(3) Handrails shall be constructed so that there will be no obstruction on or above them which will break a hand hold and shall be easy to grasp having a circular section with a diameter of 30 to 40 millimetres.

(4) Handrails on stairs and ramps shall be not less than 800 millimetres and not more than 920 millimetres high measured vertically from a line drawing through the outside edges of the stair nosing or from the surface of the ramp, except that handrails not meeting these requirements are permitted providing they are installed in addition to the required handrail.

(5) At least one handrail shall be continuous throughout the length of the stairway, including landings, except where interrupted by doorways or newels at changes in direction.

(6) Handrails shall be terminated by return to the wall, floor or post in a manner which will not obstruct pedestrian travel or create a hazard.

(7) Handrails at the side of a stairway or ramp shall extend horizontally not less than 300 millimetres beyond the top and bottom of the stairway or ramp.

(8) A clearance of not less than 40 millimetres shall be provided between every handrail and a wall to which it is fastened.

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Guards

23. (1) Every ramp, stairway or passageway shall have a wall or well-secured guard on each side.

(2) The height of guards on stairs shall be not less than 920 millimetres measured vertically to the top of the guard from a line drawn through the outside edges of the stair nosing and 1070 millimetres around landings.

(3) A guard not less than 1070 millimetres high shall be provided on ramps and their landings measured vertically to the top of the guard from the ramp surface where the difference in elevations is more than 600 millimetres.

(4) Ramps and their landings having a difference in elevation of less than 600 millimetres shall have a handrail incorporating a guarding means between the ramp and the handrail with an edge protection not more than 75 millimetres from the surface of the ramp or landing.

(5) The size of an opening through guards shall be such as to prevent the passage of a spherical object having a diameter of 100 millimetres in buildings of residential occupancy and in daycare centres, nurseries and similar type occupancies and 200 millimetres in buildings of other occupancy except where the location and size of the openings that are more than this limit do not present a hazardous condition.

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Elevators

24. (1) Passenger elevators referred to in paragraph 12(1)(g) of this Schedule shall conform to Appendix E of CAN/CSA -B44-M, "Safety Code for Elevators, Escalators, Dumbwaiters, Moving Walks and Freight Platform Lifts".

(2) The platform equipped passenger elevating device referred to in paragraph 12(1)(g) of this Schedule shall conform to CAN/CSA -B355-M "Elevating Devices for Persons with Physical Disabilities".

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Spaces in seating Area

25. Spaces designated for wheelchair use referred to in subsection 12(2) of this Schedule shall be

(a) clear and level, or level with removable seats or other flexible seating options;

(b) not less than 840 millimetres wide and 1525 millimetres long to permit wheelchairs to enter from a side approach and 1220 millimetres long where the wheelchair enters from the front or rear of the space;

(c) arranged so that at least 2 designated spaces are side by side and where fixed seating is provided be adjacent to comparable removable seats or the fixed seating;

(d) located adjoining a barrier-free path of travel without infringing on egress from a row of seating or an aisle requirement; and

(e) situated as part of the designated seating plan to provide a choice of viewing location.

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Assistive listening devices

26. (1) In buildings of assembly occupancy, all classrooms, auditoria, meeting rooms and theatres with an area of more than 100 square metres shall be equipped with an assistive listening system encompassing the entire seating area.

(2) Notwithstanding subsection (1), where assistive listening system required in that subsection is an induction loop system, only half the seating area in the room need be encompassed.

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Toilet stalls

27. Where a washroom is required by section 16 of this Schedule to be barrier-free, at least one toilet stall or enclosure shall

(a) be not less than 1500 millimetres wide by 1500 millimetres deep;

(b) be equipped with a door which shall

(i) be capable of being locked from the inside,

(ii) provide a clear opening of not less than 800 millimetres with the door in the open position,

(iii) swing outward, unless sufficient room is provided within the stall or enclosure to permit the door to be closed without interfering with the wheelchair,

(iv) be provided on the inside with a door pull not less than 140 millimetres long located so that its midpoint is not less than 200 millimetres and not more than 300 millimetres from the hinged side of the door and not less than 900 millimetres and not more than 1000 millimetres from the floor, and

(v) be provided with a door pull on the outside, near the latch side of the door;

(c) have a toilet located so that its centre line is not less than 460 millimetres and not more than 480 millimetres from an adjacent side wall on one side;

(d) be equipped with grab bars which shall

(i) be mounted horizontally on the side wall closest to the toilet and shall extend not less than 450 millimetres in both directions form the forwardmost point of the toilet,

(ii) be mounted on the wall behind the toilet so that it extends the full width of the toilet bowl or where a tank is provided the full width of the tank,

(iii) be mounted not less than 840 millimetres and not more than 920 millimetres above the floor,

(iv) be installed to resist a load of not less than 1.3 kN applied vertically or horizontally,

(v) be not less than 30 millimetres and not more than 40 millimetres in diameter, and

(vi) have a clearance of not less than 35 millimetres and not more than 45 millimetres from the wall;

(e) be equipped with a coat hook mounted not more than 1400 millimetres above the floor on a side wall and projecting not more than 50 millimetres from the wall;

(f) have a clearance of not less than 1700 millimetres between the outside of the stall face and face of an in-swinging washroom door and 1400 millimetres between the outside of the stall face and a wall-mounted fixture.

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Toilets

28. Toilets for persons with disabilities shall

(a) be equipped with seats located at not less than 400 millimetres and not more than 460 millimetres above the floor;

(b) be equipped with hand-operated flushing controls that are easily accessible to a wheelchair user or be automatically operable;

(c) be equipped with a back support such as a seat lid; and

(d) not have a spring-actuated seat.

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Sinks

29. (1) Barrier-free washrooms shall be provided with a sink which shall

(a) be located so that the distance between the centre line of the fixture and the side wall is not less than 460 millimetres;

(b) have a top surface height of not more than 865 millimetres;

(c) have a clearance beneath of not less than

(i) 735 millimetres at the front edge of the sink,

(ii) 685 millimetres at a point 205 millimetres back from the front edge, and

(iii) 230 millimetres over the distance from a point 280 millimetres to a point 430 millimetres back from the front edge;

(d) have a clear space of 750 millimetres wide by 1200 millimetres deep in front of the sink;

(e) have insulated waste pipes where these pipes present a burn hazard;

(f) be equipped with faucet handles of the lever type without spring loading, or be automatically operable.

(2) Shelves or other projections above sinks shall be located so they will not present a hazard to persons with vision impairments.

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Individual washroom

30. Where an individual washroom is provided for the use of persons with disabilities, those washrooms shall

(a) be equipped with a door capable of being locked from the inside and released from the outside in case of emergency and which has

(i) graspable latch operating and locking mechanisms located not less than 900 millimetres and not more than 1000 millimetres from the floor, and

(ii) on outward swinging doors, a door pull not less than 140 millimetres long located on the inside so that its midpoint is not less than 200 millimetres and not more than 300 millimetres from the hinged side of the door and not less than 900 millimetres and not more than 1000 millimetres from the floor;

(b) be provided with a sink conforming to section 29 of this Schedule;

(c) be equipped with a toilet conforming to section 28 of this Schedule;

(d) be equipped with grab bars conforming to paragraph 27(d) of this Schedule;

(e) have no dimension less than 1700 millimetres;

(f) have a clear space of at least 900 millimetres wide adjacent to the toilet;

(g) have fixture clearances conforming to the fixture clearances described in sections 27 to 29 of this Schedule;

(h) be equipped with a coat hook conforming to paragraph 27(e) of this Schedule and shelf located not more than 1200 millimetres above the floor; and

(i) have a doorway conforming to section 18 of this Schedule.

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Washroom accessories

31. (1) Washrooms designated for use by persons with disabilities shall have soap, towel or other dispensers located not more than 1200 millimetres above the floor.

(2) Toilet paper dispensers shall be located below the grab bar and not less than 460 millimetres above the floor.

(3) Where a mirror is provided it shall be mounted so that the bottom edge is not more than 1000 millimetres above the floor.

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Showers

32. (1) Where showers are provided, at least one shower stall shall be barrier-free and shall

(a) have interior dimensions of not less than 900 millimetres by 900 millimetres;

(b) have a clear floor space at the entrance to the shower not less than 900 millimetres deep and 1200 millimetres wide with the 1200 millimetres dimension parallel to the shower entrance, starting from the stall wall opposite the seat;

(c) have a slip-resistant floor surface;

(d) be equipped with a hinged seat that is not spring loaded or a fixed seat that is

(i) not less than 450 millimetres wide extending the full depth of the stall, less a space allowed for the shower curtain,

(ii) mounted 430 millimetres to 480 millimetres above the floor,

(iii) not of wood construction, and

(iv) designed to carry a minimum load of 1.3 kN;

(e) be equipped with a horizontal grab bar which shall

(i) be not less than 750 millimetres long,

(ii) be mounted between 700 millimetres to 800 millimetres above the shower floor,

(iii) be located on the wall opposite the seat, and

(iv) have another grab bar at least 750 millimetres long installed vertically starting 80 millimetres to 120 millimetres from the front edge of the seat between 700 to 800 millimetres above the shower floor,

(v) be not less than 30 millimetres and not more than 40 millimetres in diameter,

(vi) have a clearance of not less than 35 millimetres and not more than 45 millimetres from the wall,

(vii) be installed to resist a load of not less than 1.4kN applied vertically or horizontally;

(f) have the temperature of the water controlled by a pressure-equalizing, or an automatic thermostatically controlled valve;

(g) be equipped with faucets or other controls which can be operated with a closed fist from a seated position, or be electronically controlled;

(h) be equipped with a hand-held shower head with not less than 1500 millimetres of flexible hose located so that it can be reached from the seated position and equipped with a support so that it can operate as a fixed shower head; and

(i) have fully recessed soap holders which can be reached from the seated position.

(2) Where a roll-in shower stall is provided, it shall

(a) have interior dimensions of at least 750 millimetres by 1500 millimetres;

(b) have a minimum clear floor space in front of the shower entrance of 900 millimetres by 1200 millimetres with the 1200 millimetres dimension parallel to the shower entrance;

(c) have a slip-resistant floor surface;

(d) have a bevelled threshold not more than 13 millimetres higher than the finished floor;

(e) be equipped with one L-shaped bar or 2 grab bars in L-shaped configuration which shall

(i) be not less than 750 millimetres by 900 millimetres with the 900 millimetres arm set horizontally between 700 millimetres to 800 millimetres from the shower floor,

(ii) be mounted on the wall opposite the entrance to the shower so that not less than 300 millimetres of its length is at one side of the seat,

(iii) shall conform to subparagraphs 27(d)(iv), (v) and (vi) of this Schedule;

(f) be equipped with a seat conforming to paragraph (1)(d);

(g) conform to paragraphs (1)(f), (g), (h) and (i).

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Counters

33. (1) All counters serving the public shall have at least one barrier-free section in conformance with subsections (2) and (3).

(2) Barrier-free counter surfaces shall not be more than 865 millimetres above the floor.

(3) Knee space beneath barrier-free counters intended to be used as work surfaces shall be not less than

(a) 750 millimetres wide;

(b) 680 millimetres high; and

(c) 480 millimetres deep.

(4) A clear space not less than 750 millimetres by 1200 millimetres shall be provided in front of the barrier-free counter.

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Telephones

34. (1) Where public telephones are required to be accessible, they shall

(a) have a clear space of 740 millimetres wide by 1200 millimetres deep provided in front of the telephone;

(b) have a built in shelf or counter not less than 500 millimetres wide by 350 millimetres deep with not less than 250 millimetres clear space above the shelf or counter;

(c) have clearances as specified in subsections 33(2) and (3) of this Schedule; and

(d) be identified by the international symbol of access.

(2) In addition to subsection (1), for the deaf and hard of hearing persons, a public telephone shall

(a) be equipped with a volume control;

(b) have a flux coil;

(c) have a teletype, TTY; and

(d) be identified by international symbol of accessibility for the deaf and hard of hearing persons.

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Drinking fountains

35. Where drinking fountains are provided, at least one shall be barrier-free and shall

(a) have a spout located near the front of the unit not more than 915 millimetres above the floor; and

(b) be equipped with controls that are easily operable from a wheelchair using one hand with a force of not more than 22 N or be automatically operable;

(c) have a clear floor space of 750 millimetres deep by 1200 millimetres wide in front of the unit; and

(d) have the horizontal projection conforming to the requirements of subsection 5(3) of this Schedule.

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Floor numbering

36. Arabic numerals indicating the assigned floor number shall

(a) be mounted permanently on the stair side of the wall at the latch side of doors to exit stair shafts;

(b) be not less than 60 millimetres high, raised approximately 0.7 millimetres above the surface;

(c) be located 1500 millimetres from the finished floor and not more than 300 millimetres from the door; and

(d) be contrasting in colour with the surface on which they are applied.

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Visual alarm systems

37. Where a fire alarm system is provided, it shall have lights that

(a) flash at a frequency of approximately one Hz in conjunction with the audible emergency alarm;

(b) are visual throughout the floor area or portion of it in which they are installed;

(c) are located at exits and exit stair on each floor;

(d) are installed in not less than one bedroom, sleeping area or dwelling unit and in not less than one for each 40 bedrooms, sleeping area or dwelling units, and in each accessible room, where provided;

(e) are in public washrooms.

176/92 Sch; 66/06 s10; 8/12 s1

Appendix B

Protection of High-Value Equipment Commentary

Memorial University Of Newfoundland

St. John's, Newfoundland

Automatic Sprinkler Protection of Laboratories with High-Value Equipment

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Introduction

The use of automatic sprinkler protection for spaces containing high value equipment and materials has been an item of debate for a significant amount of time and as laboratory and computer equipment has become more costly, design and installation best practices have been continuously revaluated and adjusted to reflect these changes. The purpose of this write-up is to review the project considerations for the Memorial University of Newfoundland Core Science Building Project.

Automatic Fire Sprinkler Systems

The primary automatic fire protection system utilized for life safety and property protection throughout Canada and the United States is an Automatic Fire Sprinkler System installed in accordance with the NFPA 13 Standard for the Installation of Sprinkler Systems. These systems have a long history of reliability, and effectiveness at a limited cost. Automatic sprinkler systems utilize water as the extinguishing agent due to its effectiveness and general availability, and low cost.

Each individual sprinkler consists generally of a frame, deflector and thermally sensitive element. In the event of a fire the heat of the fire causes the thermally sensitive element to activate releasing a seal which allows the water to discharge from the sprinkler. The water impacts the sprinkler deflector which is designed to distribute the water over the sprinklers area of coverage (generally a 15 foot x 15 foot square). Due to the thermal element (typically a glass bulb designed to rupture at a specific temperature) water discharge is generally limited to the areas exposed to high temperatures from the fire limiting the area exposed to water discharge.

There are 4 primary types of automatic sprinkler systems: wet-pipe systems, dry-pipe systems, pre-action systems and deluge sprinkler systems. Each system uses water as the extinguishing but varies in its operational sequence and complexity.

Wet-Pipe Sprinkler System

The most commonly installed system type is a wet-pipe sprinkler system. In this type of sprinkler system the piping is constantly filled with water. During a fire the heat from the fire causes the thermally sensitive operating element (fusible link or glass bulb) at an individual sprinkler to "fuse" allowing water to discharge from the sprinkler. Only the sprinklers subject to the heat of the fire discharge generally limiting water discharge to areas within close proximity of the fire. The system is not initiated by the fire alarm system and water is only discharged by sprinklers subjected to high temperatures from the fire.

This system type is the predominate system utilized in typical buildings and is the predominant system utilized on this project. This system has the maximum system reliability, and effectiveness for automatic sprinkler systems as well as the lowest installed cost and maintenance requirements. From a water damage potential as each sprinkler is independently thermally actuated water discharge is generally limited to the area directly subject to the fire, but mechanical damage to a sprinkler or piping can result in local discharge of water.

Dry-Pipe Sprinkler System

As wet-pipe sprinkler systems are constantly filled with water they are not suitable for installation in spaces subjected to temperatures below the freezing point of water such as parking garages or unconditioned mechanical spaces. In these locations a dry-pipe sprinkler system is generally provided. A dry pipe system operates the same as a wet-pipe system but instead of containing water the piping is charged with compressed air which holds a "dry-pipe" valve closed. When a sprinkler operates the air pressure is released from the system which allows the dry-pipe valve to open which allows water to enter the system. When the water reaches the "fused" sprinkler water is then discharged from the system. A dry-pipe system offers freeze protection but does not reduce the likelihood of water discharge as the dry-pipe valve operates on an air pressure drop for any reason, including air leaks in piping, failure of the system air compressor, or physical damage to the piping or sprinklers that allows a system air pressure drop.

The system effectiveness and reliability is lower than that of a wet-pipe system; and the system installation and maintenance costs are higher than a wet-pipe sprinkler system. The potential for water discharge is generally higher than that of a wet-pipe system during a fire as due to the time delay for water discharge through the "dry-pipe" valve, the number of sprinklers operating during a fire may increase. This system type offers no reduction in the potential of water damage due to mechanical damage over a wet-pipe sprinkler system.

Preaction Sprinkler System

In order to reduce the potential for release of water from a wet-pipe or dry-pipe sprinkler system in a non-fire event the preaction sprinkler system was developed. Similar to a dry-pipe system a preaction system is normally charged with compressed air, but instead of directly keeping the sprinkler valve closed a standard preaction system is "interlocked" with an automatic fire detection system. The valve is generally not opened until a fire is detected by the fire detection system, minimizing the potential for water discharge due to mechanical damage to a sprinkler or piping. If air is released from the piping system (due to mechanical damage or operation of a test valve) without the operation of the detection system a supervisory signal is sent indicating a loss of pressure but the valve is not operated minimizing the water discharged.

There are two typical sequences of operation for preaction sprinkler systems, **Single-Interlock** and **Double-Interlock**. On a single-interlock preaction system, the valve is opened upon receipt of a signal from the local detection system (not when a general building alarm is initiated). This "charges" the system with water but no water is released. After adequate heat builds up and a sprinkler operates similar to a wet-pipe system, water is released at the area subject to fire conditions. When equipped with a detection system expected to operate faster than the thermal response of the installed sprinklers this system type has approximately the same effectiveness as a wet-pipe sprinkler system

The double-interlock system operates in a similar fashion to a single-interlock but the valve is not opened until both the detection system operates and the air-pressure is released due to sprinkler actuation or damage to system piping. This results in a similar increase in system response time to that of a dry-pipe sprinkler system reducing the system effectiveness and potentially increasing the area of system operation.

Sprinkler System Type Summary				
System Type	System Effectiveness (Response Time)	Installation Cost	Maintenance Cost	Water Damage Potential
Wet-Pipe (Baseline)				
Dry-Pipe				
Single-Interlock Preaction				
Double-Interlock Preaction				

Table Key	
Color	Effectiveness/Cost Impact
	Improved Effectiveness
	Good/Baseline
	Slightly Reduced / Slightly Higher
	Significantly Reduced / Significantly higher

Supplemental Fire Suppression System

In addition to water-based automatic sprinkler systems in locations where high value equipment/materials are present supplemental fire suppression systems may be provided which have a potential response time significantly faster than that of an automatic sprinkler system. These systems are typically initiated by a smoke detection system as opposed to a thermally actuated automatic sprinkler allowing the system to be initiated when the fire is much smaller limiting the damage prior to system operation.

The systems typically provided are “total-flooding” which will fill the protected area with a suppression agent suppressing the fire. Due to this “total-flooding” suppression methodology typically a fully enclosed space is required to contain the suppression agent to allow it to suppress the fire as well as to minimize the potential for the fire to restart due to dispersal of the suppressing agent.

Total-flooding suppression systems generally are a “single-shot” type system having adequate suppression agent for a single-system release, as such they are not typically seen as an equivalent to a water-based sprinkler system which will generally continuously operate until shut-down due to being connected to a large water supply.

Total-flooding suppression systems generally will require on site storage of the suppression agent which can require significant area agent storage dependent upon the agent selected and the size of the protected area. In addition, total-flooding suppression systems will result in a significant cost increase for the project due to the system cost for the agent, piping, and equipment as well as increased architectural and mechanical system costs due to the enclosure requirements.

Supplemental Fire Suppression System Summary	
	Project Impact
Reduced Actuation Time	
Fully Enclosed Space Required	
Architectural Cost Increase	
Mechanical Cost Increase	
Agent Storage Space Required	
Single - Shot	
Increased Installation Cost	
Increase Maintenance Cost	

Table Key	
Color	Project Impact
	Positive Impact
	Neutral Impact
	Negative Impact

Suppression Agent Selection

Multiple suppression agents are available for total flooding suppression systems. Selection of the agent type has a significant impact on the project as each agent type has specific characteristics resulting in varying projects for each agent type. The two agent types generally used are inerting agents and liquefied agents.

One agent type commonly utilized is the “inerting” type agent, such as Inergen and Argonite. This type of agent is typically stored as a compressed gas and is discharged via multiple open nozzles within the protected area. As the agent is stored as compressed gas it has the largest space requirements of the total flooding agents and due to the operating pressures has higher equipment costs than a “liquefied” agent system. As the agent travels through the piping as a gas the agent may be stored relatively remotely from the protected area. Inerting agents are generally commonly available atmospheric inert gases such nitrogen, carbon dioxide and argon which limits the environmental impact of the agent and the cost to “recharge” a discharged system. Inerting agents will typically require relief venting of the protected area to limit the potential for damage due to overpressurization of the space.

Inerting Agent Characteristic Summary	
	Project Impact
Significant Space Required for Agent Storage	
High Operating Pressures	
Minimal Environmental Impact	
Relief Venting Required	

Table Key	
Color	Project Impact
	Positive Impact
	Neutral Impact
	Negative Impact

The most commonly utilized total-flooding agent type is what is commonly referred to as a "liquefied" type agent, such as FM-200, and NOVEC. These agents are stored as a liquid significantly reducing the storage space required versus an inerting gas type agent. Generally these agents travel through the system piping as a liquid or a gas/liquid (two-phase) mixture significantly reducing the hydraulic efficiency of the piping system. As such there are generally significant limitations on the allowable length of the system piping requiring the agent to be stored in or in very close proximity to the protected area. Additionally, these agents are proprietary manufactured compounds with varying atmospheric lifespans and global warming potentials (GWP) which may have some environmental impact if discharged depending upon the agent selected. Additionally these agents have higher replacement costs compared to inerting agents. Relief venting is not required.

Liquefied Agent Characteristic Summary	
	Project Impact
Space Required for Agent Storage	
High Operating Pressures	
Varying Environmental Impact	Varies
No Relief Venting Required	

Table Key	
Color	Project Impact
	Positive Impact
	Neutral Impact
	Negative Impact

Generally, both agent types have similar first time installed system and maintenance cost with liquefied agents having a higher replacement cost if discharged. While liquefied agents have less flexibility with regards to storage location due to distance limitations, they require significantly less storage space than inerting type agents due to the ability to be stored as a liquid. Additionally, both agent types were developed as "environmentally-friendly" agents in response to the ceased production of Halon 1301 due to its high ozone depletion potential, and liquefied agents are available with lower GWP and atmospheric lifespans limiting environmental impact.

Total Flooding Agent Comparison		
	Inerting Agent	Liquefied Agent
Space Required for Agent Storage		
System Cost		
Agent Replacement Cost		
Environmental Impact		

Table Key	
Color	System Comparison
	Positive
	Neutral
	Negative

Code Requirements

The National Building Code of Canada and the International Building Code (IBC) both require the installation of automatic sprinkler systems to be in compliance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. A basic precept of NFPA 13 is that automatic sprinkler protection is provided throughout the facility. This is specifically codified in Chapter 4 General Requirements and Section 8.1 Basic Requirements which state the following (from NFPA 13, 2013 Edition):

> **"4.1 Level of Protection.** A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers."
>
> …
>
> **"8.1.1*** The requirements for spacing, location, and position of sprinklers shall be based on the following principles:
>
> (1) Sprinklers shall be installed throughout the premises.
> (2) Sprinklers shall be located so as not to exceed the maximum protection area per sprinkler.
> (3)*Sprinklers shall be positioned and located so as to provide satisfactory performance with respect to activation time.
> and distribution.
> (4) Sprinklers shall be permitted to be omitted from areas specifically allowed by this standard."

Obviously a sprinkler system cannot protect a space in which it is not installed, but additionally a space protected by sprinklers can be overwhelmed by a fire spreading to it from an adjacent unsprinklered area. Generally, a special suppression system is not seen as the equivalent of an automatic sprinkler system as while effective, they are "single-shot" type systems, while an automatic sprinkler system is continuously discharging the extinguishing agent maintaining effectiveness even if a fire restarts after it is initially controlled. While not directly addressed in the National Building Code of Canada, this is clarified in the IBC which requires protection throughout except "where the application of water, or flame and water, constitutes a serious life or fire hazard. " This is generally only typically applied in locations where there are materials present that could result in toxic gas production or rapid high energy discharges.

Current Practice

Typically, when automatic sprinkler protection is required for a building it is provided throughout as required by NFPA 13 regardless of the value of the contents or presence of special suppression systems. Currently water-based fire suppression is commonly provided in laboratories, hospitals including operating rooms and imaging areas, as well as Data Centers. Vanderweil Engineers have provided automatic sprinkler protection in pharmaceutical research laboratories including automated equipment, semiconductor facilities and corporate datacenters. We have also designed sprinkler systems for museums and archival facilities storing historically and culturally significant materials such as the National Archives National Personnel Records Center in St. Louis, MO, and Yale University. The US General Services Administration (GSA) requires automatic wet-pipe sprinklers in laboratories and "essential electronic facilities", "that have high value or mission essential electrical equipment" (GSA 2003 Facilities Standards (P100), 7.15 Special Fire Protection Requirements). Sprinkler protection is also provided in all new NIH and USDA laboratory facilities.

Discussion

Automatic sprinkler protection is required throughout the building in accordance with National Building Code of Canada requirements. Even if a total flooding clean agent is provided to protect high value contents, an automatic sprinkler system must still be provided as a clean agent system does not provide equivalent protection to an automatic sprinkler system. These systems are not equivalent to the installation of an automatic sprinkler system as they are a "single-shot" type system and once the agent has been discharged, new suppression agent will need to be provided. If the fire restarts or the initial activation fails to control the fire, additional protection is required. An automatic sprinkler system is connected to a permanent water supply and will continue to discharge suppression agent (i.e. water) until shut down. Even if a special suppression system is provided, an automatic sprinkler system must still be provided as a back-up to meet building code requirements.

Regarding the potential for accidental water discharge, automatic sprinkler systems are highly regulated and are pressure tested to a minimum of 200 psi for a duration of 2 hours prior to system acceptance and installation of equipment within the protected space. This minimizes the potential of an installation or material defect resulting in accidental water discharge. Additionally, as the water in the system is generally not flowing the stresses on the system are limited as opposed to mechanical heating/cooling or plumbing systems which are subject to changing pressure and flow conditions. The primary failure modes for sprinkler systems are either exposure to freezing conditions or mechanical damage to the sprinklers or piping. The potential exposure to these conditions is very limited due to the use of the space.

The additional potential for water discharge would be during a fire event. As noted above, each individual sprinkler contains a heat sensitive element that is designed to operate at a temperature of 69C (155F) or higher. As each sprinkler is actuated individually the area of water discharge is limited to the areas impacted by the high heat from a fire. Typically by the time the sprinkler reaches this temperature any sensitive electronics in direct proximity to the fire would have already been impacted by both the heat and the corrosive products of combustion (smoke). Additionally, due to its mode of operation, an automatic sprinkler system minimizes the water damage during a fire event. If sprinkler protection is not present in the space the potential for damage due to a fire is significantly higher as to the time required for a fire department to respond to an event is considerably higher than the time for a sprinkler system to be actuated. In a typical situation the fire sprinkler system will have controlled the fire prior to fire department representatives arriving on the scene. Also, each individual sprinkler is typically designed to discharge approximate 20-40 gallons per minute while a fire department fire hose can easily discharge in excess of 100 gallons per minute. Operationally, in order to provide adequate protection the firefighters hose stream would also typically be discharged over a larger area then the thermally actuated sprinklers.

Manual Suppression vs Automatic Sprinklers		
	Automatic Sprinklers	Manual Suppression
Response Time		
Area of Water Discharge		
Water Discharge Rate		

Table Key	
Color	System Comparison
	Positive
	Neutral
	Negative

The potential for a fire causing irreparable damage in an unsprinklered occupancy is very significant and can even impact other portions of the campus. As an example in 2012 a fire at the State University of New York (SUNY) Canton lab resulted in the closure of the campus due to potential issues with hazardous material discharge.

The installation of a total-flooding or “clean-agent” extinguishing system can have significant project impacts as noted above. These agents are generally gaseous agents and in order to be effective require a tightly enclosed area to keep the agent in the protected area to ensure the fire is suppressed and does not restart. As such, architectural requirements for the protected areas increase significantly, resulting in higher architectural costs. In order for a gaseous system to be practical, ceiling heights need to be limited and the protected areas need to limited in size and compartmentalized. As the suppression agent is no longer water it will also need to be locally stored. The storage area required is significant and will have an impact on the program. In addition to the architectural cost and the clean agent cost, the mechanical system cost will also increase due to the need to maintain enclosure integrity, prevent space over pressurization and potentially adding a venting system to “purge” the space after discharge.

Clean Agent System Impact	
	Impact
Response Time	
System Cost	
Architectural Enclosure Cost	
Increased Compartmentalization	
Lower Ceiling Heights	
Agent Storage Space Required	
Additional Fire Detection Requirements	

Table Key	
Color	System Comparison
	Positive
	Neutral
	Negative

Recommendations

Automatic sprinkler protection is required by code and current industry best practices call for a sprinkler system to be installed throughout the New Core Science Building except where the discharge of water would be a hazard regardless of the presence of electronic equipment or high value contents. Additionally, fire events at SUNY Canton and other locations have demonstrated the potentially significant impact of a fire in an unsprinklered laboratory. Therefore we recommend sprinkler protection be provided throughout the entire New Core Science Building as is typically provided in other occupancy types with high value contents such as museums, archives, and data centers. If requested a single interlock preaction sprinkler system may be provided to reduce the limited potential for accidental water discharge but this will result in additional system cost, maintenance and testing.

As noted above, the use of a total-flooding clean agent suppression system would have a significant cost and architectural impact, due to enclosure integrity requirements as well as agent storage requirements. If it is desired to limit the potential impact of a fire event below the threshold of damage which typically occurs in a sprinklered building, we would recommend the installation of high sensitivity smoke detection in critical areas. This would allow for human intervention during the early stages of a fire limiting the impact of an event.

Recommendations Summary	
	Recommendations
Automatic Sprinkler Protection	
Single Interlock Preaction	
Clean-Agent Suppression	
High Sensitivity Smoke Detection	

Table Key	
Color	System Comparison
	Recommended
	Optional
	Not Recommended

Appendix C

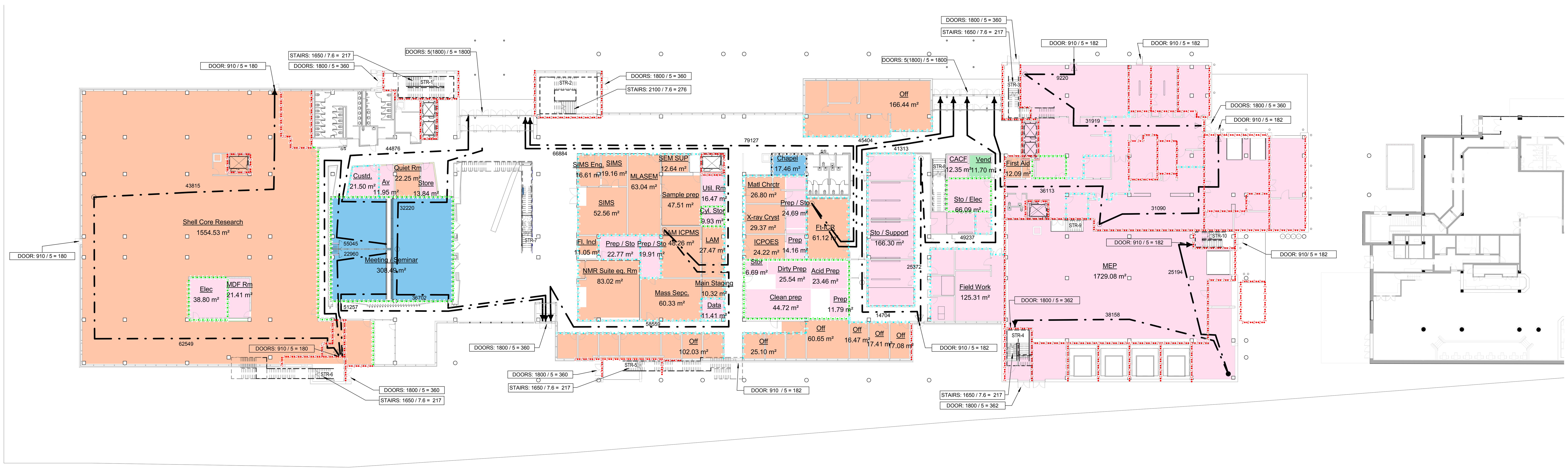
Fire Separation Drawings

Occupant Load Level 1				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1	Shell Core Research	1554.53 m²	9.30	167
LEVEL 1	SIMS Eng.	16.61 m²	9.30	2
LEVEL 1	SIMS	19.16 m²	9.30	2
LEVEL 1	MLASEM	63.04 m²	9.30	7
LEVEL 1	SIMS	52.56 m²	9.30	6
LEVEL 1	Fl. Incl	11.05 m²	9.30	1
LEVEL 1	NMR Suite eq. Rm	83.02 m²	9.30	9
LEVEL 1	LAM ICPMS	48.26 m²	9.30	5
LEVEL 1	Sample prep	47.51 m²	9.30	5
LEVEL 1	SEM SUP	12.64 m²	9.30	1
LEVEL 1	LAM	27.47 m²	9.30	3
LEVEL 1	Mass Sepc.	60.33 m²	9.30	6
LEVEL 1	Main Staging	10.32 m²	9.30	1
LEVEL 1	Ft-ICR	61.12 m²	9.30	7
LEVEL 1	Matl Chrctr	26.80 m²	9.30	3
LEVEL 1	X-ray Cryst	29.37 m²	9.30	3
LEVEL 1	ICPOES	24.22 m²	9.30	3
LEVEL 1	Off	166.44 m²	9.30	18
LEVEL 1	Off	17.08 m²	9.30	2
LEVEL 1	Off	17.41 m²	9.30	2
LEVEL 1	Off	16.47 m²	9.30	2
LEVEL 1	Off	60.65 m²	9.30	7
LEVEL 1	Off	25.10 m²	9.30	3
LEVEL 1	Off	102.03 m²	9.30	11
LEVEL 1	First Aid	12.09 m²	9.30	1
General Industrial Use (Research Labs)		2565.27 m²		276
LEVEL 1	Meeting / Seminar	308.49 m²	1.40	220

Occupant Load Level 1				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1	Chapel	17.46 m²	1.40	12
Meeting / Seminar		325.95 m²		233
LEVEL 1	Vend	11.70 m²	2.80	4
Sales Area on Street Floor		11.70 m²		4
LEVEL 1	Custd.	21.50 m²	46.50	0
LEVEL 1	Av	11.95 m²	46.50	0
LEVEL 1	Store	13.84 m²	46.50	0
LEVEL 1	MEP	1729.08 m²	46.50	37
LEVEL 1	Elec	38.80 m²	46.50	1
LEVEL 1	MDF Rm	21.41 m²	46.50	0
LEVEL 1	Prep / Sto	22.77 m²	46.50	0
LEVEL 1	Prep / Sto	19.91 m²	46.50	0
LEVEL 1	Util. Rm	16.47 m²	46.50	0
LEVEL 1	Cyl. Stor	9.93 m²	46.50	0
LEVEL 1	Data	11.41 m²	46.50	0
LEVEL 1	Clean prep	44.72 m²	46.50	1
LEVEL 1	Stor	6.69 m²	46.50	0
LEVEL 1	Dirty Prep	25.54 m²	46.50	1
LEVEL 1	Acid Prep	23.46 m²	46.50	1
LEVEL 1	Prep	11.79 m²	46.50	0
LEVEL 1	Prep / Sto	24.69 m²	46.50	1
LEVEL 1	Sto / Support	166.30 m²	46.50	4
LEVEL 1	Prep	14.16 m²	46.50	0
LEVEL 1	Field Work	125.31 m²	46.50	3
LEVEL 1	Sto / Elec	66.09 m²	46.50	1
Storage		2425.84 m²		52
Grand total		5328.75 m²		565

Fixture Count Level 1					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 reference	Notes
General Industrial Use (Research Labs) - F-3	276	14		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Meeting / Seminar - A-2	233	8		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 40 due to the proposal of 4 universal toilets in this floor
Sales Area on Street Floor - D	4	0		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Counted as part of the major occupancy of the floor (F-3)
Storage - F-3	52	6	24 regular, 4 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for level 1

Fixture Breakdown Level 1						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 1	28	14	15	6	3	4



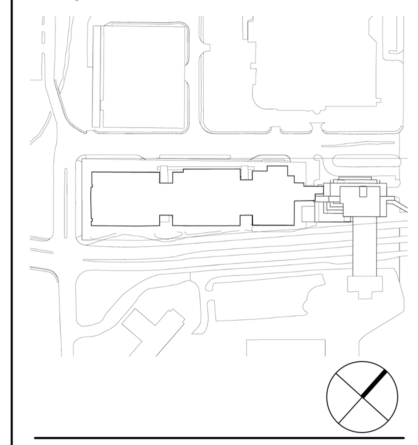
1 LEVEL 1
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

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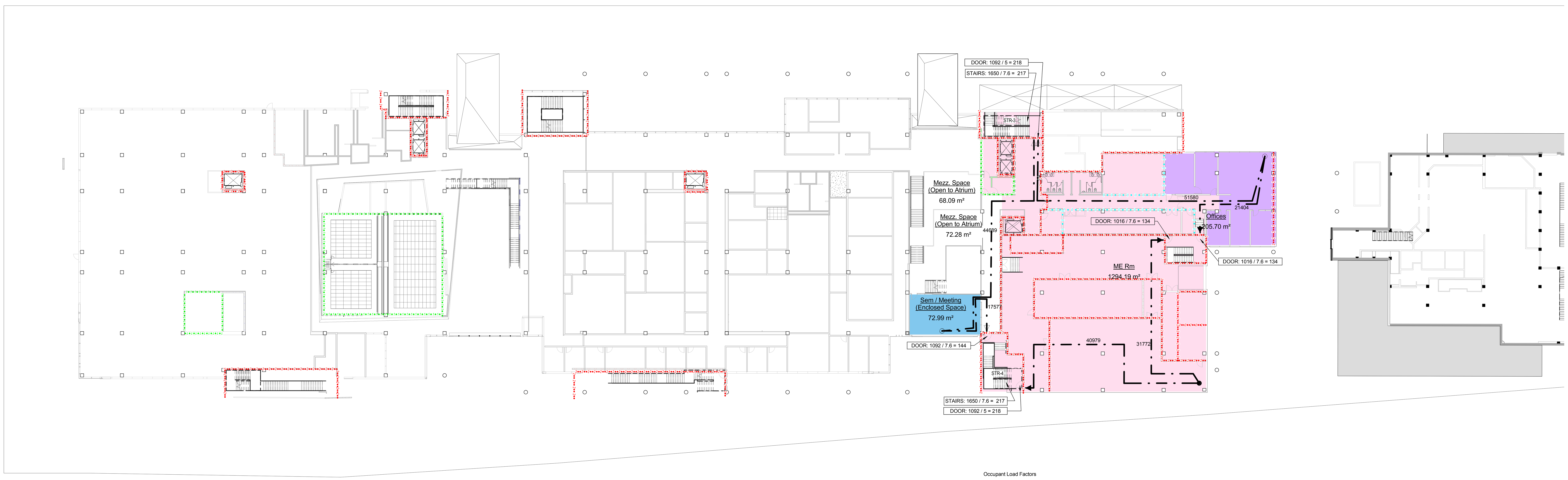
Sheet Number:
LS101

Occupant Load Level 1.5				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1 1/2	Offices	205.70 m²	9.30	22
Business (Offices)		205.70 m²		22
LEVEL 1 1/2	Sem / Meeting (Enclosed Space)	72.99 m²	9.30	8
Meeting / Seminar		72.99 m²		8
LEVEL 1 1/2	ME Rm	1294.19 m²	46.50	28
Storage		1294.19 m²		28
Grand total: 3		1572.88 m²		58

Fixture Count Level 1.5					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	22	2	6	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Meeting/Seminar - A-2	8	2	6	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
Storage - F-3	28	4	0	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	

Fixture Breakdown Level 1.5						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 1 1/2	6	4	3	2	1	0



1 LEVEL 1 1/2
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan

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Sheet Title:
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Sheet Number:
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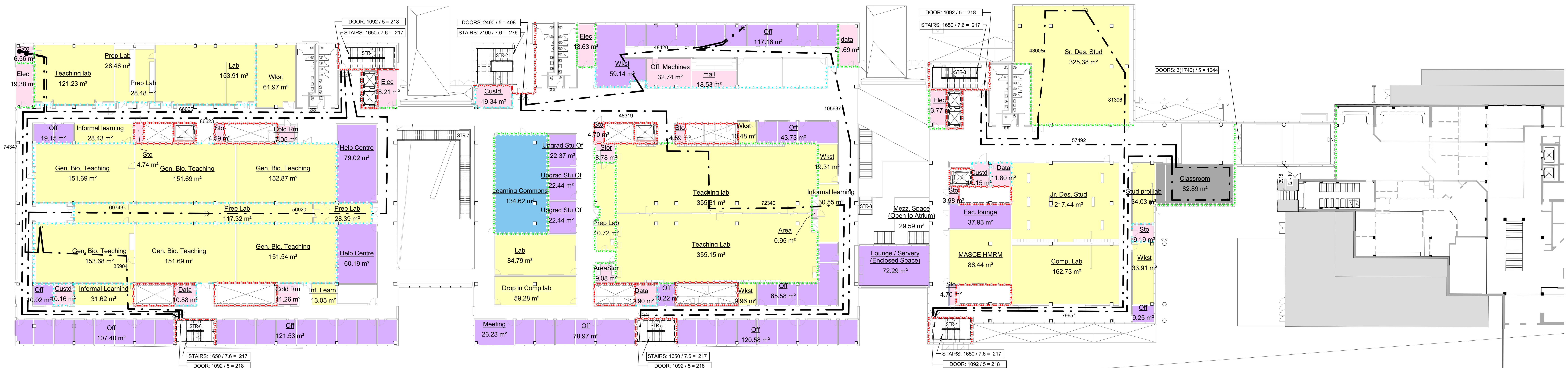
Occupant Load Level 2				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 2	Off	19.15 m²	9.30	2
LEVEL 2	Help Centre	79.02 m²	9.30	8
LEVEL 2	Help Centre	60.19 m²	9.30	6
LEVEL 2	Off	121.53 m²	9.30	13
LEVEL 2	Off	107.40 m²	9.30	12
LEVEL 2	Off	10.02 m²	9.00	1
LEVEL 2	Off	117.16 m²	9.30	13
LEVEL 2	Wkst	59.14 m²	9.30	6
LEVEL 2	Off	43.73 m²	9.30	5
LEVEL 2	Off	10.22 m²	9.30	1
LEVEL 2	Off	65.58 m²	9.30	7
LEVEL 2	Lounge / Servery (Enclosed Space)	72.29 m²	9.30	8
LEVEL 2	Upgrad Stu Of	22.44 m²	9.30	2
LEVEL 2	Off	78.97 m²	9.30	8
LEVEL 2	Meeting	26.23 m²	9.30	3
LEVEL 2	Off	120.58 m²	9.30	13
LEVEL 2	Off	9.25 m²	9.30	1
LEVEL 2	Fac. lounge	37.93 m²	9.30	4
LEVEL 2	Upgrad Stu Of	22.37 m²	9.30	2
LEVEL 2	Upgrad Stu Of	22.44 m²	9.30	2
Business (Offices)		1105.61 m²		119
LEVEL 2	Classroom	82.89 m²	1.90	44
Classrooms		82.89 m²		44
LEVEL 2	Wkst	61.97 m²	4.60	13
LEVEL 2	Lab	153.91 m²	4.60	33
LEVEL 2	Prep Lab	28.48 m²	46.50	1
LEVEL 2	Prep Lab	28.48 m²	46.50	1
LEVEL 2	Teaching lab	121.23 m²	4.60	26
LEVEL 2	Informal learning	28.43 m²	4.60	6
LEVEL 2	Gen. Bio. Teaching	152.87 m²	4.60	33
LEVEL 2	Informal Learning	31.62 m²	4.60	7
LEVEL 2	Wkst	10.48 m²	4.60	2
LEVEL 2	Prep Lab	40.72 m²	46.50	1
LEVEL 2	Teaching lab	355.31 m²	4.60	77
LEVEL 2	Informal learning	30.55 m²	4.60	7
LEVEL 2	Lab	84.79 m²	4.60	18
LEVEL 2	Sr. Des. Stud	325.38 m²	4.60	71
LEVEL 2	Stud proj lab	34.03 m²	4.60	7
LEVEL 2	Wkst	33.91 m²	4.60	7
LEVEL 2	Inf. Learn.	13.05 m²	4.60	3
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.54 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	153.68 m²	4.60	33
LEVEL 2	MASCE HMRM	86.44 m²	4.60	19
LEVEL 2	Jr. Des. Stud	217.44 m²	4.60	47
LEVEL 2	Comp. Lab	162.73 m²	4.60	35
LEVEL 2	Wkst	19.31 m²	4.60	4
LEVEL 2	Teaching Lab	355.15 m²	4.60	77
LEVEL 2	Wkst	9.96 m²	4.60	2

Occupant Load Level 2				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 2	Drop in Comp lab	59.28 m²	4.60	13
Concent. business (teaching labs)		3205.82 m²		678
LEVEL 2	Learning Commons	134.62 m²	1.40	96
Meeting / Seminar		134.62 m²		96
LEVEL 2	Elec	19.38 m²	46.50	0
LEVEL 2	Sto	4.74 m²	46.50	0
LEVEL 2	Sto	4.59 m²	46.50	0
LEVEL 2	Custd	10.16 m²	46.50	0
LEVEL 2	Data	10.88 m²	46.50	0
LEVEL 2	Cold Rm	11.26 m²	46.50	0
LEVEL 2	Custd.	19.34 m²	46.50	0
LEVEL 2	Elec	18.63 m²	46.50	0
LEVEL 2	data	21.69 m²	46.50	0
LEVEL 2	mail	18.53 m²	46.50	0
LEVEL 2	Off. Machines	32.74 m²	46.50	1
LEVEL 2	Sto	4.70 m²	46.50	0
LEVEL 2	Sto	4.59 m²	46.50	0
LEVEL 2	Data	10.90 m²	46.50	0
LEVEL 2	AreaStor	9.08 m²	46.50	0
LEVEL 2	Stor	8.78 m²	46.50	0
LEVEL 2	Area	0.95 m²	46.50	0
LEVEL 2	Elec	13.77 m²	46.50	0
LEVEL 2	Data	11.80 m²	46.50	0
LEVEL 2	Sto	3.98 m²	46.50	0
LEVEL 2	Sto	4.70 m²	46.50	0
LEVEL 2	Sto	9.19 m²	46.50	0
LEVEL 2	Sto	6.56 m²	46.50	0
LEVEL 2	Elec	18.21 m²	46.50	0
LEVEL 2	Custd	10.15 m²	46.50	0
LEVEL 2	Cold Rm	7.05 m²	46.50	0
Storage		296.36 m²		6
Grand total: 77		4825.30 m²		943

Fixture Count Level 2					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	119	6		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Classrooms - D	44	1		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	676	16		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
Storage - F-3	2	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 2
Meeting/Seminar - A-2	96	3		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	6	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 2

Fixture Breakdown Level 2						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 2	28	18	15	6	6	3



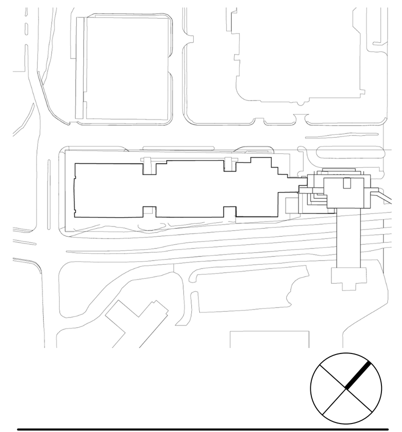
1 LEVEL 2
SCALE: 1 : 250

Occupant Load Factors

Atrium Spaces
Business (Offices)
Classrooms
Concent. business (teaching labs)
General Industrial Use (Research Labs)
Meeting / Seminar
Sales Area on Street Floor
Storage

TRAVEL DISTANCE TO EXIT
0-HR FIRE RATING
1-HR FIRE RATING
2-HR FIRE RATING
SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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LIFE SAFETY PLANS

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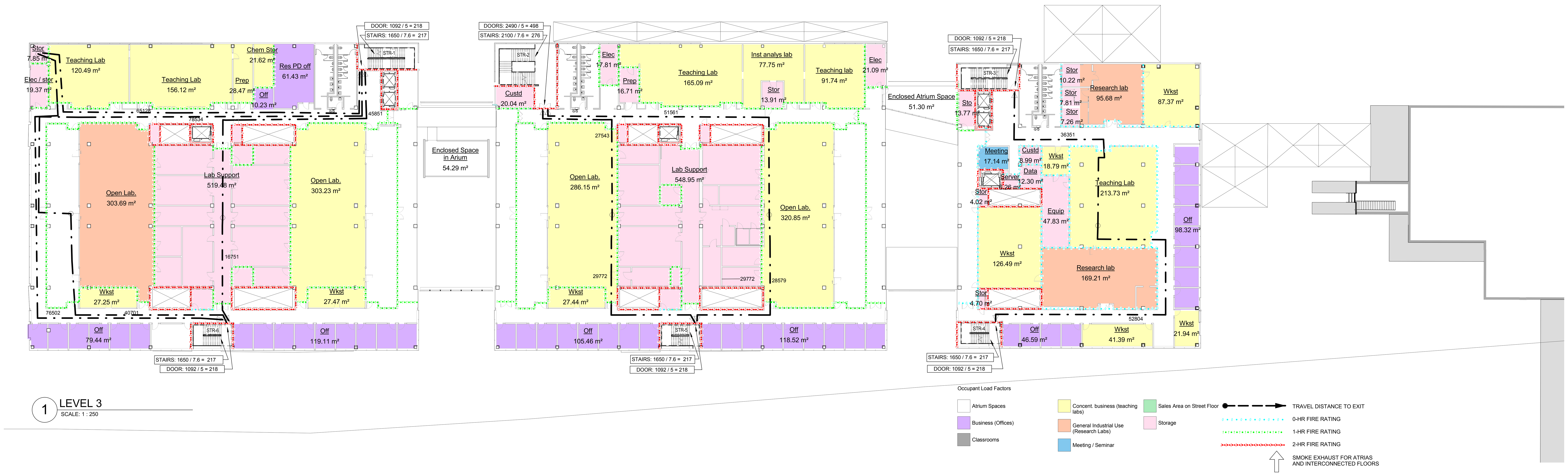
LS102

Occupant Load Level 3				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 3	Off	10.23 m²	9.30	1
LEVEL 3	Res PD off	61.43 m²	9.30	7
LEVEL 3	Off	79.44 m²	9.30	9
LEVEL 3	Off	119.11 m²	9.30	13
LEVEL 3	Off	98.32 m²	9.30	11
LEVEL 3	Off	46.59 m²	9.30	5
LEVEL 3	Off	118.52 m²	9.30	13
LEVEL 3	Off	105.46 m²	9.30	11
Business (Offices)		639.10 m²		69
LEVEL 3	Teaching Lab	156.12 m²	4.60	34
LEVEL 3	Prep	28.47 m²	46.50	1
LEVEL 3	Chem Stor	21.62 m²	46.50	0
LEVEL 3	Wkst	27.25 m²	4.60	6
LEVEL 3	Open Lab.	303.23 m²	4.60	66
LEVEL 3	Wkst	27.47 m²	4.60	6
LEVEL 3	Teaching Lab	120.49 m²	4.60	26
LEVEL 3	Teaching Lab	165.09 m²	4.60	36
LEVEL 3	Inst analys lab	77.75 m²	4.60	17
LEVEL 3	Teaching lab	91.74 m²	4.60	20
LEVEL 3	Open Lab.	286.15 m²	4.60	62
LEVEL 3	Wkst	27.44 m²	4.60	6
LEVEL 3	Open Lab.	320.85 m²	4.60	70
LEVEL 3	Wkst	18.79 m²	4.60	4
LEVEL 3	Teaching Lab	213.73 m²	4.60	46
LEVEL 3	Wkst	87.37 m²	4.60	19
LEVEL 3	Wkst	41.39 m²	4.60	9
LEVEL 3	Wkst	126.49 m²	4.60	27
LEVEL 3	Wkst	21.94 m²	4.60	5
Concent. business (teaching labs)		2163.39 m²		460

Occupant Load Level 3				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 3	Open Lab.	303.69 m²	4.60	66
LEVEL 3	Research lab	169.21 m²	9.30	18
LEVEL 3	Research lab	95.68 m²	9.30	10
General Industrial Use (Research Labs)		568.57 m²		95
LEVEL 3	Elec / stor	19.37 m²	46.50	0
LEVEL 3	Custd	20.04 m²	46.50	0
LEVEL 3	Stor	7.85 m²	46.50	0
LEVEL 3	Elec	17.81 m²	46.50	0
LEVEL 3	Prep	16.71 m²	46.50	0
LEVEL 3	Stor	13.91 m²	46.50	0
LEVEL 3	Elec	21.09 m²	46.50	0
LEVEL 3	Sto	13.77 m²	46.50	0
LEVEL 3	Custd	8.99 m²	46.50	0
LEVEL 3	Data	12.30 m²	46.50	0
LEVEL 3	Server	6.26 m²	46.50	0
LEVEL 3	Equip	47.83 m²	46.50	1
LEVEL 3	Stor	7.81 m²	46.50	0
LEVEL 3	Stor	7.26 m²	46.50	0
LEVEL 3	Stor	10.22 m²	46.50	0
LEVEL 3	Stor	4.70 m²	46.50	0
LEVEL 3	Stor	4.02 m²	46.50	0
Storage		239.95 m²		5
Grand total: 47		3611.02 m²		629

Fixture Count Level 3					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	69	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	459	12		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
Storage - F-3	1	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 3
Concentrated Business (Teaching Labs) - D	66	12		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
General Industrial Use (Research Labs) - F-3	28	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	5	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 3

Fixture Breakdown Level 3						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 3	22	18	15	6	6	3



1 LEVEL 3
SCALE: 1 : 250

Key Plan

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Project No: 14.32005.00
Project
CSF-001-12 Core Science Facility
Sheet Title:
LIFE SAFETY PLANS

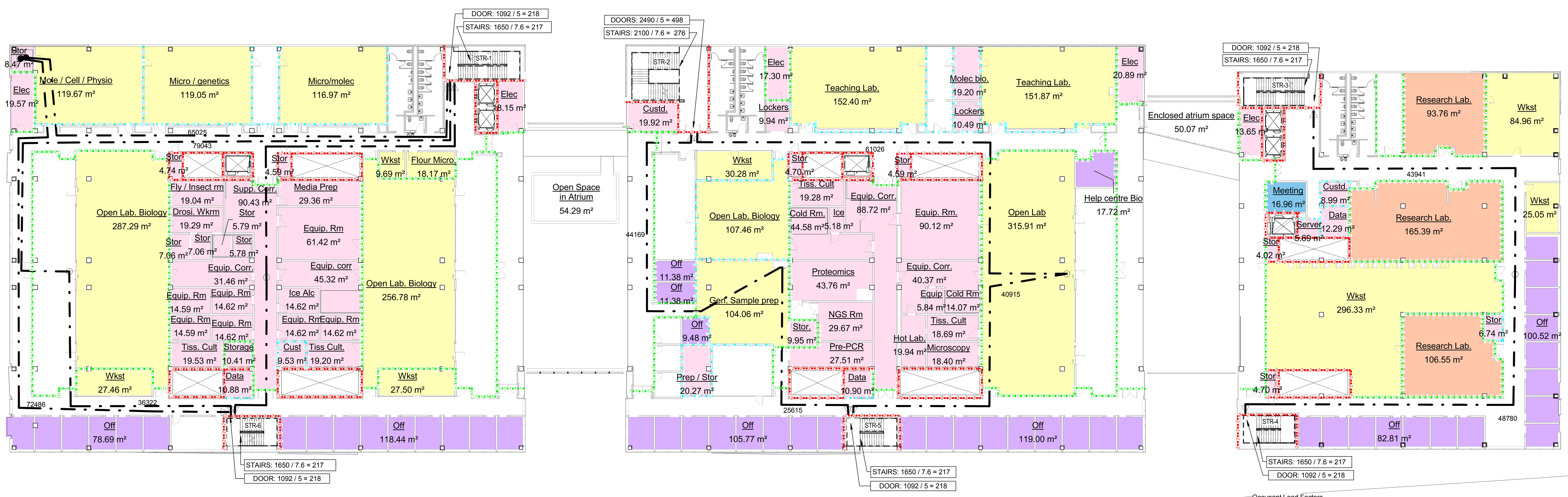
Original drawing is A0. Do not scale contents of this drawing.
Sheet Number:
LS103

Occupant Load Level 4				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 4	Off	118.44 m²	9.30	13
LEVEL 4	Off	78.69 m²	9.30	8
LEVEL 4	Help centre Bio	17.72 m²	9.30	2
LEVEL 4	Off	119.00 m²	9.30	13
LEVEL 4	Off	105.77 m²	9.30	11
LEVEL 4	Off	100.52 m²	9.30	11
LEVEL 4	Off	82.81 m²	9.30	9
LEVEL 4	Off	11.38 m²	9.30	1
LEVEL 4	Off	11.38 m²	9.30	1
LEVEL 4	Off	9.48 m²	9.30	1
Business (Offices)		655.18 m²		70
LEVEL 4	Mole / Cell / Physio	119.67 m²	4.60	26
LEVEL 4	Micro / genetics	119.05 m²	4.60	26
LEVEL 4	Micro/molec	116.97 m²	4.60	25
LEVEL 4	Wkst	9.69 m²	4.60	2
LEVEL 4	Flour Micro.	18.17 m²	4.60	4
LEVEL 4	Open Lab. Biology	256.78 m²	4.60	56
LEVEL 4	Wkst	27.50 m²	4.60	6
LEVEL 4	Open Lab. Biology	287.29 m²	4.60	62
LEVEL 4	Wkst	27.46 m²	4.60	6
LEVEL 4	Open Lab. Biology	107.46 m²	4.60	23
LEVEL 4	Wkst	30.28 m²	4.60	7
LEVEL 4	Gen. Sample prep	104.06 m²	4.60	23
LEVEL 4	Open Lab	315.91 m²	4.60	69
LEVEL 4	Teaching Lab.	152.40 m²	4.60	33
LEVEL 4	Teaching Lab.	151.87 m²	4.60	33
LEVEL 4	Wkst	84.96 m²	4.60	18
LEVEL 4	Wkst	25.05 m²	4.60	5
LEVEL 4	Wkst	296.33 m²	4.60	64
Concent. business (teaching labs)		2250.91 m²		489
LEVEL 4	Research Lab.	93.76 m²	9.30	10
LEVEL 4	Research Lab.	165.39 m²	9.30	18
LEVEL 4	Research Lab.	106.55 m²	9.30	11
General Industrial Use (Research Labs)		365.69 m²		39
LEVEL 4	Stor	8.47 m²	46.50	0
LEVEL 4	Elec	19.57 m²	46.50	0
LEVEL 4	Tiss Cult.	19.20 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Ice Alc	14.62 m²	46.50	0
LEVEL 4	Cust	9.53 m²	46.50	0
LEVEL 4	Equip. Rm	61.42 m²	46.50	1
LEVEL 4	Equip. corr	45.32 m²	46.50	1
LEVEL 4	Media Prep	29.36 m²	4.60	6
LEVEL 4	Fly / Insect rm	19.04 m²	46.50	0
LEVEL 4	Stor	7.06 m²	46.50	0
LEVEL 4	Stor	7.06 m²	46.50	0

Occupant Load Level 4				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 4	Stor	5.79 m²	46.50	0
LEVEL 4	Stor	5.78 m²	46.50	0
LEVEL 4	Equip. Rm	14.59 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.59 m²	46.50	0
LEVEL 4	Tiss. Cult	19.53 m²	46.50	0
LEVEL 4	Storage	10.41 m²	46.50	0
LEVEL 4	Data	10.88 m²	46.50	0
LEVEL 4	Drosi. Wkrm	19.29 m²	46.50	0
LEVEL 4	Elec	18.15 m²	46.50	0
LEVEL 4	Stor	4.59 m²	46.50	0
LEVEL 4	Stor	4.70 m²	46.50	0
LEVEL 4	Tiss. Cult	19.28 m²	46.50	0
LEVEL 4	Ice	5.18 m²	46.50	0
LEVEL 4	Proteomics	43.76 m²	46.50	1
LEVEL 4	NGS Rm	29.67 m²	46.50	1
LEVEL 4	Pre-PCR	27.51 m²	46.50	1
LEVEL 4	Stor.	9.95 m²	46.50	0
LEVEL 4	Data	10.90 m²	46.50	0
LEVEL 4	Cold Rm.	44.58 m²	46.50	1
LEVEL 4	Equip. Rm.	90.12 m²	46.50	2
LEVEL 4	Equip	5.84 m²	46.50	0
LEVEL 4	Cold Rm	14.07 m²	46.50	0
LEVEL 4	Tiss. Cult	18.69 m²	46.50	0
LEVEL 4	Microscopy	18.40 m²	46.50	0
LEVEL 4	Hot Lab.	19.94 m²	46.50	0
LEVEL 4	Prep / Stor	20.27 m²	4.60	4
LEVEL 4	Elec	17.30 m²	46.50	0
LEVEL 4	Lockers	9.94 m²	46.50	0
LEVEL 4	Molec bio.	19.20 m²	46.50	0
LEVEL 4	Elec	20.89 m²	46.50	0
LEVEL 4	Custd.	19.92 m²	46.50	0
LEVEL 4	Elec	13.65 m²	46.50	0
LEVEL 4	Custd.	8.99 m²	46.50	0
LEVEL 4	Data	12.29 m²	46.50	0
LEVEL 4	Server	5.69 m²	46.50	0
LEVEL 4	Stor	4.02 m²	46.50	0
LEVEL 4	Stor	6.74 m²	46.50	0
LEVEL 4	Stor	4.70 m²	46.50	0
LEVEL 4	Stor	4.74 m²	46.50	0
Storage		953.68 m²		30
Grand total: 85		4225.47 m²		629

Fixture Count Level 4					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	70	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	489	12		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
General Industrial Use (Research Labs) - F-3	39	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	30	4	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	

Fixture Breakdown Level 4						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 4	24	18	15	6	6	3



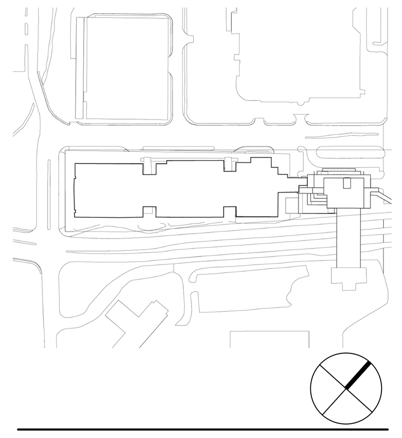
1 LEVEL 4
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Project No: 14.32005.00

Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

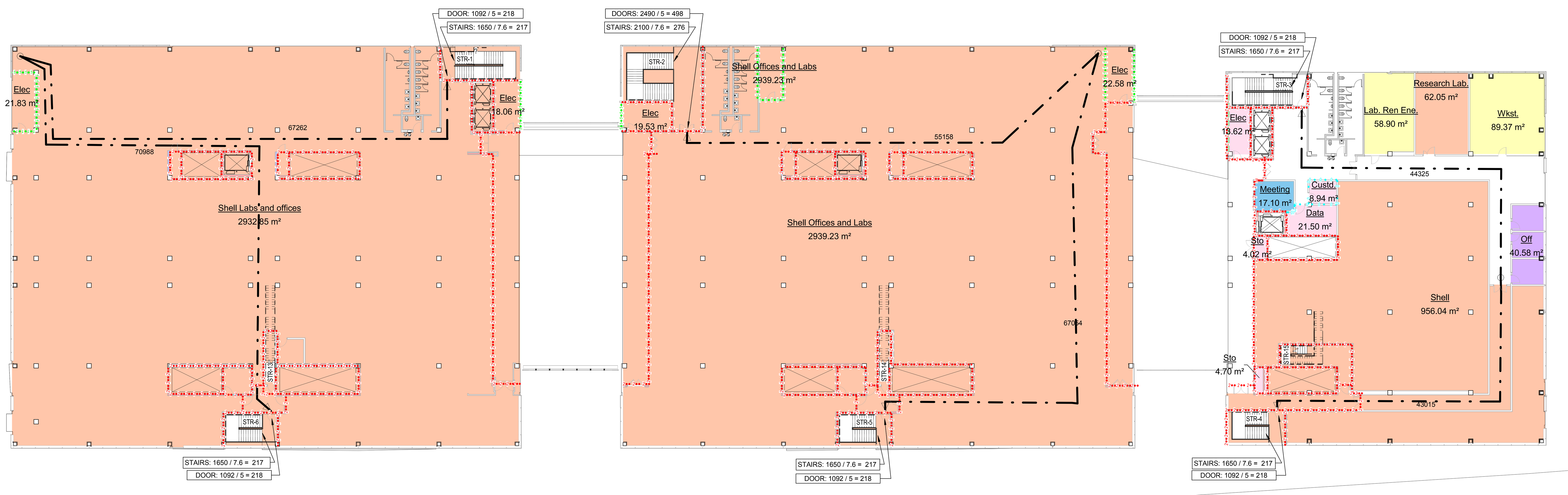
Original drawing is A0. Do not scale contents of this drawing.

Sheet Number:
LS104

Occupant Load Level 5				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 5	Lab. Ren Ene.	58.90 m²	4.60	13
LEVEL 5	Wkst.	89.37 m²	4.60	19
Concent. business (teaching labs)				32
LEVEL 5	Research Lab.	62.05 m²	9.30	7
LEVEL 5	Shell	956.04 m²	9.30	103
LEVEL 5	Shell Offices and Labs	2939.23 m²	9.30	316
LEVEL 5	Shell Labs and offices	2932.85 m²	9.30	315
General Industrial Use (Research Labs)				741
LEVEL 5	Elec	13.62 m²	46.50	0
LEVEL 5	Custd.	8.94 m²	46.50	0
LEVEL 5	Data	21.50 m²	46.50	0
LEVEL 5	Sto	4.02 m²	46.50	0
LEVEL 5	Sto	4.70 m²	46.50	0
Storage				1
Grand total: 11				774

Fixture Count Level 5					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Concentrated Business (Teaching Labs) - D	32	2		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
General Industrial Use (Research Labs) - F-3	741	18		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
Storage - F-3	1	0	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 5

Fixture Breakdown Level 5						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 5	20	18	15	6	6	3



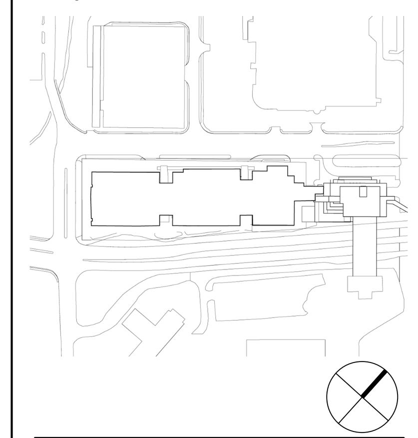
1 LEVEL 5
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

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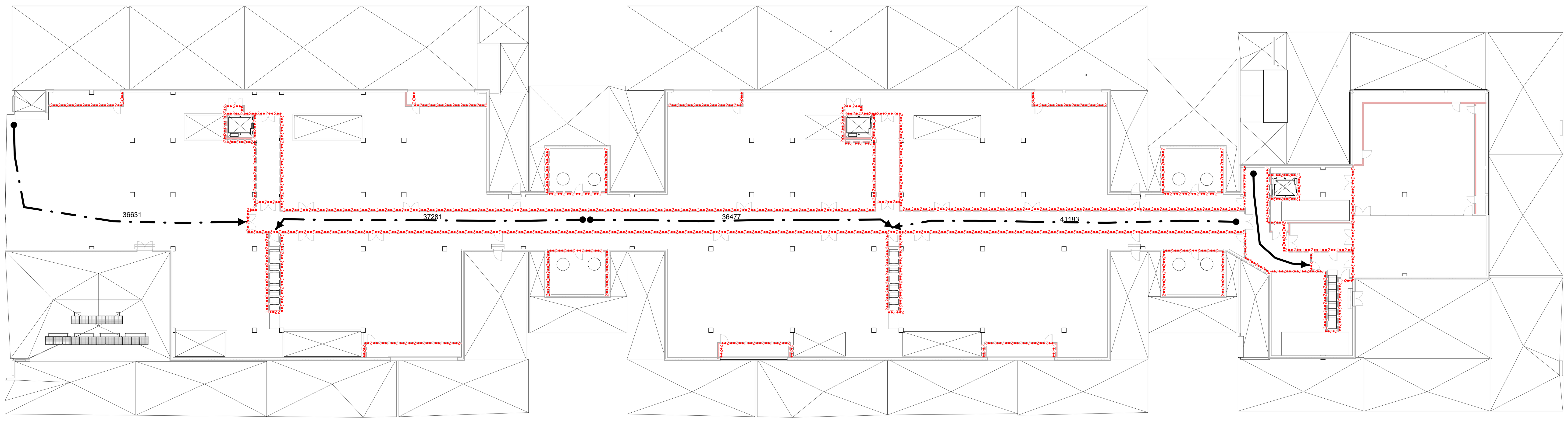
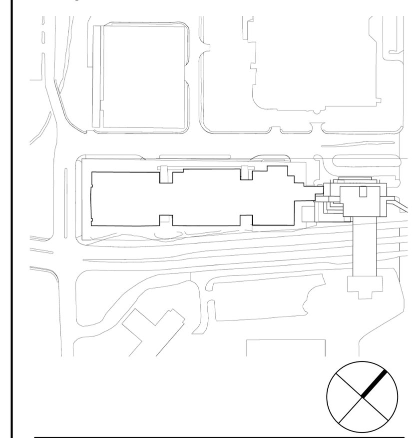
Sheet Number:
LS105



1 LEVEL PH
SCALE: 1 : 250

TRAVEL DISTANCE TO EXIT
0-HR FIRE RATING
1-HR FIRE RATING
2-HR FIRE RATING
SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Project
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Sheet Title:
LIFE SAFETY PLANS

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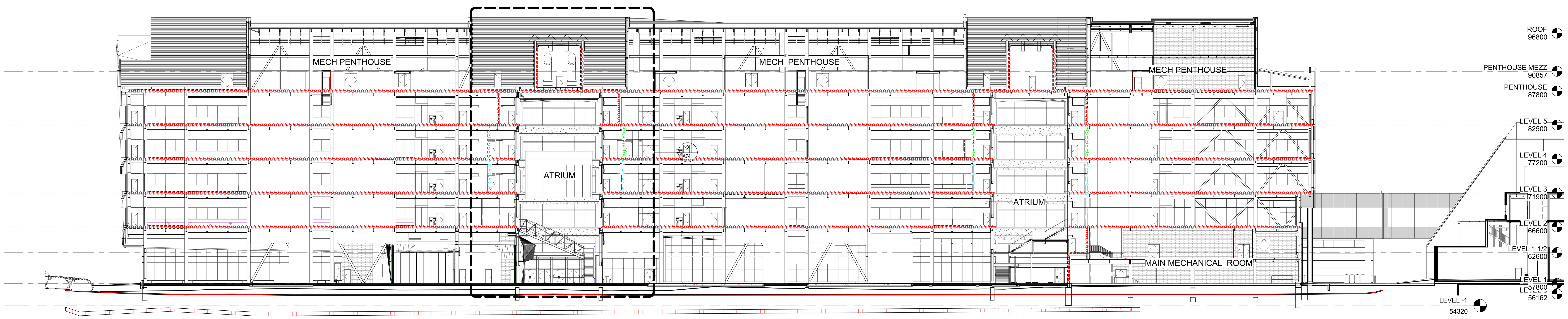
Sheet Number:
LS106



1 FIRE SEPARATION
SCALE: 1 : 250

TRAVEL DISTANCE TO EXIT
0-HR FIRE RATING
1-HR FIRE RATING
2-HR FIRE RATING
SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan

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Appendix D

RJBEL Alternative Solution Report

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HOK

MUN Core Science Building
St. John's, NL

Fire Protection Engineering Analysis
for Interconnected Floor Space

REGISTERED PROFESSIONAL ENGINEER
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PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
BENJAMIN COLES
SIGNATURE
2017/01/19
DATE
NEWFOUNDLAND & LABRADOR

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEG Newfoundland and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
PERMIT HOLDER
This Permit Allows
R.J. BARTLETT ENGINEERING LTD.
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEG D0114 which is valid for the year 2017.

14336 Sealed FPE Analysis R170119

QUALITY REVIEW FORM

RJ Bartlett Engineering Ltd

Document Verification

Project Title	Fire Protection Engineering Analysis for MUN Core Science Building, St. John's, NL	Project Number 14336

Revision	Date	Issued to	14336 Sealed FPE Analysis R170119		
			Prepared By:	Checked By:	Approved By:
Sealed	January 19, 2017	Client	Kevin McCarthy, EIT	Christian Oickle, M.E., P.Eng.(NL) Fire Protection Engineer	Ben Coles, M.Sc.E., MBA, P.Eng. (NL), PE Fire Protection Engineer
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Technical Calculation Review:

Yes ☑ **N/A** ☐

Peer Review:

Yes ☑ **N/A** ☐

Table of Contents

1 Introduction

1.1 Executive Summary

This project involves the construction of a new educational facility having a building footprint of approximately 8,600 m^2 on the Memorial University of Newfoundland (MUN) campus in St. John's, NL.

The building will be constructed with two central atrium spaces, which effectively creates three distinct pavilions. Floor interconnection has been proposed via openings in the floor assemblies. Per the NBC acceptable solutions requirements, these interconnected floor spaces are required to be provided with special protection features.

RJ Bartlett Engineering Ltd (RJBEL) has been retained by HOK to develop a performance-based alternative solution to satisfy the fire and life safety objectives associated with these interconnections, in an effort to deviate from the traditional protection features. This will in turn facilitate several functional and aesthetic goals of the design team, without compromise to the level of performance as it relates to fire and life safety.

This performance-based alternative solution has been shown to achieve a level of performance as required by the 2010 National Building Code of Canada (NBC) in the areas defined by the corresponding objectives and functional statements, as attributed to the applicable acceptable solutions requirements.

The proposed conditions have been evaluated through the combined use of Computational Fluid Dynamics (CFD) fire and egress simulations. The results of this analysis serve as the foundation for this performance-based alternative solution and allow for the formulation of opinions and subsequent required design measures.

The approach followed in this analysis has been based on the guidelines set forth in the Society of Fire Protection Engineers (SFPE) "*Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*" [1] and the International Fire Engineering Guidelines (IFEG) [2].

The analysis has evaluated the fire and life safety performance of the proposed Core Science Building. It has considered multiple design fire scenarios that include fuel loads representative of "*worst-credible case*" scenarios for the types of spaces being evaluated.

The analysis has demonstrated that the proposed atrium design and floor interconnection will provide a level of fire and life safety performance as required by the NBC, subject to implementation of the measures outlined in Section 6 of this report. These measures include, but are not limited to the following. Refer to Section 6 for detailed design information.

1. Each of the two atria are required to be provided with a dedicated smoke exhaust system designed with a minimum capacity of 5,660 m^3/min (200,000 cfm).

2. Make-up air for all of the smoke exhaust systems outlined in Item 1 is required to be provided with a capacity no less than 90% of the exhaust rate. The following make-up air configuration is to be implemented:
   - The Level 1 exterior doors north of both atriums are to be equipped with listed power door operators. These operators are to fully open the doors upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.
   - Operable windows on the north face of both atriums for Level 1. These panels are to be equipped with listed power operators. These operators are to fully open the windows/panels upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.
   - Operable windows on the north face of the pedway/link for Level 2. These panels are to be equipped with listed power operators. These operators are to fully open the windows/panels upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.

All make-up air velocities are to be limited to 1.02 m/s (200 fpm).

3. The smoke exhaust and make-up air systems are to be programmed to reduce the likelihood that either the exhaust or make-up systems will operate independently. The following measures are required:
   - Mechanical proofing switches are to be provided in order to confirm that the make-up air system does not operate independently of the mechanical exhaust system.
   - A delay is to be provided for the activation of all mechanical smoke exhaust system components. This delay is to provide time for the power door operators to fully open doors/louvers serving as part of the make-up air supply, prior to the activation of the mechanical systems. A manual override will be provided at the CACF.
   - Power door operators are not to be equipped with readily accessible disconnect switches (i.e. "ON/OFF" power toggle switches, etc.). If such disconnect switches are provided on the model of door operator specified, tamper-proof housings are to be installed over the switches so they are not readily accessible for anyone other than maintenance staff.

4. All smoke control systems are to be designed such that door opening forces throughout the building do not exceed 133 N (30 lb).

5. Listed beam and air aspirating detection is to be provided within both of the atrium spaces, installed in accordance with CAN/ULC-S524. Listed spot type smoke detection devices are also to be provided adjacent draft stops along the perimeter of atrium openings, consistent with the NBC requirements for special protection measures.

   Zoning of detection devices is to be designed such that two distinct atrium zones are created (i.e. an east atrium and a west atrium zone). Initiation of any of the following conditions in one of the zones shall activate that zones smoke exhaust fans, as well as the buildings passive make up air vents:

   - Any two smoke detectors, or the air aspirating system,
   - One interconnected floor space sprinkler flow switch, or
   - Activation of the manual control switches at the CACF.

   Manual override controls (i.e. "ON/OFF/AUTO" toggle switches) are to be provided at the CACF and fire alarm annunciator panels.

6. All dedicated components considered to be part of the smoke management system (exhaust and make-up air) are to be supervised such that a trouble signal will be transmitted to the fire alarm system should any power interruption occur.

7. The design, installation, testing, and maintenance of the smoke management system is to be completed in accordance with NFPA 92.

8. Control systems that are considered to be part of the smoke management system (exhaust and make-up air) are to be listed in accordance with UL 864, "*Standard for Control Units and Accessories for Fire Alarm Systems",* category UUKL for their intended purpose.

9. All mechanical and electrical systems used to satisfy the requirements of this report are to be provided with emergency back-up power for a duration of no less than 2 h. Protection of electrical conductors serving this equipment shall be in compliance with NBC Article 3.2.7.10.

10. The automatic sprinkler systems serving all floor areas are to be equipped with fast-response type sprinkler heads with an activation temperature of 57˚C. Some exceptions apply such as service rooms, at the ceiling level of the atrium space, and other areas where high ambient temperatures are expected.

11. Levels 4 and 5 pavilion neighborhoods are fire separated from the atrium spaces by no less than 1 h and 2 h fire separations, respectively. The two exit stairs serving each of the neighborhoods are located within the protected floor spaces and not the atrium proper. Level 3 pavilion neighborhoods are fire separated from the atrium spaces by no less than a 0 h fire separation. Exit stairs serving the neighborhoods are located within the protected floor spaces and not the atrium proper.

12. Exit stairs serving each of the three pavilions are designed with stair widths no less than 1,650 mm.

13. Multiple fire department connections are to be provided along the north building face and form a looped system. Primary fire department response will occur at the east atrium along the north face and include the provision of a CACF in accordance with NBC Article 3.2.6.7. Secondary fire department response will occur at the west atrium and include the provision of an annunciator panel.

14. A firefighter's elevator in accordance with NBC Article 3.2.6.5. is to be provided within the vicinity of each of the two fire department response points.

Refer to Section 6 of this report for a description of the above measures to be implemented.

Information contained within this report is specific to the MUN Core Science (MCS) project. In this regard, all conclusions and subsequent required design measures are only applicable to this project. Any changes to life safety systems, and/or function of the building in the future are to be reviewed by the building Owner with respect to the impact on these performance-based alternative solutions.

1.2 Building Owner Responsibilities

This performance-based alternative solution utilizes fire and life safety components that deviate from the acceptable solution requirements of the NBC. The Owner acknowledges that while the life safety objective and functional requirements of the NBC are met, there is a possibility that the building and its contents could suffer greater property damage from a fire than if it were constructed to the acceptable solution requirements. This condition is to be reviewed with the owner's insurance underwriter and all property Stakeholders.

The Owner or their qualified representative shall be responsible to develop and maintain all documentation associated with this performance-based alternative solution, and retain these documents on the building premises. A specific section for alternate solutions is to be included in the fire safety plan.

The maintenance of fire and life safety components required by the NBC and this performance-based alternative solution are the responsibility of the Owner and are required to be implemented in accordance with Section 2.8. of the National Fire Code of Canada (NFC). Integrated fire and life safety system testing is to be conducted in accordance with CAN/ULC-S1001.

Any changes to the building in terms of function, occupancy use, and/or fire and life safety systems will require re-evaluation in terms of their impact on these alternative solutions. This is the responsibility of the Owner.

1.3 Project Description

The MCS building will have a building area (footprint) of approximately 8,600 m^2. The building height is to be six storeys, including both a Service Level above the first storey (Level 1.5), and a Mechanical Penthouse. A pedway/link will connect the adjacent University Centre (UC) building with Level 2 of the MCS building on the east face.

A site plan is provided in Figure 1 with the building located on the MUN Campus such that it is bounded by:

- Arctic Avenue to the north,
- Parking and the University Centre to the east,
- Prince Philip Drive to the south, and
- Westerland Road to the west.

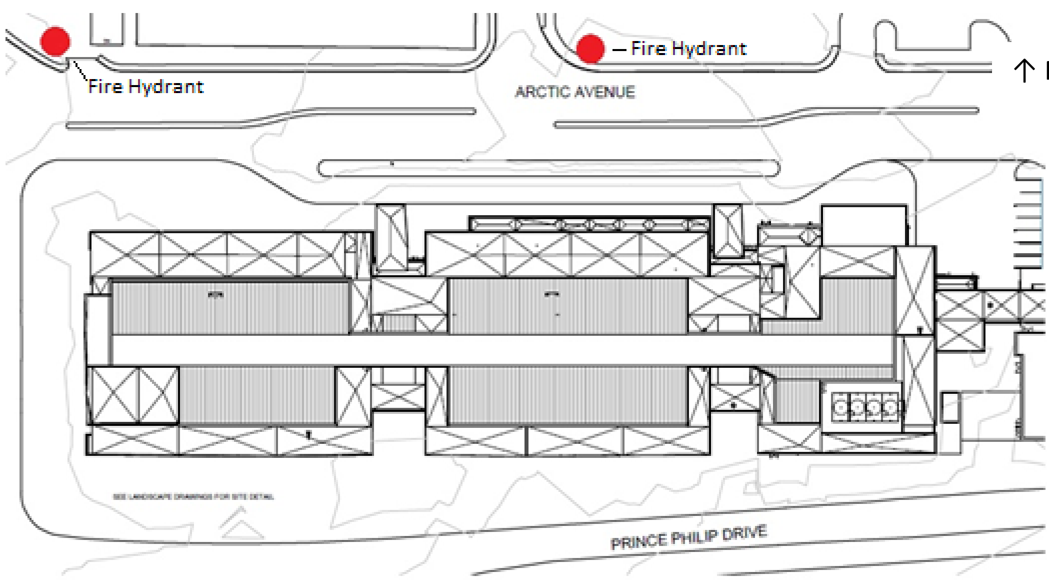

Figure 1: MCS Facility Site Plan

Fire department access routes will be available along the north, east, and south building faces. Through consultation with the St John's Regional Fire Department (SJRFD), it has been determined that primary fire department response will occur at the east atrium along the north face and include the provision of a CACF in accordance with NBC Article 3.2.6.7. Secondary fire department response will occur at the west atrium and include the provision of an annunciator panel. Multiple fire department connections along the north face will be provided and form a looped system. Hydrants are located along Arctic Avenue as shown in Figure 1, and are within 45 m of each of the fire department connections. A firefighter's elevator in accordance with NBC Article 3.2.6.5. will also be provided within the vicinity of each of the two fire department response points.

The building will be of noncombustible construction and will be equipped with fire detection and alarm, automatic sprinkler suppression and standpipe systems throughout. Refer to the RJBEL "*14024 Design Development Building Code Analysis Revised R160622",* for more information. This will include air-aspirating and beam type smoke detection systems within the open atrium portions of the building.

General occupancy use will involve a combination of research and teaching laboratories, with approximately 1,645 m^2 of the first floor, as well as portions of the Level 5 (sixth storey) being reserved as shell space for future expansion.

The various functional uses of the MCS building can be divided into three major NBC occupancy classifications as per below.

- Group A, Division 2 – Assembly.
- Group D - Business and Personal Services.
- Group F, Division 3 – Low-Hazard, Industrial.

Table 2 identifies the associated occupancies and uses by floor level. F2 occupancies may be present to account for incidental areas such as chemical storage and handling. The client has acknowledged that there will be no combustible fuel loading greater than 50 kg/m^2. NFPA 101 is the applicable Code in terms of egress for the building and the classifications provided from this Code have been used as they will affect the occupant load and exit capacity. It is noted that teaching laboratories (instructional laboratories serving less than 50 persons) have been identified as a business use in accordance with NFPA 45/101. Research laboratories are to be considered as a general industrial occupancy use per NFPA 45 Section 4.2.2. and NFPA 101 Section 6.1.11. Refer to Section 4.10 of this report for additional requirements regarding maximum allowable quantities in these labs.

Table 1 identifies the associated occupancies and uses by floor level.

Level	NBC Major Occupancy Classification	NFPA 45/101 Classification	Functional Use of Space
1	A2, D, and F3	Assembly, High-Hazard and General-Hazard Industrial, Business	Shell Space, Research Labs, Offices, Loading/Receiving/Stock Area, Assembly Space, and Building Services
1.5	D and F3	Business and General-Hazard Industrial	Offices and Building Services
2	F3	Business	Teaching Labs
3	F3	Business	Teaching Labs
4	F3	Business and General-Hazard Industrial	Teaching and Research Labs
5	D and F3	Business and General-Hazard Industrial	Shell Space, Teaching, and Research Labs
Penthouse	F3	General-Hazard Industrial	Building Services

Table 1: Occupancies by Floor Level

It is noted that any lab/classroom or meeting area which contains an occupant load greater than 50 persons is to be regarded as an assembly use (NFPA 101 Article 6.1.2.1).

The first storey is served by exit doors which discharge directly to the exterior. Upper storeys are served by two fire rated exit stairs for each of the three pavilions, which typically discharge to the exterior on the first storey. A pedway to the UC building is located along the east face at the Second Level and provides additional horizontal exiting. Exit stairs serving each of the three pavilions are designed with stair widths no less than 1,650 mm, resulting in available capacities exceeding calculated occupant loads by no less than 70% on any of the upper three levels. Refer to RJBEL report "*14024 Design Development Building Code Analysis Revised R160622"* for further information regarding calculated occupant loads and exit capacities.

The building will feature two 5 level atriums with both atriums separated from:

- Level 5 neighborhoods, Level 1.5, and Level 1 BOH by a 2 h fire-resistance rating,
- Level 4 neighborhoods by a minimum 1 h fire-resistance rating, and
- Level 3 neighborhoods by a 0 h fire-resistance rating.

A mechanical smoke exhaust system will be provided at the ceiling level of both of the atrium spaces, with each having a capacity of 5,660 m^3/min (200,000 cfm).

Levels 1 and 2 will be interconnected throughout, with the exception of the Level 1 back-of-house areas within the east pavilion. The meeting rooms and lounges that are present within Levels 1.5 and 2 in the east atrium and within Levels 3 and 4 in the west atrium are to be constructed as mezzanines having a fire-resistance rating of 1 h. Refer to Figure 8 for a section of the building and to Table 2 below for a list of spaces and mezzanine uses located within the two atriums, by level.

Floor Level	West Atrium	East Atrium
1	No occupancy	Offices, Storage, and Service Rooms
1.5	No occupancy	Meeting Rooms
2	No occupancy	Lounge
3	Lounge	Meeting Room
4	Lounge	Meeting Room
5	No occupancy	No occupancy

Table 2: Summary of Spaces and Mezzanines within Atriums

Refer to Figures 2 through 7 for fire separation drawings. Refer to Appendix A for the building floor plans and elevations.

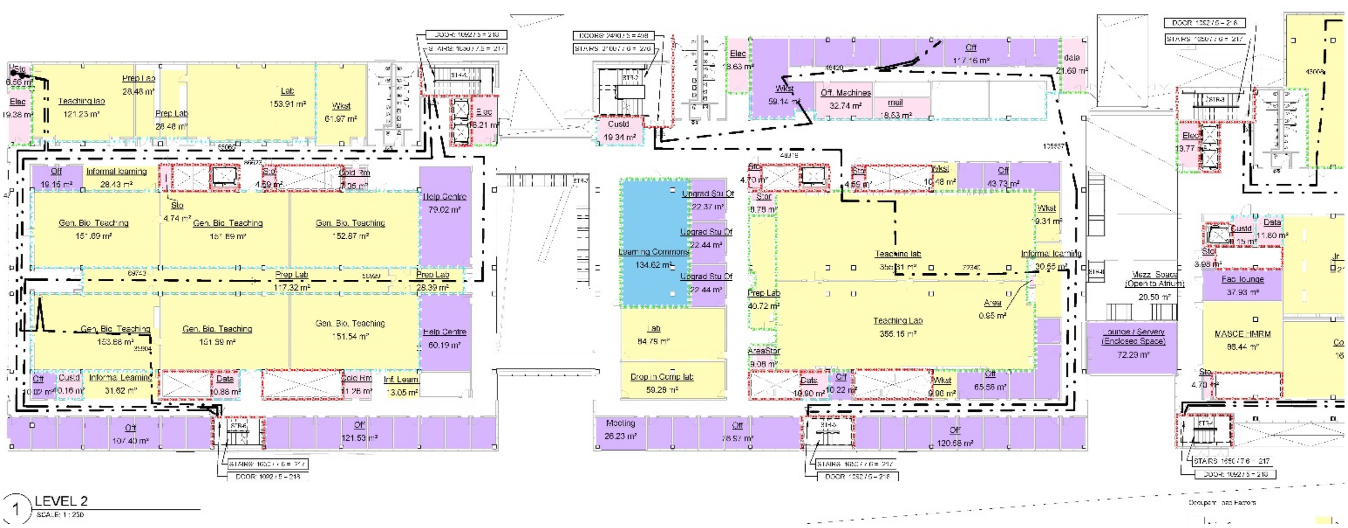

Figure 2: Level 1

Figure 3: Level 1.5

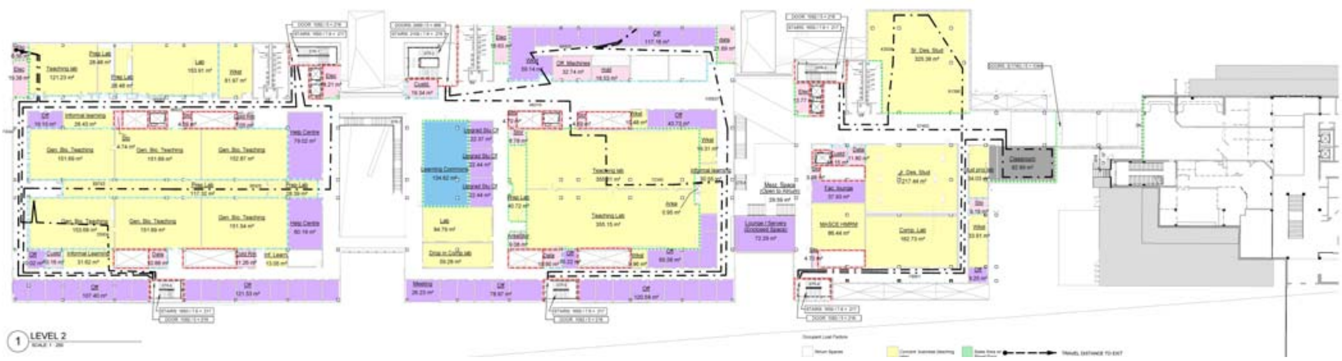

Figure 4: Level 2

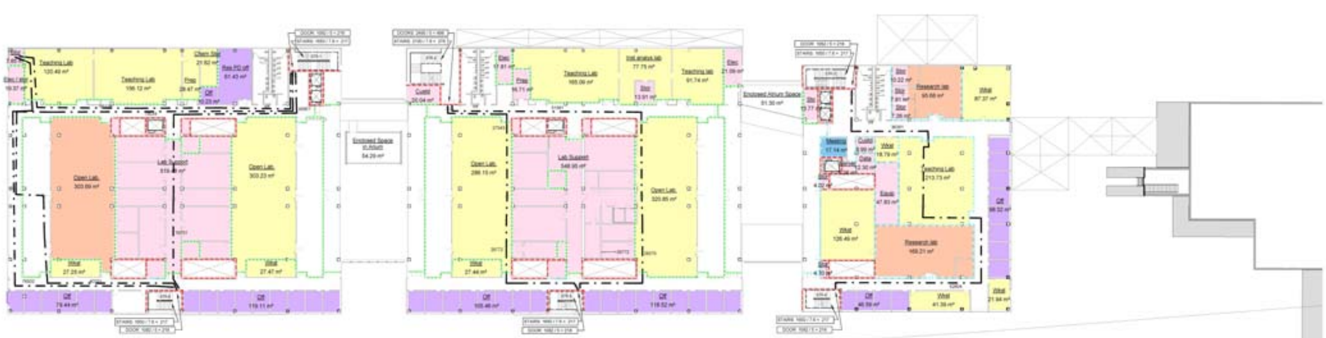

Figure 5: Level 3

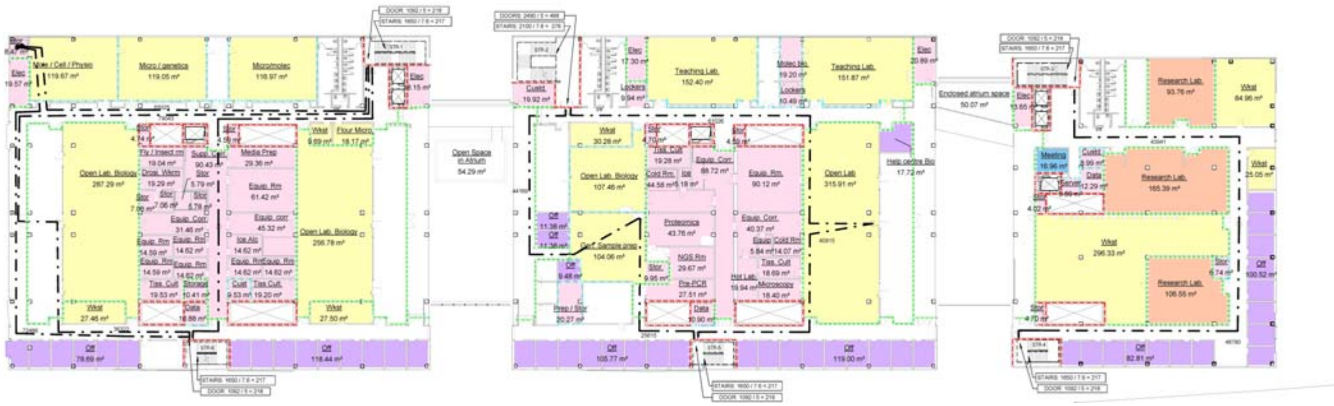

Figure 6: Level 4

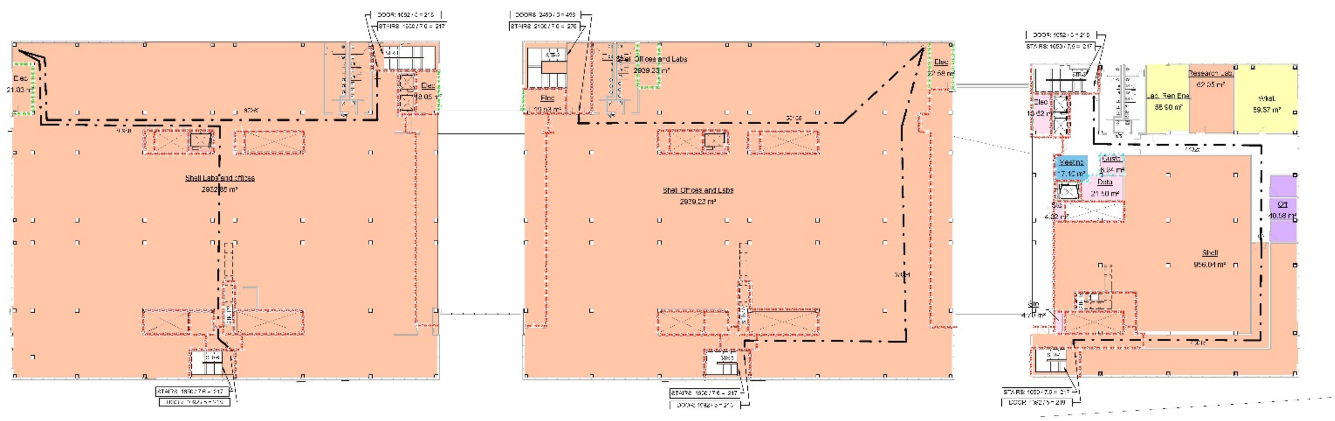

Figure 7: Level 5

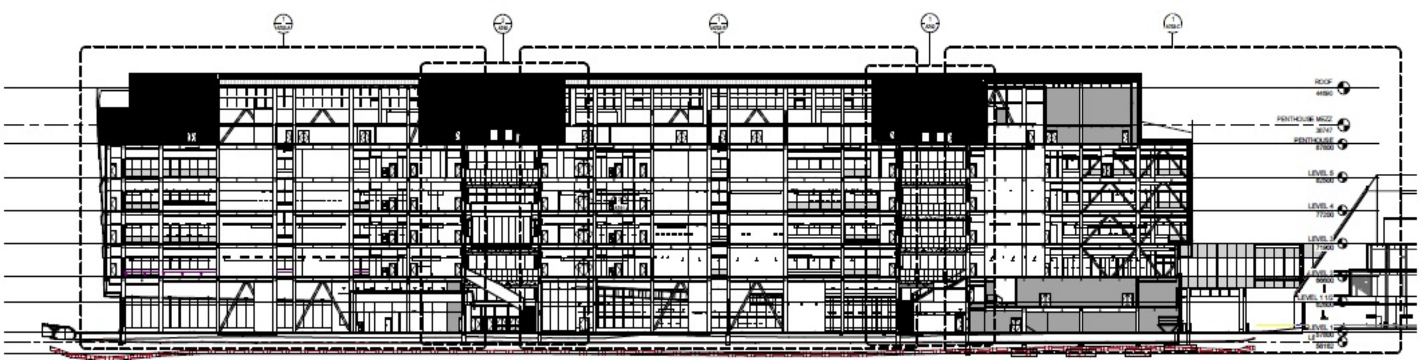

Figure 8: MCS Building Section

1.4 Dominant Occupant Characteristics

Occupants of the building will be representative of a general university population in terms of age, mobility, and familiarity with the building. Given its use as a research and instructional type facility, there is a proportion of the population that is expected to be familiar with the building layout and locations of exits.

Occupants are expected to be awake, alert, and fully conscious. There will be no sedation or sleeping to occur on site, and all occupants are expected to be capable of self-preservation (i.e. no care or treatment occupancy as defined by the NBC).

University staff will be present during typical hours of operation and familiar with the building layout. Staff will have emergency procedure training and will be able to assist students and the general public with evacuation of the building in the event of an alarm.

Special procedures are to be developed for the evacuation of mobility impaired occupants and persons requiring special assistance. These procedures are to be documented in the building's fire safety plan.

2 Applicable Codes and Standards

The Codes and Standards referenced for this fire protection engineering analysis include, but are not limited to, the following:

- 2010 National Building Code of Canada (NBC).
- 2010 National Fire Code of Canada (NFC).
- CAN/ULC-S524*, "Installation of Fire Alarm Systems",* 2014 Edition
- NFPA 13, *"Standard for the Installation of Sprinkler Systems"*, 2013 Edition.
- NFPA 92, *"Standard for Smoke Control Systems"*, 2015 Edition.
- NFPA 101, "*Life Safety Code*", 2015 Edition.
- National Fire Protection Association, "*Standard on Fire Protection for Laboratories Using Chemicals",* 2015 Edition (NFPA 45).
- ASHRAE, "*Handbook of Smoke Control Engineering"*, 2012.
- National Fire Protection Association, "*Standard for Fixed Guideway Transit and Passenger Rail Systems*", 2014 (NFPA 130).
- National Fire Protection Association, "*Standard for Road Tunnels, Bridges, and Other Limited Access Highways*", 2014 (NFPA 502).
- National Fire Protection Association, *"Standard for Determination of Fire Loads for use in Structural Fire Protection Design",* 2012 (NFPA 557).
- National Fire Protection Association, "*Building Construction and Safety Code*", 2015 (NFPA 5000).
- CAN/ULC-S1001, "*Integrated Systems Testing of Fire Protection and Life Safety Systems*", 2011.

- CAN/CSA – C282, *"Emergency Electrical Supply for Buildings"*, 2015.

2.1 Alternative Compliance

Division A, Section 1.2. of the NBC states that:

> "C*ompliance with the NBC shall be achieved by either*:
>
> - *Compliance with the NBC acceptable solutions as presented in Division B*, or
> - *Using alternative solutions that will achieve at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the applicable acceptable solutions*".

The acceptable solution requirements of the NBC are intended to benchmark levels of risk associated with life safety and property protection.

2.2 Acceptable Solution Requirements

For the MCS building, exemption from the special protection requirements of NBC Articles 3.2.8.3. to 3.2.8.9. would require that (NBC Sentence 3.2.8.2.(6)):

- The interconnected floor space consists of the first storey and the storey next above or below it, but not both,
- The openings through the floor are used only for stairways, escalators or moving walks or the interconnected floor space is sprinklered throughout,
- The interconnected floor space contains only Group A, Division 1,2 or 3, Group D, Group E, or Group F, Division 2 or 3 major occupancies, and
- The building area is not more than one half of the area permitted by Subsection 3.2.2.

The building and its two atria are in conformance with the above requirements, with the exception that the interconnected floor space consists of more than two storeys; the three pavilion neighborhoods on Levels 3 and 4 are not isolated from the atria by 2 h fire separations as required by Sentence 3.2.8.1.(1), but rather 0 h and 1 h separations, respectively.

This performance-based alterative solution will be supported by the implementation of enhanced fire and life safety measures to offset this discrepancy and achieve an acceptable level of performance. The selection of these enhancements has been based in large part on their ability to limit smoke movement and reduce delays and/or inefficiencies in occupant and emergency responder responses.

The complete functional, objective and intent statements associated with NBC Sentence 3.2.8.1.(1) and Sentence 3.2.8.2.(6), specific to the interconnected floor space exemptions, are provided in Appendix B. In summary, the fire safety intent of this exemption is as follows:

> *The intent is to exempt certain interconnected floor spaces from the requirements of Sentence 3.2.8.1.(1) and Articles 3.2.8.3. to 3.2.8.9., which would otherwise require a vertical fire separation or certain protection measures, if:*
>
> - *The location and number of interconnected floors is limited, which will minimize:*
>   - *Vertical fire spread, and*
>   - *Delays in emergency responder access and the evacuation of occupants.*

3 Research, Related Theory, and Background Information

3.1 Computational Fluid Dynamics Simulation

The CFD software package '*Fire Dynamics Simulator*' (FDS) [3] used in this analysis facilitates the ability to model and estimate site specific variables that can yield a representation of fire conditions. These simulation models take into consideration parameters such as:

- Fuel loads and characteristics of combustion by-products,
- Design fire locations and specified heat release rate profiles,
- Compartment geometries and material properties, and
- Ventilation (mechanical and natural) conditions.

The design fire scenarios selected in this analysis have been developed and simulated using CFD software. The software has been programmed for this analysis to estimate values for:

- Fire evolution and tenable conditions due to smoke and combustion by-products, and
- Detection times of the fire and life safety systems (i.e. smoke detectors and sprinklers).

Refer to Appendix C for additional information and assumptions regarding tenable conditions.

3.2 Egress Time Model

Safe evacuation in a fire condition is achieved when the required safe egress time (RSET) is less than the available safe egress time (ASET) [2] [4] [5].

The RSET specific to this analysis has been considered as the total estimated time for occupants to exit the building. The ASET has been considered as the time at which:

- Conditions within the egress paths become untenable due to temperature, visibility, or carbon monoxide (CO) levels as estimated by the CFD simulations.

An egress time model has been developed in this analysis using the Pathfinder simulation software [6], results from the FDS models, and information obtained from referenced literature.

The Pathfinder software is based on empirical calculations that have been developed through testing and observation as outlined in the SFPE Handbook [4] [5]. These methods are used by fire protection engineers in estimating occupant movement in fire emergency situations.

Conservative factors such as reduced travel speeds, simultaneous occupant merging, and furthest travel distances have been incorporated into the analysis.

Refer to Appendix D for further considerations and assumptions regarding the egress time model.

3.3 NFPA 101 Mini Atrium Requirements

Although Chapter 8 of NFPA 101 is not enforceable within this jurisdiction, Section 8.6.6 of NFPA 101 has been referenced as a best practice guide to further evaluate the alternative solution approach and resulting performance levels.

NFPA 101 acknowledges that when the requirements noted below are met for three level "mini atriums", an adequate level of fire and life safety is established in lieu of the more stringent requirements of Section 8.6.7., which deals with atria of all heights.

Unenclosed floor openings forming a communicating space between floor levels are to be permitted, provided that the following conditions are met (NFPA 101, Section 8.6.6):

- The communicating space does not connect more than three contiguous stories,
- The lowest or next-to-lowest story within the communicating space is a street floor,
- The entire floor area of the communicating space is open and unobstructed, such that a fire in any part of the space will be readily obvious to the occupants of the space prior to the time it becomes an occupant hazard (see discussion below regarding use of enhanced fire detection and alarm systems),

- The communicating space is separated from the remainder of the building by fire barriers with not less than a 1 h fire resistance rating, unless the building is protected throughout by an approved automatic sprinkler system in accordance with NFPA 13, in which case a smoke barrier is permitted. Refer to Figure 9.

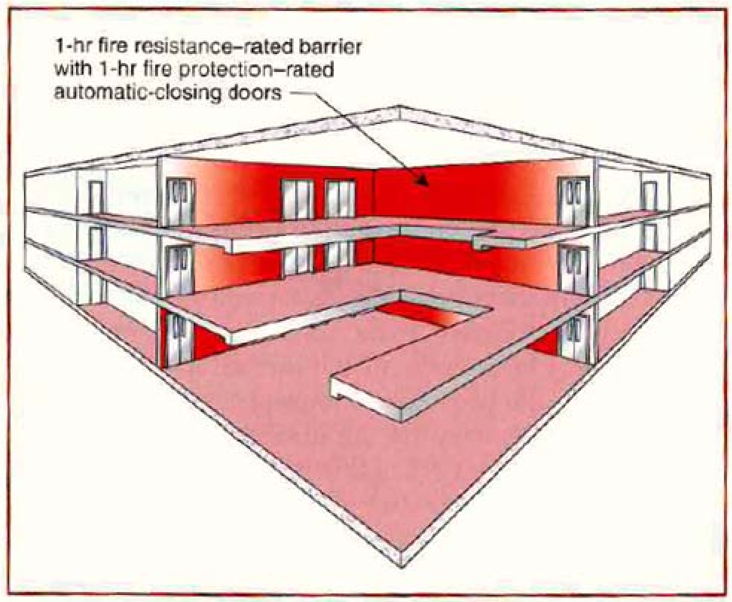

Figure 9: Separation of Communicating Space from the Remainder of the Building

- The communicating space has ordinary hazard contents protected throughout by an approved automatic sprinkler system, or has only low hazard contents,

- Egress capacity is sufficient to allow all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single floor area in determining the required egress capacity,

- Each occupant within the communicating space has access to not less than one exit without having to traverse another story within the communicating space, and

- Each occupant not in the communicating space has access to not less than one exit without having to enter the communicating space.

The vertical opening is permitted to include Level 1 or Basement through to Level 2 as shown in Figure 10 below.

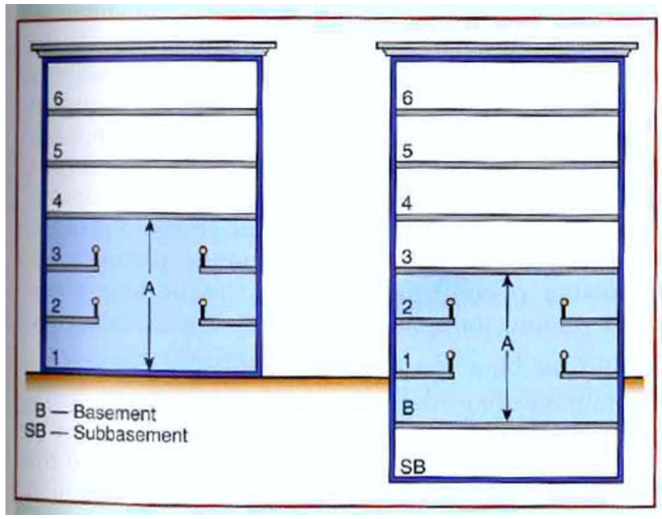

Figure 10: Permitted Location of Three Storey Interconnection

The communicating space includes all of the areas within the vertical opening itself and all of the adjoining areas left open to the vertical opening, as well as those areas not separated by the minimum fire separations. The communicating space must be open and unobstructed, so that occupants will be aware of fire and smoke conditions emanating from any part of the communicating space prior to the time such conditions become a hazard. An enhanced number of detection devices may be acceptable, where approved by the AHJ, as a means of providing awareness and early warning to occupants.

Ordinary Hazard contents are classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke (NFPA 101, Section 6.2.2.3.). Ordinary Hazard classification represents the conditions found in most buildings and is the basis for general requirements of the NFPA 101.

Because all occupants within the communicating space might be exposed within a short period of time to the effects of fire, simultaneous evacuation capability needs to be provided. Thus, the combined occupant load for all spaces, on all levels, in the communicating space needs to be included when sizing the means of egress.

3.4 Effects of Sprinkler Control

Automatic sprinklers are acknowledged as being an effective component in a global design for fire protection in buildings.

From 2006 to 2010 in the United States for public assembly properties, when wet pipe sprinklers are present, the following statistics are reported in comparison to buildings without automatic extinguishing equipment present [7]:

- Deaths per thousand fires are 100% lower, and
- Direct property damage per fire was 75% lower.

Sprinklers are designed to confine a fire to the room or area of origin. Flame damage is expected to be confined to the room of origin in 95% of fires across all occupancies when any type of sprinkler is present [7].

The reliability of fire suppression systems is a function of both operational and performance reliability. The operational reliability is a measure of the probability that a system or component will operate as intended when needed, while the performance reliability is a measure of the adequacy of the system once it has operated. The operational reliability is a function of proper design and installation, however research has shown that performance reliability can be improved with proper fire safety planning (i.e. maintenance, housekeeping, education/training, etc.).

The MCS is required to be constructed and maintained in accordance with the NBC and the NFC. As such, should the fire protection systems, including the sprinkler system, be out of service, impairment procedures are to be established. Such procedures include, but are not limited to: arranging an approved fire watch, establishing a temporary water supply, eliminating potential ignition sources, and limiting the fuel load.

Given the supporting research for increased performance reliability of sprinkler systems with proper fire safety planning, sprinkler systems are assumed to actuate in the design fire scenarios where specifically noted in this report. A conservative assumption that the sprinklers will control and not suppress the design fire has been applied [2].

In support of the approach, it is noted that the NBC does make allowances and relaxations based solely on the presence of sprinkler protection. Such variances are evidence of the reliance that building codes and standards place on fire suppression systems, and their assumption that these systems are reliable when installed and maintained properly.

3.5 Fire Protection Engineering Qualifications

RJBEL has been providing professional fire protection engineering solutions since 1987 with services provided locally, regionally, nationally, and internationally. The firm has an in-house technical staff which currently includes eight licensed Professional Engineers, three of whom have degrees in fire protection engineering.

RJ Bartlett has successfully provided fire-protection engineering consulting services on a variety of projects in Newfoundland and Labrador, and other Canadian jurisdictions using performance-based alternative solutions for university facilities.

4 Performance-Based Solution

4.1 Project Stakeholders and Design Objectives

The Stakeholders identified for this project are as follows:

- Memorial University of Newfoundland (Building Owner).
- HOK, with Hearn Fougere Architects Inc. (Project Architect).
- Vanderweil with Team Terra Nova (Mechanical and Electrical Engineering Consultant).
- RJ Bartlett Engineering Ltd (Fire Protection Engineering Consultant).
- Fire and Emergency Services of Newfoundland and Labrador (Authority Having Jurisdiction).
- St. John’s Regional Fire Department (Emergency Responder).

The primary fire protection goal common to all Stakeholders and the AHJ’s is the minimization of fire related injuries, the prevention of loss of life to building occupants and emergency responders, and the minimization of property damage.

The objective of this analysis is to rationalize a greater degree of interconnected floor space without the exhaustive application of traditional special protection features. Several enhanced fire protection features will be required as a compensatory measure, to facilitate an acceptable level of fire and life safety performance.

4.2 Defined Performance Criteria

The performance criteria defined for a performance-based alternative solution establishes the level of acceptable risk based on the stated goals and Code objectives.

For the purpose of this analysis, the acceptable level of risk is benchmarked by the corresponding fire and life safety objective and intent statements, as outlined in Section 2.2 of this report.

Based on this benchmark and the goals and objectives for this analysis, the performance criteria developed by RJBEL for this project will be defined as:

> *"The RSET shall not exceed the ASET, as outlined in Section 3.2 of this report in terms of tenability",*
>
> *and*
>
> *"Sufficient fire protection features are to be provided such that vertical fire spread is limited, either by their physical presence or their ability to facilitate efficient emergency responder access".*

4.3 Approach and Method of Analysis

Both qualitative and quantitative approaches have been applied in this report.

A quantitative, absolute analysis has been utilized in establishing both the ASET and RSET values. Additional NBC compliant configurations have been evaluated relative to the proposed conditions in terms of ASET/RSET to allow further analysis and opinions to be developed.

A qualitative engineering judgment has been included in support of the enhanced fire protection features provided, which are intended to limit vertical fire spread and reduce delays associated with a fire department response/occupant evacuation.

4.4 Design Fire Development

Multiple design fire scenarios have been considered in this analysis and reflect guidance presented in standards such as NFPA 5000 (refer to Table 2). Four "*worst-credible case*" design fire scenarios have been presented within this report. These fires have been selected based on the potential impact on fire and life safety and fuel loads representative of those that are expected to be present in the interconnected floor spaces.

NFPA 101 Design Fire Scenarios	Description	MCS Design Fire Scenarios
1	Occupancy-specific scenario representative of a typical fire for the occupancy.	All
2	An ultrafast-developing fire in the primary means of egress, with interior doors open at the start of the fire.	(a)
3	A fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in a large room or other area.	(b)
4	A fire that originates in a concealed wall space or ceiling space adjacent to a large, occupied room.	(c)
5	A slow-developing fire, shielded from fire protection systems, in close proximity to a high occupancy area.	(b)
6	The most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.	1, 2, 3
7	An outside exposure fire.	(d)
8	A fire originating with ordinary combustibles in a room or area with each passive or active fire protection system or fire protection feature independently rendered ineffective.	(e)

a) The concerns associated with this design fire scenario are not expected to be a worst case scenario for the purposes of the smoke control analysis due to the limited heat-release rates associated with these types of fires (i.e. The heat release rate of a 1 L gasoline pool fire that may be associated with arson is less than 600 kW). Furthermore, as there are two primary entrances to the building on Level One, this scenario is not directly applicable.

b) The concerns associated with this scenario are expected to be no worse than the selected design fire scenarios and/or have been addressed by the selected design fire scenarios in terms of the defined performance criteria.

c) Concealed spaces in this noncombustible building are required to have minimum combustibles, and therefore are expected to be minimal in size and would impact the atrium no worse than the other scenarios.

d) Outside exposure fires near the atrium are expected to be minimal in size and impact the atrium no worse than the other scenarios.

e) The selected design fire scenarios are dependent on activation of the fire and life safety systems. As such, to ensure the performance reliability of the fire and life safety systems are maintained, a maintenance program for the fire and life safety systems is to be included in the building's fire safety plan. In addition, to ensure that the sprinkler system will be designed and installed in accordance with the applicable Codes and Standards, RJBEL will review the sprinkler system drawings and test certificates, and conduct a site visit to witness the acceptance testing for the automatic sprinkler and fire alarm systems. Ineffective operation of individual fire protection systems has also been explored as part of the sensitivity analysis presented in report section 4.5.5.

Table 2: Section of Design Fire Scenarios

The heat release rates applied to the design fire scenarios are based on data from non-sprinklered full-scale testing of fires with fuel loads representative of those that may be present in the areas of concern. The design fire scenarios and heat release rates applied in this analysis are presented in Table 3.

Design Fire Scenario	Full-Scale Test	Peak Heat Release Rate (kW)	Combustible Mass (kg)	Growth Rate	Location	Full-Scale Test Reference
1a	Newsstand Display	3,600	15[(a)]	Ultra Fast	Level 1 East Atrium	[8]
1b					Level 1 West Atrium	
2a	Office Workstation	4,000	335[(b)]	Medium	Level 2 Lab space adjacent atrium	[9]
2b					Level 2 lounge adjacent atrium	
3a	General Atrium Fire Load for areas with furniture or other combustibles	5,000	----	Fast	Level 1 East Atrium	[10]
3b					Level 1 West Atrium	
3c					Level 2 West Atrium	
4	Upholstered Couch	3,200 [(c)]	-	Fast	Level 1 center pavilion egress	[9]

a) Ignition source is a small pool of gasoline to represent an arson fire.
b) Includes modern furniture with two acoustic side panels.
c) HRR capped at approximately 900 kW following sprinkler activation.

Table 3: Summary of Design Fire Scenario Parameters

The development of the design fire scenarios and the referenced full-scale testing data can be found in Appendix E.

A detailed description of the following four design fire scenarios, which have been deemed to represent the most challenging in terms of ASET, is as follows:

<u>Design Fire Scenario 3a</u> is located on the First Level near the CACF within the east atrium. The design fire will be located within the atrium proper. The development of a fire in this location is expected to have the greatest effects on the fire plume dynamics (i.e. transport lag time, smoke layer volume, and toxin concentrations due to plume entrainment, etc.).

The scenario has been considered to estimate the time for a fire alarm system detector to activate in the east atrium. This will quantify the time for the fire alarm system to activate, thereby initiating start-up of the atrium smoke control system.

This Design Fire Scenario represents an axisymmetric plume and involves plume contact with architectural features, including walkways between pavilions and rooms within the atrium, resulting in a plume disruption and greater air entrainment.

The scenario has been modeled with an ambient air temperature equivalent to the summer dry bulb temperature corresponding to the July 2.5 % cumulative frequency of occurrence at the project site. This temperature is 24°C (NBC Division B, Appendix C). The summer design temperature is considered to represent a worst-case scenario in determining minimum volumetric flow rates required due to the reduced density of gases at higher temperatures. The atrium would reach this temperature soon after smoke control system activation in the summer months due to the large influx of make-up air from the exterior.

A visual representation of the 3a design fire scenario is shown in Figure 11.

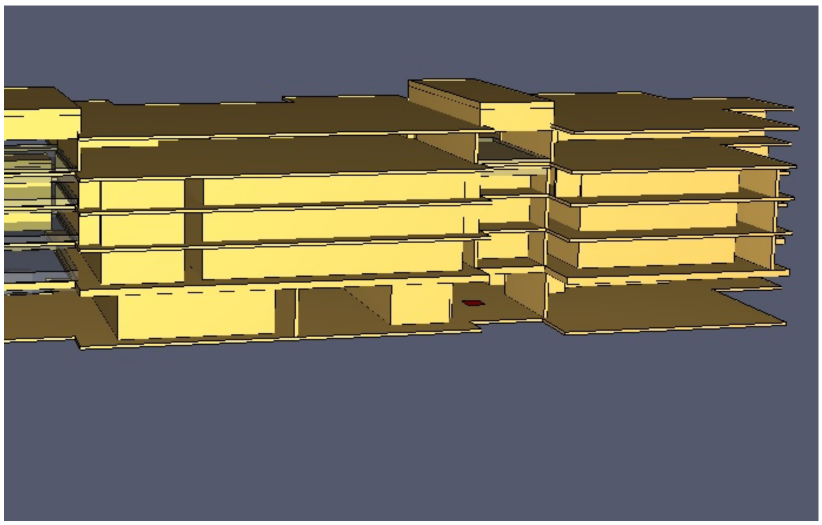

Figure 11: Design Fire 3a – East Atrium Level 1

Design Fire Scenario 3b is located within west atrium and is open direct to the roof assembly. The design fire selected is similar to Design Fire Scenario 3a, however it represents a greater open atrium volume and greater floor area on Level 1. Similar to Design Fire Scenario 3a, an ambient temperature of 24°C has been specified.

The scenario has been considered to estimate the time for a fire alarm system detector to activate in the west atrium. This will quantify the time for the fire alarm system to activate, thereby initiating start-up of the atrium smoke control system.

This Design Fire Scenario represents an axisymmetric plume and involves plume contact with architectural features (a whale), including walkways between pavilions and rooms within the atrium, resulting in a plume disruption and greater air entrainment.

A visual representation of the 3b design fire scenario is shown in Figure 12.

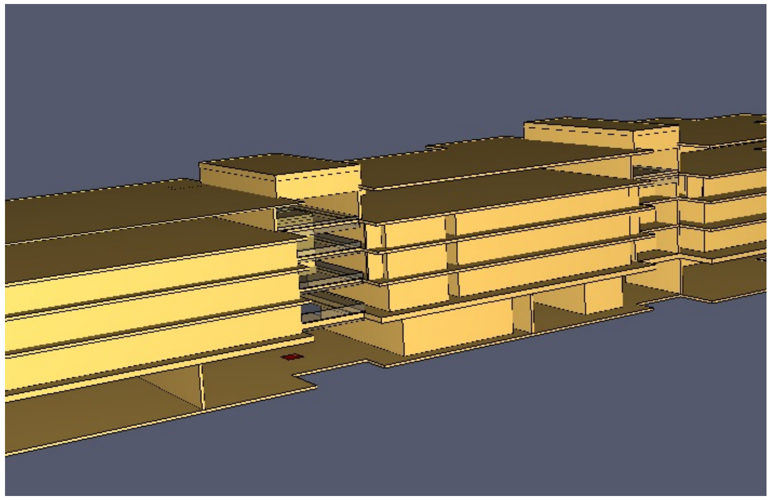

Figure 12: Design Fire 3b – West Atrium Level 1

Design Fire Scenario 3c is located within the corridor system adjacent the west atrium and is located within the atrium proper on Level 2. The design fire selected is intended to evaluate whether a fire originating above Level 1 would result in appreciably worse tenability conditions. Similar to Design Fire Scenario 3a, an ambient temperature of 24°C has been specified.

This Design Fire Scenario represents, to some degree, a balcony spill plume and involves plume contact the overhead floor assembly, resulting in a plume disruption and greater air entrainment.

A visual representation of the 3c design fire scenario is shown in Figure 13.

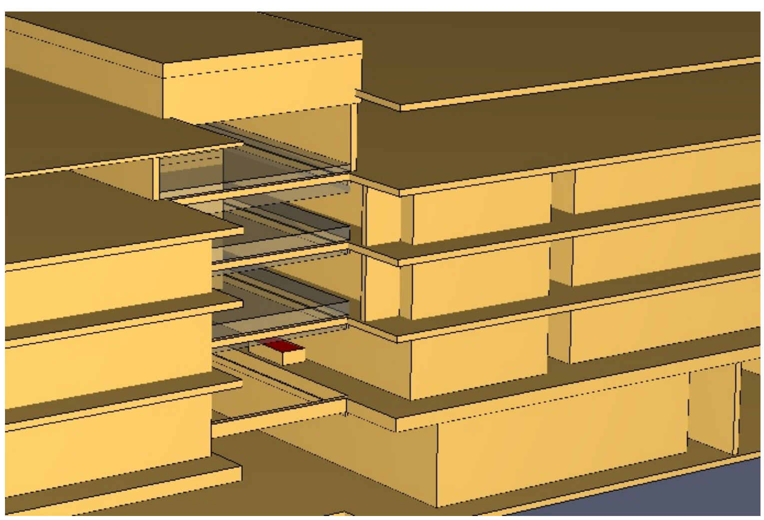

Figure 13: Design Fire 3 – West Atrium Level 2

Design Fire Scenario 4 is located within the interconnected corridor system of the Centre Pavilion on Level 1. This location will allow smoke to travel to the East and West Atriums through the Level One floor openings, creating two separate spill plumes.

Using sub-routines within the FDS software, this scenario has been used to estimate the time it takes for the building sprinkler system to activate and control fire growth to the heat release rate at sprinkler activation. The time for smoke detection systems to activate will also be estimated for comparative purposes.

Similar to Design Fire Scenario 3a, an ambient temperature of 24°C has been specified.

A visual representation of the first design fire scenario is shown in Figure 14.

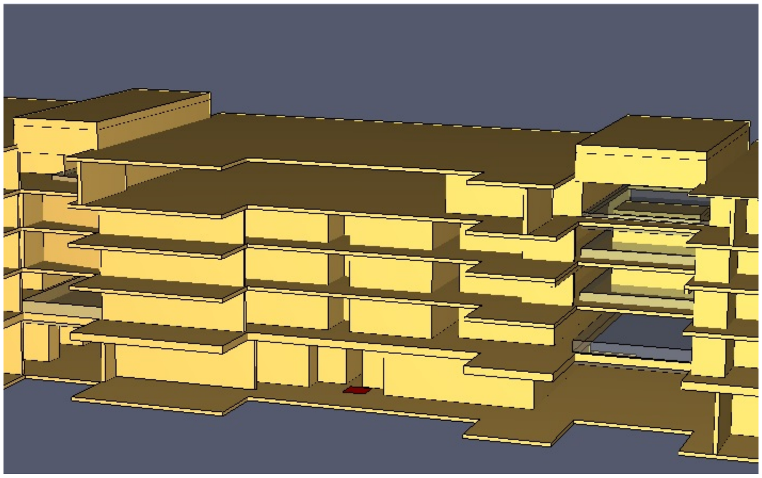

Figure 14: Design Fire 4 – Centre Pavilion Level 1

All design fire scenarios have also been modeled with a cold winter temperature of -15°C (NBC Division B, Appendix C) and it was determined that summer design temperatures produce worst-case results.

Stack effect and its potential to adversely interfere with the building's smoke exhaust systems has been considered. This phenomenon is minimal in non-high rise buildings, and its impact has been determined to not significantly affect estimated ASET.

Similarly, adverse effects of wind on the smoke exhaust systems performance has to be considered. These effects are considered to impact the mechanical systems in a different manner from the passive systems.

To address the impact on the mechanical exhaust systems, the exhaust and intake locations have been spatially separated in conformance with ASHRAE requirements. The actual performance of these systems within the atria is not expected to vary greatly with wind conditions.

To address the impact on the passive systems (exterior vents), the project Pedestrian Wind Assessment was reviewed. Refer to Appendix F. The report indicates that the wind speeds at the north building face (location of the exterior vents) are not expected to exceed 10 km/h more than 5% of the time during all seasons, with slightly greater speeds occurring during the winter months.

The prevailing winds in the summer months are primarily from the southwest through west, and from the west-southwest through west-northwest in the winter months.

Given the relatively low percentage of the make-up air systems that may be affected by adverse wind conditions, the low frequency of high wind speeds occurring at the north building face, wind effects have not been considered to have a major impact on the smoke control system performance.

Wind entering the atria at velocities exceeding 1.02 m/s would be expected to be throttled to reduced velocities once entering the atrium proper.

4.5 Trial Design Evaluations

4.5.1 RSET

The "*worst-credible case*" RSET considered for the purposes of this analysis, in terms of the stated performance criteria, has been compared with the ASET resulting from the fire induced environment estimated for the various design fire scenarios.

The RSET includes the total time required for building occupants to evacuate the building via the proposed atrium space. This includes a cumulative time for the fire detection, occupant pre-movement, and occupant travel from the most remote location within the MCS floor areas to the exits, including occupant queuing at transition/merge points.

Sprinkler and fire detection times have been estimated from the FDS models, the pre-movement time has been based on information obtained from available research literature, and the travel time has been obtained from the Pathfinder egress modeling software. The Pathfinder simulation is based on the current floor plan layouts and anticipated occupant loads as outlined in the RJBEL *"14024 Design Development Building Code Analysis Revised R160202"*.

The total number of occupants that are expected to evacuate from the building was calculated to be 3,632. The occupant load distribution accounts for a prescriptive occupant load of 800 on Level 5, 639 on Level 4, 630 on Level 3, 930 on Level 2, 59 on Level 1.5, and 574 Level 1. It is notable that exit stairs serving each of the three pavilions are designed with widths no less than 1,650 mm, resulting in available capacities exceeding calculated occupant loads by no less than 70% on any of the upper three levels.

A summary of the RSET results determined with Pathfinder is presented in Table 4. This summary reflects RSET values for Level 3, which has been shown to be the location where untenable conditions are reached earliest, under a range of design fire conditions and discounting for any protection provided for by the 0 h pavilion fire separations.

Detection Time[(a)] (s)	Pre-Movement Time (s)	Travel and Queue Time (s)	RSET (s)
57	63	389	509

a) Longest time for all design fires and based on activation of two atrium smoke detection devices.

Table 4: Summary of RSET Results

Hand calculations have been completed using Microsoft Excel to validate the Pathfinder results. Refer to Appendix D. The hand calculations are consistent with the Pathfinder results and show that the algorithms and assumptions inherent in Pathfinder analysis have produced comparatively conservative results. Refer to Appendix D for sample input/output files of the Pathfinder software simulation.

4.5.2 ASET – Results

The following sections discuss the results of the ASET analysis, defined in terms of the performance criteria identified in Section 4.2.

In order to achieve the stated performance criteria, it is proposed to provide listed beam and air aspirating detection within both of the atrium spaces, installed in accordance with CAN/ULC-S524. Listed spot type smoke detection devices are also to be provided adjacent draft stops along the perimeter of atrium openings, consistent with the NBC requirements for special protection measures.

Zoning of detection devices is to be designed such that two distinct atrium zones are created (i.e. an east atrium and a west atrium zone). Initiation of any of the following conditions in one of the zones shall activate that zones smoke exhaust fans, as well as the buildings passive make up air vents:

- Any two smoke detectors, or the air aspirating system,
- One interconnected floor space sprinkler flow switch, or
- Activation of the manual control switches at the CACF.

It is noted that the activation of a manual pull station is not to activate the smoke control systems.

Note that all FDS models accounted for a 60 second ramp up time for the exhaust fans and make up vents to reach 100% capacity, which is in agreement with the maximums allowed by the UL 864 listing.

The rate of both atriums' smoke exhaust system was initially considered at approximately four air changes per hour (ACPH) based on the volume of the interconnected floor space that is not segregated by at least a 1 h fire separation. The four ACPH is the minimum exhaust rate for interconnected floor space requirements (NBC Article 3.2.8.8.) and equates approximately to the 5,660 m^3/min (200,000 cfm) per atrium to be provided. This value proved to be a reasonable size that resulted in the smoke layer interface consistently settling at approximately 2 m above Level 3 finished floor elevation. A review of exhaust rates both greater and less than this value was completed as part of the sensitivity analysis, which concluded that this rate was the most suitable for satisfying ASET:RSET.

Each atrium smoke exhaust system includes four exhaust fans, rated for 1,415 m^3/min (50,000 cfm), located at the top of each atrium; two each at the north and south ends.

A visual representation of these smoke exhaust units is shown in Figure 15.

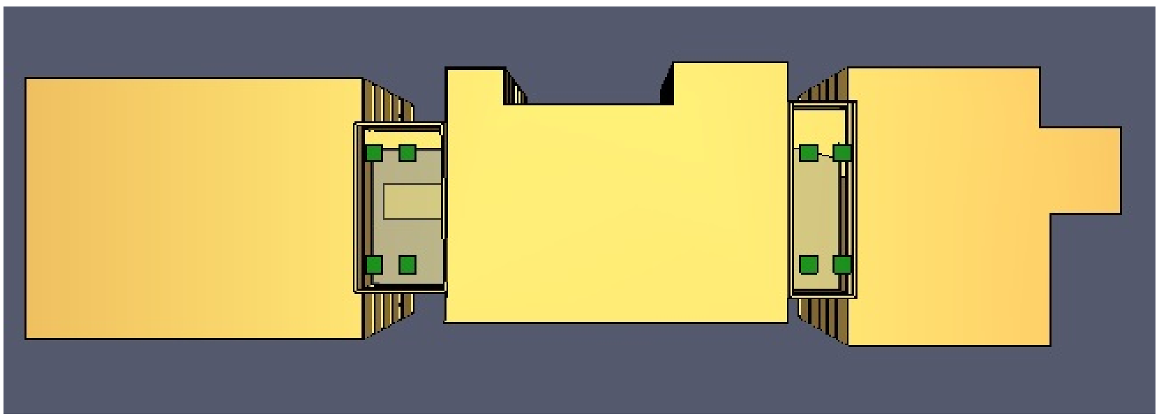

Figure 15: Exhaust Units and FDS Model

As part of the mechanical smoke exhaust system design, the atrium spaces will be required to be provided with make-up air sized to provide approximately 90% of the exhaust capacity. Make up air will be provided along the MCS north face via approximately 235 m^2 of operable exterior façade which includes a portion of the UC pedway/link. Refer to Appendix A for specific locations.

The smoke exhaust and make-up air systems are required to be designed and installed in accordance with NFPA 92.

Refer to Figure 16 for the modeled heat release rate of Design Fire Scenarios 3a, 3b, and 3c. Sample FDS Input/Output files are included in Appendix E.

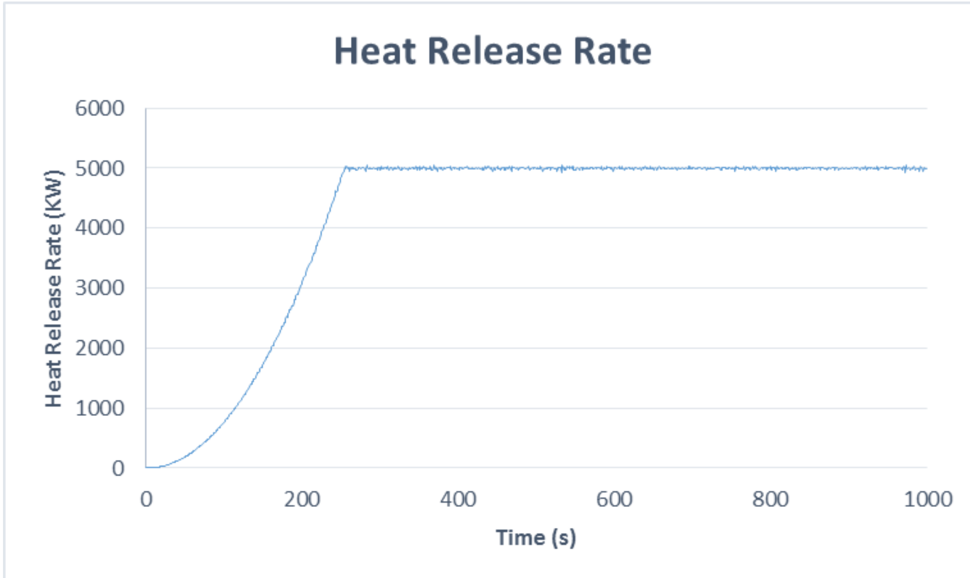

Figure 16: Design Fire Scenarios 3a, 3b, and 3c - Modeled Heat Release Rate

It was noted that when determining the maximum expected heat release rate for Design Fire Scenario 4, the sprinkler activation time was estimated at 103 s which corresponds to a peak heat release rate of approximately 900 kW as shown in Figure 17, below.

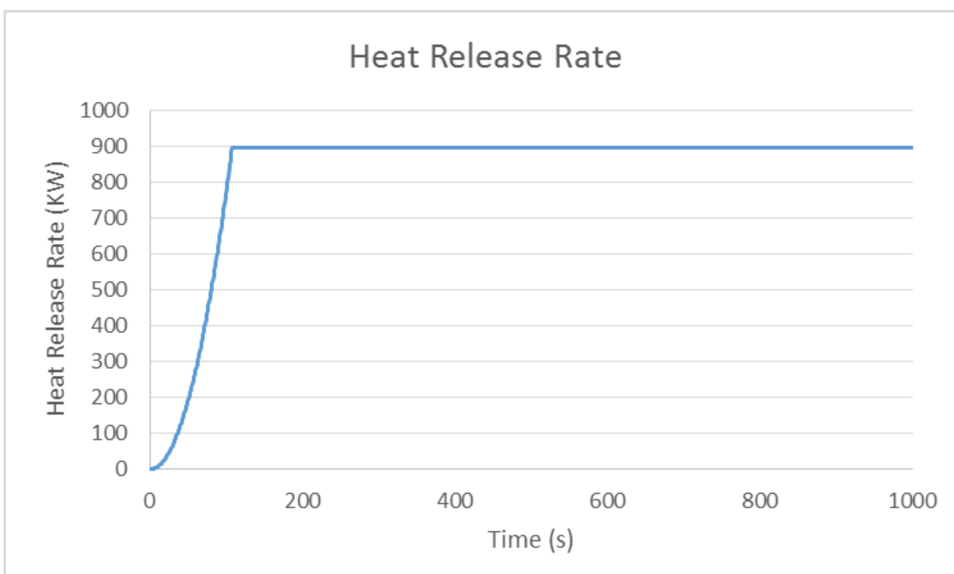

Figure 17: Design Fire Scenario 4- Modeled Heat Release Rate

Tenability limits were estimated along the egress routes throughout the building for all design fires. Temperature, visibility, and CO measurements have been obtained from the FDS models at a 2.0 m height above finished floor for the various storeys.

The FDS simulations indicate that the tenability thresholds will not be exceeded at any of the measurement locations during the RSET. Onset of untenable conditions was observed to occur on Level 3 first and a summary of ASET results for this level has been presented in this report. Design fire 3a has been included as it was found to result in the lowest ASET conditions.

It is shown in Figure 18 that the exposure temperatures do not exceed the specified tenability limit of 49^{o} C on Level 3.

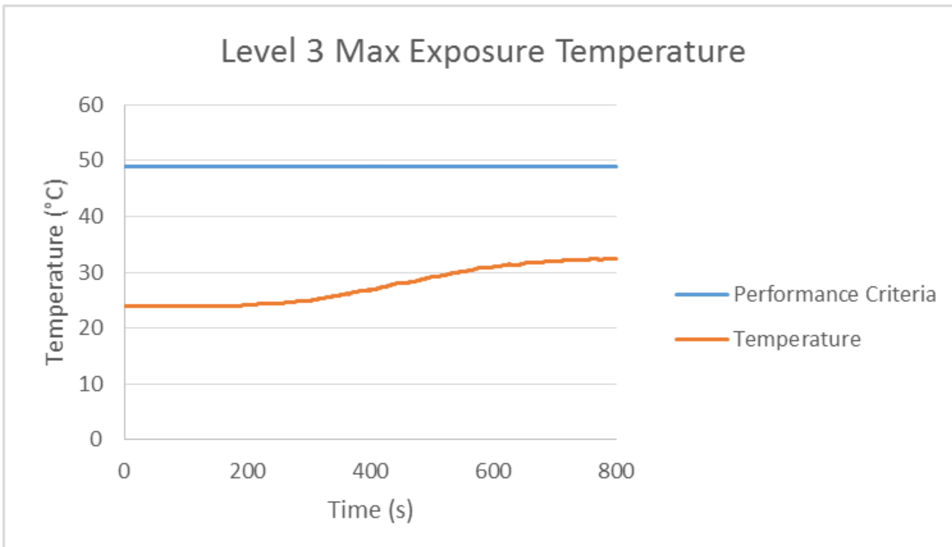

Figure 18: Maximum Exposure Temperature

It is shown in Figure 19 that the visibility threshold is not met for the specified tenability limit of 7.6 m on Level 3 until approximately 700 s where the conditions stabilize. The use of the 7.6 m is based on the expected familiarity of the majority of building occupants with egress routes, particularly on the upper storeys. The few occupants that may not be familiar with the building are expected to move with those who are. [10]

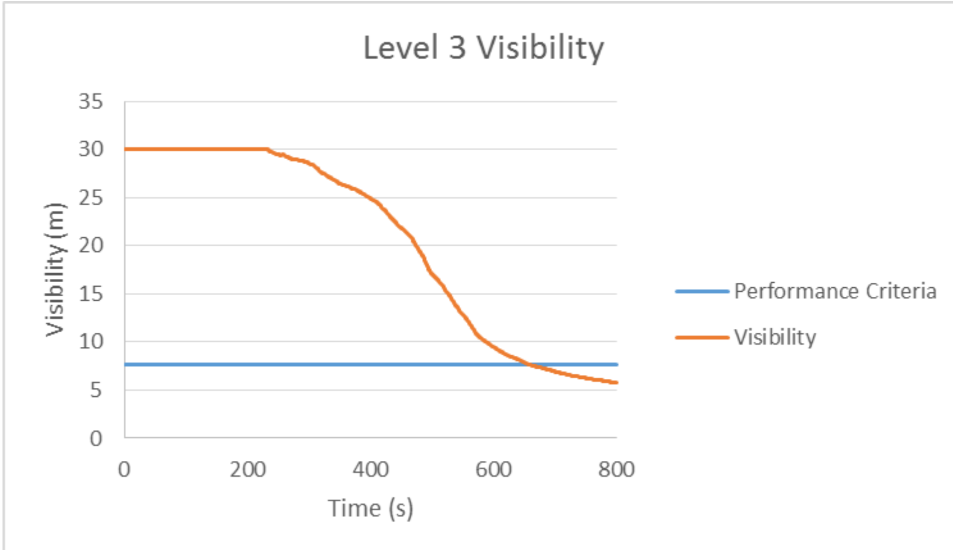

Figure 19: Minimum Visibility

It is shown in Figure 20 that the CO concentration does not exceed the specified tenability limit of 800 ppm on Level 3.

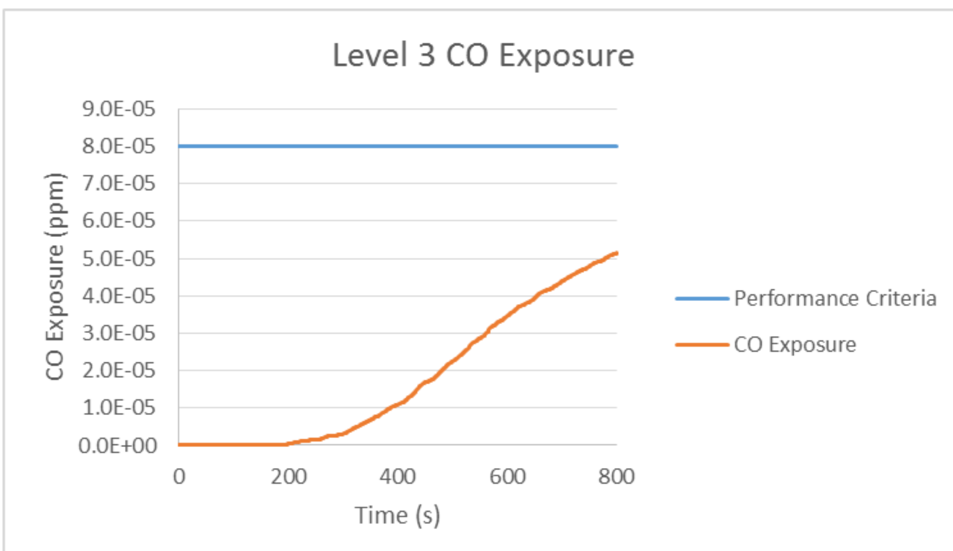

Figure 20: CO Density Exposure

The resulting ASET for the above data set has been estimated as being not less than 700 s. In comparison with the "*worst-credible case*" RSET, as presented in Section 4.5.1, the results indicate that the proposed conditions, subject to the measures outlined in this report, will satisfy the stated performance criteria complete with a safety factor of at least 1.375 (i.e. 700 ÷ 509 = 1.375). This safety factor does not include the additional safety factors inherent with the assumptions and approaches employed in the analysis.

4.5.3 NBC Compliant Arrangement

The modeling of a NBC compliant interconnected floor area has been completed in order to establish a performance benchmark for a building satisfying the NBC requirements in a two storey configuration that conforms to NBC Sentence 3.2.8.2.(6).

The NBC compliant model designed consists of the first two storeys of the MCS building with each floor having a height of 5.3 m. The floor layout for the upper storey of this atria arrangement will be identical to the floor layout of Level 3 of the MCS in order to provide consistency in our comparison.

Using the proposed occupant loading for each level, the exit components were modified such that available exit capacity was utilized to 100%.

In terms of RSET, this NBC compliant configuration resulted in a detection time of approximately 40 s, a pre-movement time of 63 s, travel and queuing of 640 s, and a total RSET of 743 s, which is greater than the 509 s calculated for the proposed configuration.

The design fire considered is located within the west atrium and is open direct to the roof assembly. The design fire selected is identical to Design Fire Scenario 3b and an ambient temperature of 24°C has been specified.

A visual representation of this design fire scenario is shown in Figure 21.

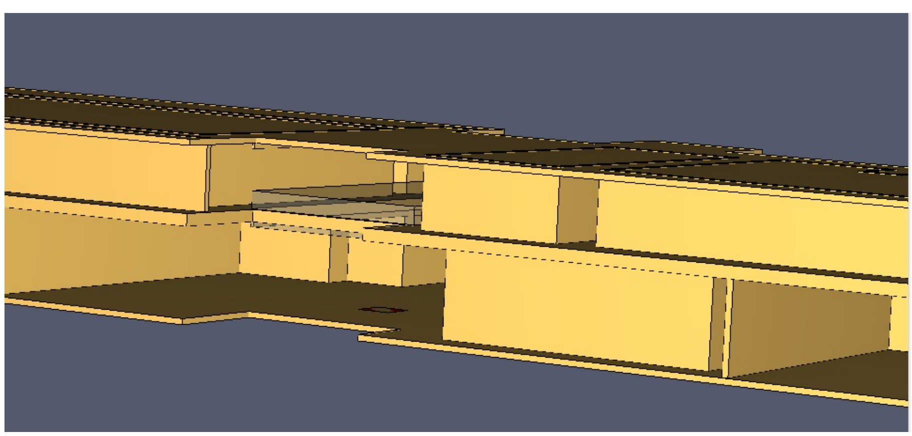

Figure 21: NBC Compliant Arrangement

Refer to Figure 22 for the modeled heat release rate of the NBC Compliant scenario.

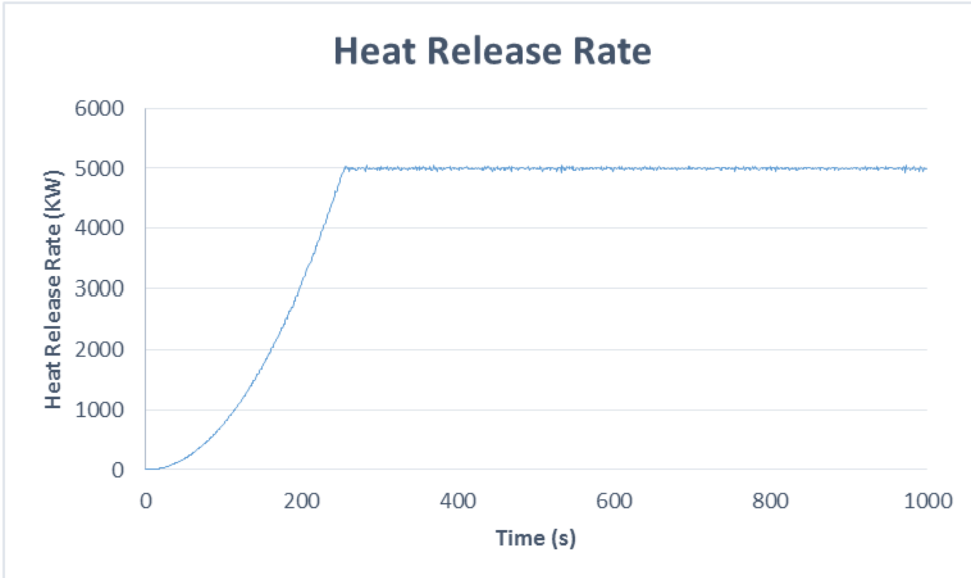

Figure 22: NBC Compliant Scenario - Modeled Heat Release Rate

Temperature, visibility, and CO measurements have been obtained from the FDS models at a 2.0 m height above second floor finish.

It is shown in Figure 23 that the exposure temperatures do not exceed the tenability limit of 49^{o} C on Level 2.

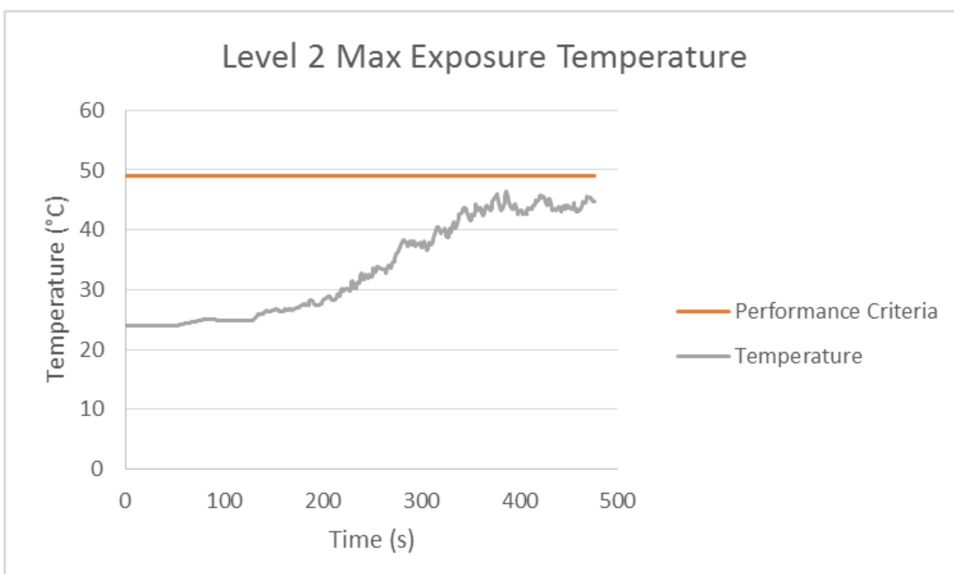

Figure 23: Maximum Exposure Temperature

It is shown in Figure 24 that the visibility threshold does not exceed the specified tenability limit of 7.6 m on Level 2 during the established RSET.

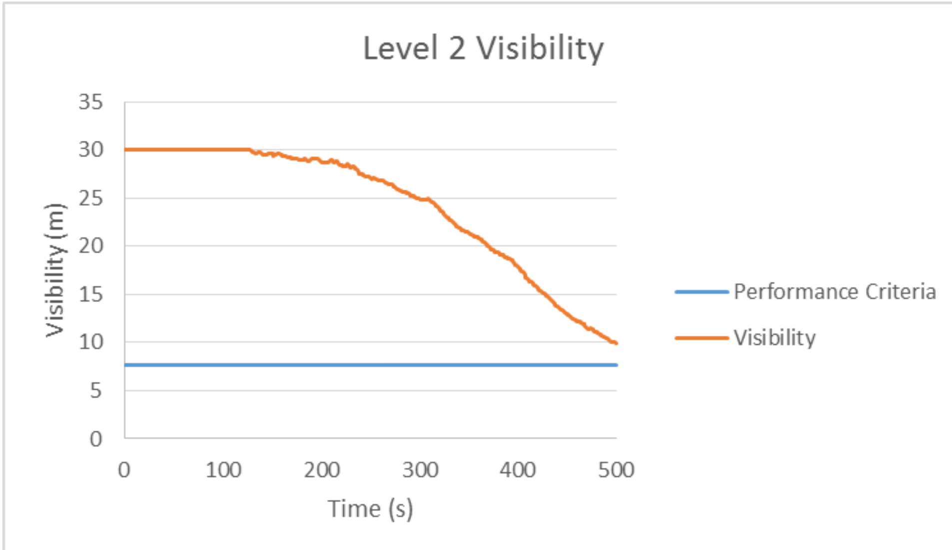

Figure 24: Minimum Visibility

It is shown in Figure 25 that the CO concentration does not exceed the specified tenability limit of 800 ppm on Level 2 during the established RSET.

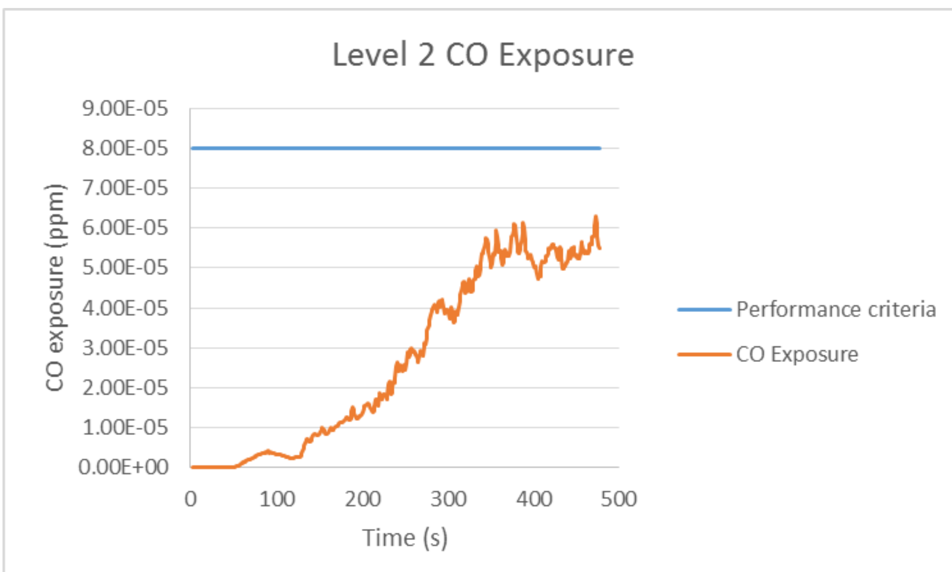

Figure 25: CO Density Exposure

These results indicate that the MCS building, as proposed, will arrive at comparable tenable limits no less than approximately 200 s after that which would be experienced under a NBC compliant configuration.

4.5.4 Sensitivity Analysis

The trial designs and technical calculations presented in this report have been subjected to a sensitivity analysis. The purpose of this sensitivity analysis is to gauge the level of relative importance of input parameters by investigating the impact on fire and life safety outcomes when subjected to change.

The input parameters investigated as part of the sensitivity analysis included the design fire locations, fire growth periods, heat release rates, impact of sprinkler operation, exhaust and makeup air sizing, location and availability, size and locations of available exits, fire compartment sizes, and CFD software grid resolution.

Through the fire protection engineering analysis, it was determined that alterations specific to the size and locations of exits, sprinkler operation, and mechanical exhaust capacity resulted in the greatest impact on fire and life safety outcomes. The design fires presented in this report reflect "*worst-credible cases*" and have been selected via an iterative approach that considers the nature of use intended for the building, impact of potential fire conditions on the mechanical smoke exhaust system and available egress systems, and variability of fuel loads that could be present.

The sensitivity analysis indicates that the proposed alternative solution, as presented in this report, is expected to provide an acceptable level of redundancy and accounts for uncertainties associated with input parameters and calculation techniques through conservative assumptions and safety factors.

5 Assumptions

The analysis presented in this report has been based on the following assumptions:

1. The building's fire and life safety systems (i.e. sprinkler, fire alarm, etc.) will be designed, installed, tested, and maintained in accordance with applicable Standards. It is assumed that should any of the buildings fire safety systems be out of service, impairment procedures as identified by the NFC will be established as part of the building fire safety plan.

   These procedures include:
   - Notifying the fire department and AHJ,
   - Providing an approved fire watch to patrol the building until the system is restored to operating conditions,
   - Procedures to notify occupants of the building if a fire emergency occurs when the fire alarm and detection system is shut down or inoperative, and
   - Procedures to provide protection to the building if a sprinkler system, or part thereof, is shut down for more than 6 h. This could include:
     - Providing emergency hose lines and portable extinguishers, and
     - Limiting combustible fuel loads and providing temporary water connections to the sprinkler system.

2. All normally operating air-handling systems that are deemed nonessential by the End User will automatically shut down upon activation of the fire alarm system.

3. Commissioning of the integrated life safety and fire protection systems in the building will be performed as a whole to ensure the proper operation and inter-relationship between the systems as required by NBC Article 3.2.4.6. This is intended to ensure that the life safety systems and their components (i.e. fire alarm systems, sprinklers, standpipes, ventilation, emergency lighting, etc.) are functioning according to the intent of their design.

4. The MCS will function as outlined in this report and contain fuel loads representative of those found in a typical building of this nature. Should the major occupancy or functional use change during the building's lifespan, the hazards associated with the new occupancy/use are to be assessed in the context of impact on this alternative solution. The sprinkler system would also require a review to confirm the hazard classification in accordance with NBC Sentence 3.2.5.12.(1) and NFPA 13.

5. The future contents of the Levels 1 and 5 shell space will not pose a more severe hazard to fire and life safety than that considered in this analysis. This to be confirmed during tenant fit-up. Should the hazard associated with the future use of these spaces exceed that considered herein, modification to the buildings fire and life safety systems may be required.

6. All other fire and life safety aspects of the building not specifically addressed herein or as part of the alternative solutions discussed in RJBEL *"14024 Design Development Building Code Analysis R151109"* have been designed and constructed in accordance with the acceptable solution requirements identified in said report.

7. Pyrotechnics and large quantities of flammable or combustible liquids will not be present or used within the interconnected floor spaces or outside of established lab units. Events involving large quantities of combustibles are to be reviewed with the Authority Having Jurisdiction, in recognition of the limitations of the smoke management system.

8. The detailed design documents for all of the building's smoke control systems will be completed by qualified, licensed professional designers, in accordance with the requirements of NFPA 92, the NBC, and good engineering practice.

6 Measures to be Implemented

The information presented in this report is specific to the MCS project. In this regard, all conclusions and subsequent required measures to be implemented are only applicable to this project. Any changes to life safety systems, or function of the building in the future, are to be reviewed by the Building Owner with respect to the impact on this alternative solution.

It is the opinion of RJBEL that the fire protection engineering analysis described in this report will provide an acceptable level of performance as intended by the NBC, subject to implementation of the following required measures:

1. Each of the two atria are required to be provided with a dedicated smoke exhaust system designed with a minimum capacity of 5,660 m^3/min (200,000 cfm).

2. Make-up air for all of the smoke exhaust systems outlined in Item 1 is required to be provided with a capacity no less than 90% of the exhaust rate. The following make-up air configuration is to be implemented:
   - The Level 1 exterior doors north of both atriums are to be equipped with listed power door operators. These operators are to fully open the doors upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.
   - Operable windows on the north face of both atriums for Level 1. These panels are to be equipped with listed power operators. These operators are to fully open the windows/panels upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.
   - Operable windows on the north face of the pedway/link for Level 2. These panels are to be equipped with listed power operators. These operators are to fully open the windows/panels upon activation of either of the atrium smoke exhaust systems, allowing make-up air to be drawn in naturally.

All make-up air velocities are to be limited to 1.02 m/s (200 fpm).

3. The smoke exhaust and make-up air systems are to be programmed to reduce the likelihood that either the exhaust or make-up systems will operate independently. The following measures are required:
   - Mechanical proofing switches are to be provided in order to confirm that the make-up air system does not operate independently of the mechanical exhaust system.
   - A delay is to be provided for the activation of all mechanical smoke exhaust system components. This delay is to provide time for the power door operators to fully open doors/louvers serving as part of the make-up air supply, prior to the activation of the mechanical systems.
   - Power door operators are not to be equipped with readily accessible disconnect switches (i.e. "ON/OFF" power toggle switches, etc.). If such disconnect switches are provided on the model of door operator specified, tamper-proof housings are to be installed over the switches so they are not readily accessible for anyone other than maintenance staff.

4. All smoke control systems are to be designed such that door opening forces throughout the building do not exceed 133 N (30 lb).

5. Listed beam and air aspirating detection is to be provided within both of the atrium spaces, installed in accordance with CAN/ULC-S524. Listed spot type smoke detection devices are also to be provided adjacent draft stops along the perimeter of atrium openings, consistent with the NBC requirements for special protection measures.

   Zoning of detection devices is to be designed such that two distinct atrium zones are created (i.e. an east atrium and a west atrium zone). Initiation of any of the following conditions in one of the zones shall activate that zones smoke exhaust fans, as well as the buildings passive make up air vents:

   - Any two smoke detectors, or the air aspirating system,

   - One interconnected floor space sprinkler flow switch, or

   - Activation of the manual control switches at the CACF.

   Manual override controls (i.e. "ON/OFF/AUTO" toggle switches) are to be provided at the CACF and fire alarm annunciator panels.

6. All dedicated components considered to be part of the smoke management system (exhaust and make-up air) are to be supervised such that a trouble signal will be transmitted to the fire alarm system should any power interruption occur.

7. The design, installation, testing, and maintenance of the smoke management system is to be completed in accordance with NFPA 92.

8. Control systems that are considered to be part of the smoke management system (exhaust and make-up air) are to be listed in accordance with UL 864, "*Standard for Control Units and Accessories for Fire Alarm Systems",* category UUKL for their intended purpose.

9. All mechanical and electrical systems used to satisfy the requirements of this report are to be provided with emergency back-up power for a duration of no less than 2 h. Protection of electrical conductors serving this equipment shall be in compliance with NBC Article 3.2.7.10.

10. An operation and maintenance manual is to be submitted to the Owner that includes the following:
    - Commissioning documentation (including system performance criteria),
    - Testing, maintenance, and inspection requirements, and
    - Critical assumptions used in the design of the system and the limitations they impose on the building and its use (i.e. a copy of this report).

11. The automatic sprinkler systems serving all floor areas are to be equipped with fast-response type sprinkler heads with an activation temperature of 57˚C. Some exceptions apply such as service rooms, at the ceiling level of the atrium space, and other areas where high ambient temperatures are expected.

12. Levels 4 and 5 pavilion neighborhoods are fire separated from the atrium spaces by no less than 1 h and 2 h fire separations, respectively. The two exit stairs serving each of the neighborhoods are located within the protected floor spaces and not the atrium proper. Level 3 pavilion neighborhoods are fire separated from the atrium spaces by no less than a 0 h fire separation. Exit stairs serving the neighborhoods are located within the protected floor spaces and not the atrium proper.

13. Exit stairs serving each of the three pavilions are designed with stair widths no less than 1,650 mm.

14. Multiple fire department connections are to be provided along the north building face and form a looped system. Primary fire department response will occur at the east atrium along the north face and include the provision of a CACF in accordance with NBC Article 3.2.6.7. Secondary fire department response will occur at the west atrium and include the provision of an annunciator panel.

15. A firefighter's elevator in accordance with NBC Article 3.2.6.5. is to be provided within the vicinity of each of the two fire department response points.

16. The building Owner is to develop and maintain a comprehensive fire safety plan in accordance with the requirements of the NFC.

    The fire safety plan is to include but not be limited to:

    - Committee structure,
    - Administration requirements,
    - Instructions for building occupants,
    - Posted evacuation drawings,
    - Posted instruction for action upon:
        - Discovery of smoke/fire, and
        - Hearing a fire alarm.
    - Drawings showing major fire safety components,
    - Maintenance program, including log documentation, for all fire safety components and systems,
    - Procedures for fire drills,
    - Impairment procedures in the event any life safety system or component of the building is out of service, and
    - A copy of this report.

17. The building Owner is to post signage adjacent to the fire alarm annunciator located near the main entrance stating:

> "*This building has been designed in accordance with acceptable solutions outlined in the 2010 National Building Code of Canada and the alternative solution documented in the RJBEL 14024 Design Development Building Code Analysis R151109*".

18. As part of project completion confirmation, the following is to be completed prior to occupancy:
    - Sprinkler system design and as-built drawings and test certificates, including above and below ground piping, are to be submitted to RJBEL for review.
    - The building's fire and life safety systems are to be commissioned in accordance with the requirements of CAN/ULC-S1001 for integrated system testing. The commissioning plan is to be submitted to RJBEL for review prior to commencement of testing.
    - The building's fire safety plan is to be reviewed by RJBEL and approved by the AHJ prior to occupancy.
    - RJBEL is to conduct a site visit to observe implementation of the measures outlined in this report. This is to include witness of acceptance testing for the automatic sprinkler, fire alarm, and smoke exhaust systems.

    Subsequent to completion of the above noted items, RJBEL will provide documentation to the Project Stakeholders confirming that the alternative solution has been implemented according to the measures outlined in this report.

7 Reliance

This report has been prepared for the sole benefit of HOK. This report may not be used by any other person without the expressed written consent of HOK and RJ Bartlett Engineering Ltd. Any use which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. RJ Bartlett Engineering Ltd accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

References

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Appendix A

Floor Plan and Elevation Drawings

Occupant Load Level 1

Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1	Shell Core Research	1554.53 m²	9.30	167
LEVEL 1	SIMS Eng.	16.61 m²	9.30	2
LEVEL 1	SIMS	19.16 m²	9.30	2
LEVEL 1	MLASEM	63.04 m²	9.30	7
LEVEL 1	SIMS	52.56 m²	9.30	6
LEVEL 1	Fl. Incl	11.05 m²	9.30	1
LEVEL 1	NMR Suite eq. Rm	83.02 m²	9.30	9
LEVEL 1	LAM ICPMS	48.26 m²	9.30	5
LEVEL 1	Sample prep	47.51 m²	9.30	5
LEVEL 1	SEM SUP	12.64 m²	9.30	1
LEVEL 1	LAM	27.47 m²	9.30	3
LEVEL 1	Mass Sepc.	60.33 m²	9.30	6
LEVEL 1	Main Staging	10.32 m²	9.30	1
LEVEL 1	Ft-ICR	61.12 m²	9.30	7
LEVEL 1	Matl Chrctr	26.80 m²	9.30	3
LEVEL 1	X-ray Cryst	29.37 m²	9.30	3
LEVEL 1	ICPOES	24.22 m²	9.30	3
LEVEL 1	Off	166.44 m²	9.30	18
LEVEL 1	Off	17.08 m²	9.30	2
LEVEL 1	Off	17.41 m²	9.30	2
LEVEL 1	Off	16.47 m²	9.30	2
LEVEL 1	Off	60.65 m²	9.30	7
LEVEL 1	Off	25.10 m²	9.30	3
LEVEL 1	Off	102.03 m²	9.30	11
LEVEL 1	First Aid	12.09 m²	9.30	1
General Industrial Use (Research Labs)		2565.27 m²		276
LEVEL 1	Meeting / Seminar	308.49 m²	1.40	220

Occupant Load Level 1

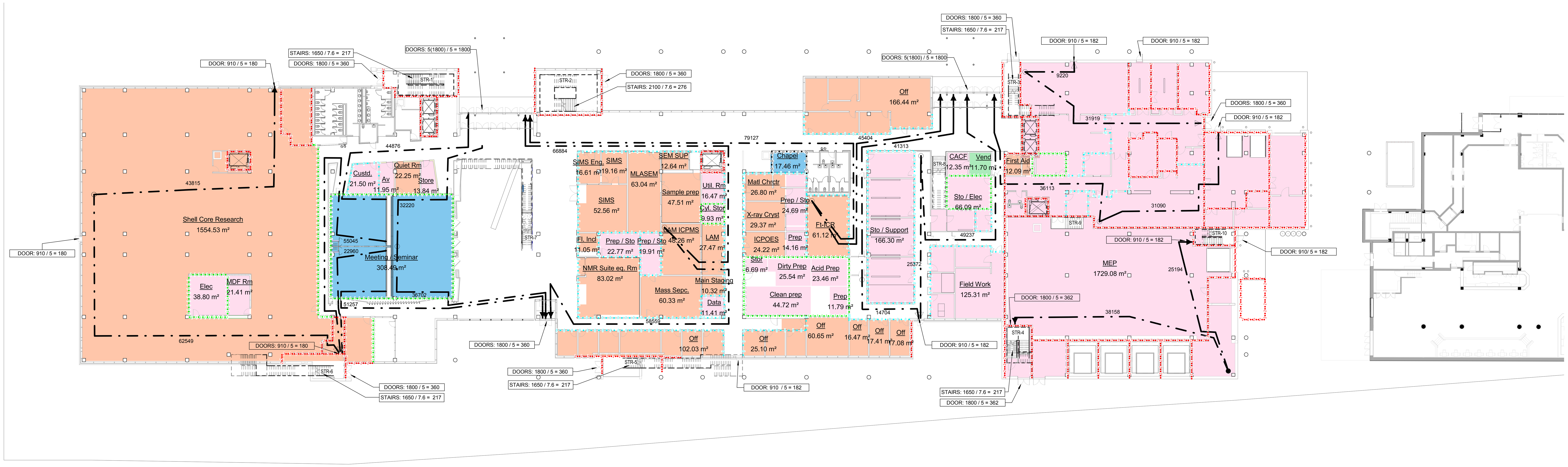
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1	Chapel	17.46 m²	1.40	12
Meeting / Seminar		325.95 m²		233
LEVEL 1	Vend	11.70 m²	2.80	4
Sales Area on Street Floor		11.70 m²		4
LEVEL 1	Custd.	21.50 m²	46.50	0
LEVEL 1	Av	11.95 m²	46.50	0
LEVEL 1	Store	13.84 m²	46.50	0
LEVEL 1	MEP	1729.08 m²	46.50	37
LEVEL 1	Elec	38.80 m²	46.50	1
LEVEL 1	MDF Rm	21.41 m²	46.50	0
LEVEL 1	Prep / Sto	22.77 m²	46.50	0
LEVEL 1	Prep / Sto	19.91 m²	46.50	0
LEVEL 1	Util. Rm	16.47 m²	46.50	0
LEVEL 1	Cyl. Stor	9.93 m²	46.50	0
LEVEL 1	Data	11.41 m²	46.50	0
LEVEL 1	Clean prep	44.72 m²	46.50	1
LEVEL 1	Stor	6.69 m²	46.50	0
LEVEL 1	Dirty Prep	25.54 m²	46.50	1
LEVEL 1	Acid Prep	23.46 m²	46.50	1
LEVEL 1	Prep	11.79 m²	46.50	0
LEVEL 1	Prep / Sto	24.69 m²	46.50	1
LEVEL 1	Sto / Support	166.30 m²	46.50	4
LEVEL 1	Prep	14.16 m²	46.50	0
LEVEL 1	Field Work	125.31 m²	46.50	3
LEVEL 1	Sto / Elec	66.09 m²	46.50	1
Storage		2425.84 m²		52
Grand total		5328.75 m²		565

Fixture Count Level 1

Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 reference	Notes
General Industrial Use (Research Labs) - F-3	276	14		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Meeting / Seminar - A-2	233	8		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 40 due to the proposal of 4 universal toilets in this floor
Sales Area on Street Floor - D	4	0		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Counted as part of the major occupancy of the floor (F-3)
Storage - F-3	52	6	24 regular, 4 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for level 1

Fixture Breakdown Level 1

Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 1	28	14	15	6	3	4



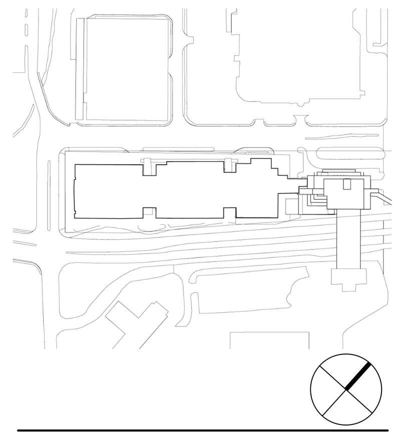
1 LEVEL 1
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Department of Facilities Management

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- Dedication plaque, Arts & Administration Building, St. John's Campus

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No.	Description	Date
	95% Design Development	May 1, 2015
	Issued for Pre-Tender Estimate	July 3, 2015
	Issued for CP-1A Review	August 4, 2015
	Issued for CP-1A Tender	August 10, 2015
	Issued for 50% Printing	September 21, 2015
	Issued for 90% CD Costing	Nov 4, 2015

Drawn by: Author Reviewed by: Checker

Project No: 14.32005.00

Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

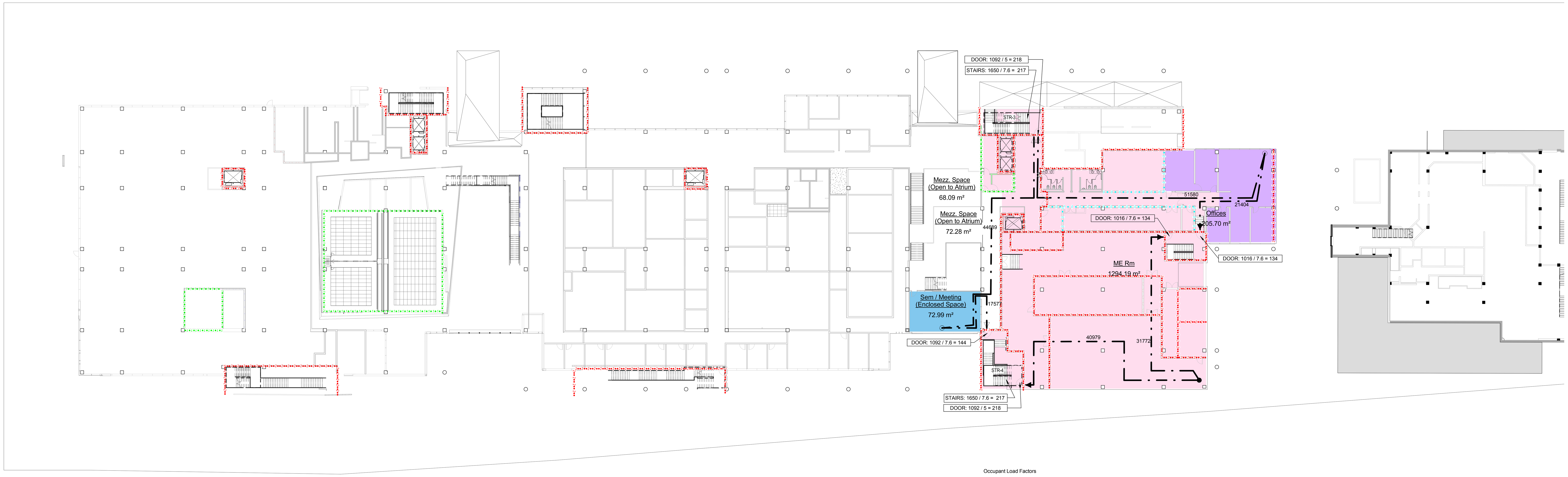
Original drawing is A0. Do not scale contents of this drawing.

Sheet Number:
LS101

Occupant Load Level 1.5				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 1 1/2	Offices	205.70 m²	9.30	22
Business (Offices)		205.70 m²		22
LEVEL 1 1/2	Sem / Meeting (Enclosed Space)	72.99 m²	9.30	8
Meeting / Seminar		72.99 m²		8
LEVEL 1 1/2	ME Rm	1294.19 m²	46.50	28
Storage		1294.19 m²		28
Grand total: 3		1572.88 m²		58

Fixture Count Level 1.5					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	22	2	6	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Meeting/Seminar - A-2	8	2	6	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
Storage - F-3	28	4	0	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	

Fixture Breakdown Level 1.5						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 1 1/2	6	4	3	2	1	0



1 LEVEL 1 1/2
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan

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Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

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Sheet Number:
LS101.5

Occupant Load Level 2

Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 2	Off	19.15 m²	9.30	2
LEVEL 2	Help Centre	79.02 m²	9.30	8
LEVEL 2	Help Centre	60.19 m²	9.30	6
LEVEL 2	Off	121.53 m²	9.30	13
LEVEL 2	Off	107.40 m²	9.30	12
LEVEL 2	Off	10.02 m²	9.00	1
LEVEL 2	Off	117.16 m²	9.30	13
LEVEL 2	Wkst	59.14 m²	9.30	6
LEVEL 2	Off	43.73 m²	9.30	5
LEVEL 2	Off	10.22 m²	9.30	1
LEVEL 2	Off	65.58 m²	9.30	7
LEVEL 2	Lounge / Servery (Enclosed Space)	72.29 m²	9.30	8
LEVEL 2	Upgrad Stu Of	22.44 m²	9.30	2
LEVEL 2	Off	78.97 m²	9.30	8
LEVEL 2	Meeting	26.23 m²	9.30	3
LEVEL 2	Off	120.58 m²	9.30	13
LEVEL 2	Off	9.25 m²	9.30	1
LEVEL 2	Fac. lounge	37.93 m²	9.30	4
LEVEL 2	Upgrad Stu Of	22.37 m²	9.30	2
LEVEL 2	Upgrad Stu Of	22.44 m²	9.30	2
Business (Offices)		1105.61 m²		119
LEVEL 2	Classroom	82.89 m²	1.90	44
Classrooms		82.89 m²		44
LEVEL 2	Wkst	61.97 m²	4.60	13
LEVEL 2	Lab	153.91 m²	4.60	33
LEVEL 2	Prep Lab	28.48 m²	46.50	1
LEVEL 2	Prep Lab	28.48 m²	46.50	1
LEVEL 2	Teaching lab	121.23 m²	4.60	26
LEVEL 2	Informal learning	28.43 m²	4.60	6
LEVEL 2	Gen. Bio. Teaching	152.87 m²	4.60	33
LEVEL 2	Informal Learning	31.62 m²	4.60	7
LEVEL 2	Wkst	10.48 m²	4.60	2
LEVEL 2	Prep Lab	40.72 m²	46.50	1
LEVEL 2	Teaching lab	355.31 m²	4.60	77
LEVEL 2	Informal learning	30.55 m²	4.60	7
LEVEL 2	Lab	84.79 m²	4.60	18
LEVEL 2	Sr. Des. Stud	325.38 m²	4.60	71
LEVEL 2	Stud proj lab	34.03 m²	4.60	7
LEVEL 2	Wkst	33.91 m²	4.60	7
LEVEL 2	Inf. Learn.	13.05 m²	4.60	3
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.54 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	151.69 m²	4.60	33
LEVEL 2	Gen. Bio. Teaching	153.68 m²	4.60	33
LEVEL 2	MASCE HMRM	86.44 m²	4.60	19
LEVEL 2	Jr. Des. Stud	217.44 m²	4.60	47
LEVEL 2	Comp. Lab	162.73 m²	4.60	35
LEVEL 2	Wkst	19.31 m²	4.60	4
LEVEL 2	Teaching Lab	355.15 m²	4.60	77
LEVEL 2	Wkst	9.96 m²	4.60	2

Occupant Load Level 2

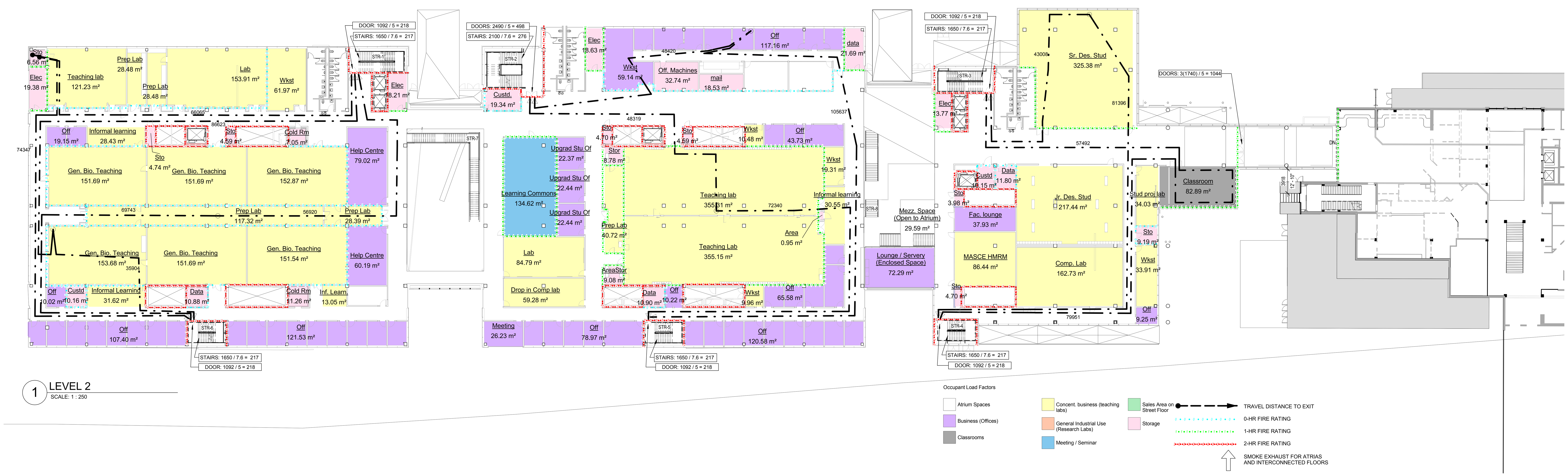
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 2	Drop in Comp lab	59.28 m²	4.60	13
Concent. business (teaching labs)		3205.82 m²		678
LEVEL 2	Learning Commons	134.62 m²	1.40	96
Meeting / Seminar		134.62 m²		96
LEVEL 2	Elec	19.38 m²	46.50	0
LEVEL 2	Sto	4.74 m²	46.50	0
LEVEL 2	Sto	4.59 m²	46.50	0
LEVEL 2	Custd	10.16 m²	46.50	0
LEVEL 2	Data	10.88 m²	46.50	0
LEVEL 2	Cold Rm	11.26 m²	46.50	0
LEVEL 2	Custd.	19.34 m²	46.50	0
LEVEL 2	Elec	18.63 m²	46.50	0
LEVEL 2	data	21.69 m²	46.50	0
LEVEL 2	mail	18.53 m²	46.50	0
LEVEL 2	Off. Machines	32.74 m²	46.50	1
LEVEL 2	Sto	4.70 m²	46.50	0
LEVEL 2	Sto	4.59 m²	46.50	0
LEVEL 2	Data	10.90 m²	46.50	0
LEVEL 2	AreaStor	9.08 m²	46.50	0
LEVEL 2	Stor	8.78 m²	46.50	0
LEVEL 2	Area	0.95 m²	46.50	0
LEVEL 2	Elec	13.77 m²	46.50	0
LEVEL 2	Data	11.80 m²	46.50	0
LEVEL 2	Sto	3.98 m²	46.50	0
LEVEL 2	Sto	4.70 m²	46.50	0
LEVEL 2	Sto	9.19 m²	46.50	0
LEVEL 2	Sto	6.56 m²	46.50	0
LEVEL 2	Elec	18.21 m²	46.50	0
LEVEL 2	Custd	10.15 m²	46.50	0
LEVEL 2	Cold Rm	7.05 m²	46.50	0
Storage		296.36 m²		6
Grand total: 77		4825.30 m²		943

Fixture Count Level 2

Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	119	6		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Classrooms - D	44	1		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	676	16		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
Storage - F-3	2	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 2
Meeting/Seminar - A-2	96	3		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	6	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 2

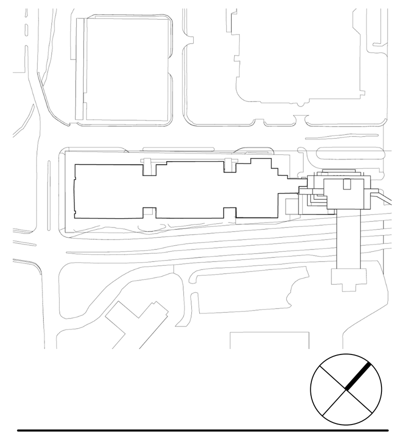
Fixture Breakdown Level 2

Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 2	28	18	15	6	6	3



1 LEVEL 2
SCALE : 1 : 250

Key Plan



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Professional Seals

No.	Description	Date
	95% Design Development	May 1, 2015
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	Issued for 50% Printing	September 21, 2015
	Issued for 90% CD Costing	Nov 4, 2015

Drawn by: Author Reviewed by: Checker

Project No: 14.32005.00

Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

Original drawing is A0. Do not scale contents of this drawing.

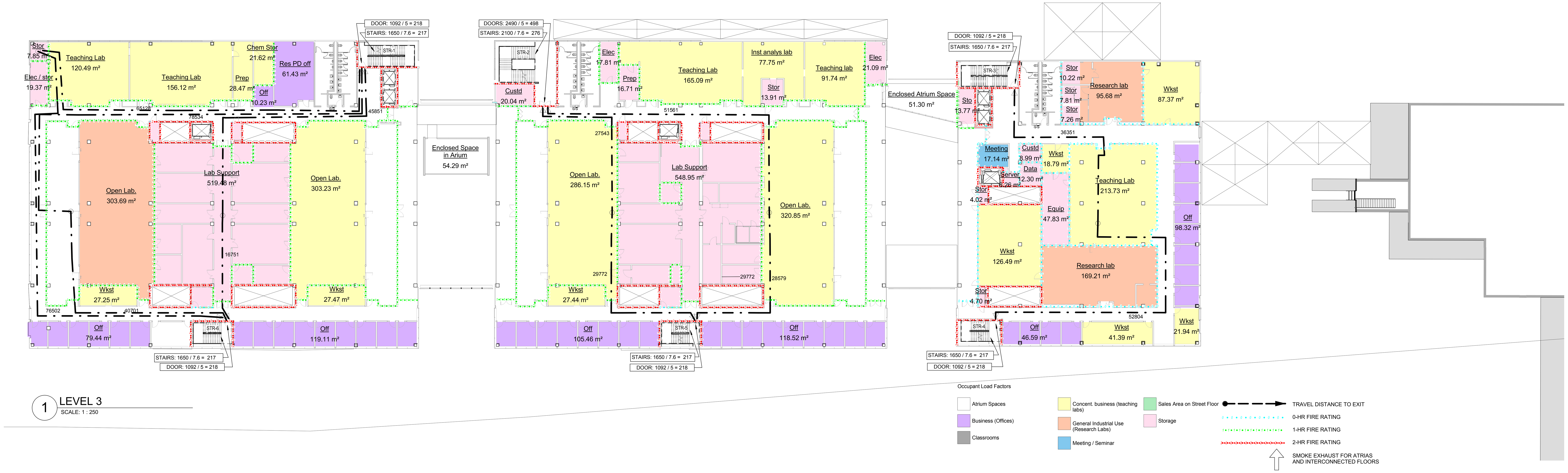
Sheet Number:
LS102

Occupant Load Level 3				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 3	Off	10.23 m²	9.30	1
LEVEL 3	Res PD off	61.43 m²	9.30	7
LEVEL 3	Off	79.44 m²	9.30	9
LEVEL 3	Off	119.11 m²	9.30	13
LEVEL 3	Off	98.32 m²	9.30	11
LEVEL 3	Off	46.59 m²	9.30	5
LEVEL 3	Off	118.52 m²	9.30	13
LEVEL 3	Off	105.46 m²	9.30	11
Business (Offices)		639.10 m²		69
LEVEL 3	Teaching Lab	156.12 m²	4.60	34
LEVEL 3	Prep	28.47 m²	46.50	1
LEVEL 3	Chem Stor	21.62 m²	46.50	0
LEVEL 3	Wkst	27.25 m²	4.60	6
LEVEL 3	Open Lab.	303.23 m²	4.60	66
LEVEL 3	Wkst	27.47 m²	4.60	6
LEVEL 3	Teaching Lab	120.49 m²	4.60	26
LEVEL 3	Teaching Lab	165.09 m²	4.60	36
LEVEL 3	Inst analys lab	77.75 m²	4.60	17
LEVEL 3	Teaching lab	91.74 m²	4.60	20
LEVEL 3	Open Lab.	286.15 m²	4.60	62
LEVEL 3	Wkst	27.44 m²	4.60	6
LEVEL 3	Open Lab.	320.85 m²	4.60	70
LEVEL 3	Wkst	18.79 m²	4.60	4
LEVEL 3	Teaching Lab	213.73 m²	4.60	46
LEVEL 3	Wkst	87.37 m²	4.60	19
LEVEL 3	Wkst	41.39 m²	4.60	9
LEVEL 3	Wkst	126.49 m²	4.60	27
LEVEL 3	Wkst	21.94 m²	4.60	5
Concent. business (teaching labs)		2163.39 m²		460

Occupant Load Level 3				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 3	Open Lab.	303.69 m²	4.60	66
LEVEL 3	Research lab	169.21 m²	9.30	18
LEVEL 3	Research lab	95.68 m²	9.30	10
General Industrial Use (Research Labs)		568.57 m²		95
LEVEL 3	Elec / stor	19.37 m²	46.50	0
LEVEL 3	Custd	20.04 m²	46.50	0
LEVEL 3	Stor	7.85 m²	46.50	0
LEVEL 3	Elec	17.81 m²	46.50	0
LEVEL 3	Prep	16.71 m²	46.50	0
LEVEL 3	Stor	13.91 m²	46.50	0
LEVEL 3	Elec	21.09 m²	46.50	0
LEVEL 3	Sto	13.77 m²	46.50	0
LEVEL 3	Custd	8.99 m²	46.50	0
LEVEL 3	Data	12.30 m²	46.50	0
LEVEL 3	Server	6.26 m²	46.50	0
LEVEL 3	Equip	47.83 m²	46.50	1
LEVEL 3	Stor	7.81 m²	46.50	0
LEVEL 3	Stor	7.26 m²	46.50	0
LEVEL 3	Stor	10.22 m²	46.50	0
LEVEL 3	Stor	4.70 m²	46.50	0
LEVEL 3	Stor	4.02 m²	46.50	0
Storage		239.95 m²		5
Grand total: 47		3611.02 m²		629

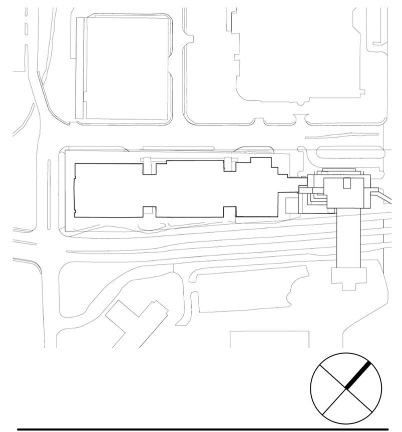
Fixture Count Level 3					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	69	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	459	12		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
Storage - F-3	1	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 3
Concentrated Business (Teaching Labs) - D	66	12		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor (NBC 3.7.2.2 (2)
General Industrial Use (Research Labs) - F-3	28	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	[illegible]	2	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 3

Fixture Breakdown Level 3						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 3	22	18	15	6	6	3



1 LEVEL 3
SCALE: 1 : 250

Key Plan



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Drawn by: Author Reviewed by: Checker

Project No. 14.32005.00

Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

Original drawing is A0. Do not scale contents of this drawing.

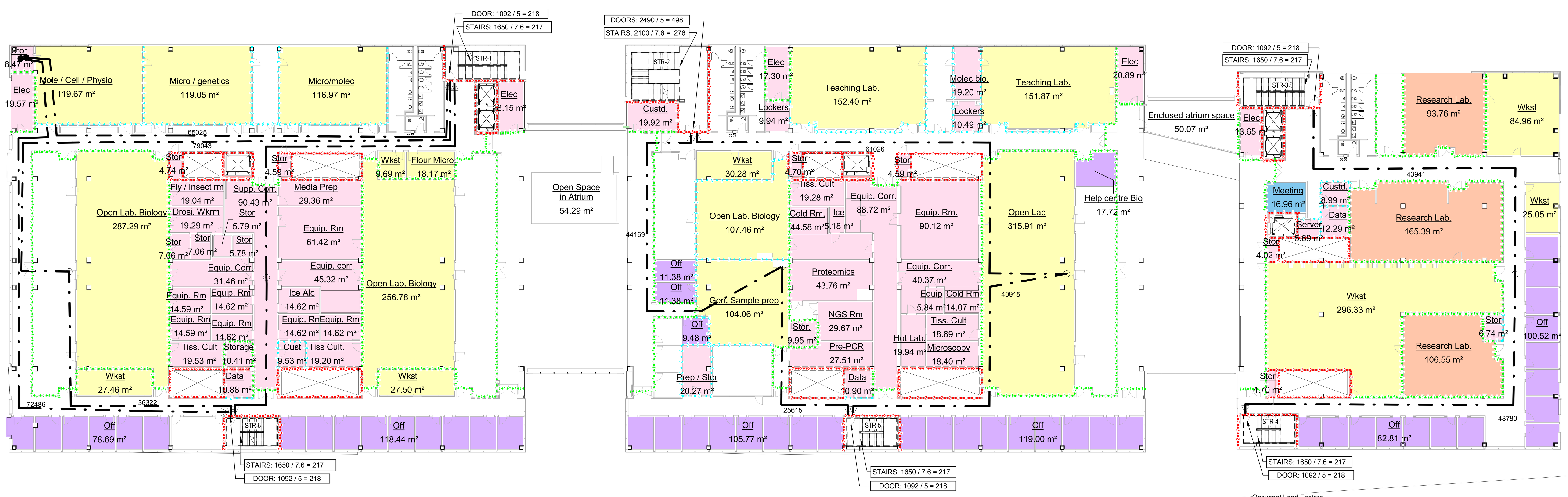
Sheet Number:
LS103

Occupant Load Level 4				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 4	Off	118.44 m²	9.30	13
LEVEL 4	Off	78.69 m²	9.30	8
LEVEL 4	Help centre Bio	17.72 m²	9.30	2
LEVEL 4	Off	119.00 m²	9.30	13
LEVEL 4	Off	105.77 m²	9.30	11
LEVEL 4	Off	100.52 m²	9.30	11
LEVEL 4	Off	82.81 m²	9.30	9
LEVEL 4	Off	11.38 m²	9.30	1
LEVEL 4	Off	11.38 m²	9.30	1
LEVEL 4	Off	9.48 m²	9.30	1
Business (Offices)		655.18 m²		70
LEVEL 4	Mole / Cell / Physio	119.67 m²	4.60	26
LEVEL 4	Micro / genetics	119.05 m²	4.60	26
LEVEL 4	Micro/molec	116.97 m²	4.60	25
LEVEL 4	Wkst	9.69 m²	4.60	2
LEVEL 4	Flour Micro.	18.17 m²	4.60	4
LEVEL 4	Open Lab. Biology	256.78 m²	4.60	56
LEVEL 4	Wkst	27.50 m²	4.60	6
LEVEL 4	Open Lab. Biology	287.29 m²	4.60	62
LEVEL 4	Wkst	27.46 m²	4.60	6
LEVEL 4	Open Lab. Biology	107.46 m²	4.60	23
LEVEL 4	Wkst	30.28 m²	4.60	7
LEVEL 4	Gen. Sample prep	104.06 m²	4.60	23
LEVEL 4	Open Lab	315.91 m²	4.60	69
LEVEL 4	Teaching Lab.	152.40 m²	4.60	33
LEVEL 4	Teaching Lab.	151.87 m²	4.60	33
LEVEL 4	Wkst	84.96 m²	4.60	18
LEVEL 4	Wkst	25.05 m²	4.60	5
LEVEL 4	Wkst	296.33 m²	4.60	64
Concent. business (teaching labs)		2250.91 m²		489
LEVEL 4	Research Lab.	93.76 m²	9.30	10
LEVEL 4	Research Lab.	165.39 m²	9.30	18
LEVEL 4	Research Lab.	106.55 m²	9.30	11
General Industrial Use (Research Labs)		365.69 m²		39
LEVEL 4	Stor	8.47 m²	46.50	0
LEVEL 4	Elec	19.57 m²	46.50	0
LEVEL 4	Tiss Cult.	19.20 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Ice Alc	14.62 m²	46.50	0
LEVEL 4	Cust	9.53 m²	46.50	0
LEVEL 4	Equip. Rm	61.42 m²	46.50	1
LEVEL 4	Equip. corr	45.32 m²	46.50	1
LEVEL 4	Media Prep	29.36 m²	4.60	6
LEVEL 4	Fly / Insect rm	19.04 m²	46.50	0
LEVEL 4	Stor	7.06 m²	46.50	0
LEVEL 4	Stor	7.06 m²	46.50	0

Occupant Load Level 4				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 4	Stor	5.79 m²	46.50	0
LEVEL 4	Stor	5.78 m²	46.50	0
LEVEL 4	Equip. Rm	14.59 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.62 m²	46.50	0
LEVEL 4	Equip. Rm	14.59 m²	46.50	0
LEVEL 4	Tiss. Cult	19.53 m²	46.50	0
LEVEL 4	Storage	10.41 m²	46.50	0
LEVEL 4	Data	10.88 m²	46.50	0
LEVEL 4	Drosi. Wkrm	19.29 m²	46.50	0
LEVEL 4	Elec	18.15 m²	46.50	0
LEVEL 4	Stor	4.59 m²	46.50	0
LEVEL 4	Stor	4.70 m²	46.50	0
LEVEL 4	Tiss. Cult	19.28 m²	46.50	0
LEVEL 4	Ice	5.18 m²	46.50	0
LEVEL 4	Proteomics	43.76 m²	46.50	1
LEVEL 4	NGS Rm	29.67 m²	46.50	1
LEVEL 4	Pre-PCR	27.51 m²	46.50	1
LEVEL 4	Stor.	9.95 m²	46.50	0
LEVEL 4	Data	10.90 m²	46.50	0
LEVEL 4	Cold Rm.	44.58 m²	46.50	1
LEVEL 4	Equip. Rm.	90.12 m²	46.50	2
LEVEL 4	Equip	5.84 m²	46.50	0
LEVEL 4	Cold Rm	14.07 m²	46.50	0
LEVEL 4	Tiss. Cult	18.69 m²	46.50	0
LEVEL 4	Microscopy	18.40 m²	46.50	0
LEVEL 4	Hot Lab.	19.94 m²	46.50	0
LEVEL 4	Prep / Stor	20.27 m²	4.60	4
LEVEL 4	Elec	17.30 m²	46.50	0
LEVEL 4	Lockers	9.94 m²	46.50	0
LEVEL 4	Molec bio.	19.20 m²	46.50	0
LEVEL 4	Elec	20.89 m²	46.50	0
LEVEL 4	Custd.	19.92 m²	46.50	0
LEVEL 4	Elec	13.65 m²	46.50	0
LEVEL 4	Custd.	8.99 m²	46.50	0
LEVEL 4	Data	12.29 m²	46.50	0
LEVEL 4	Server	5.69 m²	46.50	0
LEVEL 4	Stor	4.02 m²	46.50	0
LEVEL 4	Stor	6.74 m²	46.50	0
LEVEL 4	Stor	4.70 m²	46.50	0
LEVEL 4	Stor	4.74 m²	46.50	0
Storage		953.68 m²		30
Grand total: 85		4225.47 m²		629

Fixture Count Level 4					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Business (Offices) - D	70	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Concentrated Business (Teaching Labs) - D	489	12		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
General Industrial Use (Research Labs) - F-3	39	4		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
Storage - F-3	30	4	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	

Fixture Breakdown Level 4						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 4	24	18	15	6	6	3



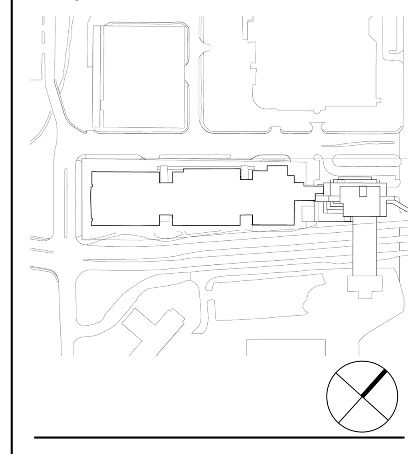
1 LEVEL 4
SCALE: 1 : 250

Occupant Load Factors

- Atrium Spaces
- Business (Offices)
- Classrooms
- Concent. business (teaching labs)
- General Industrial Use (Research Labs)
- Meeting / Seminar
- Sales Area on Street Floor
- Storage

- TRAVEL DISTANCE TO EXIT
- 0-HR FIRE RATING
- 1-HR FIRE RATING
- 2-HR FIRE RATING
- SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan



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Drawn by: Author Reviewed by: Checker

Project No: 14.32005.00

Project

CSF-001-12 Core Science Facility

Sheet Title:

LIFE SAFETY PLANS

Original drawing is A0. Do not scale contents of this drawing.

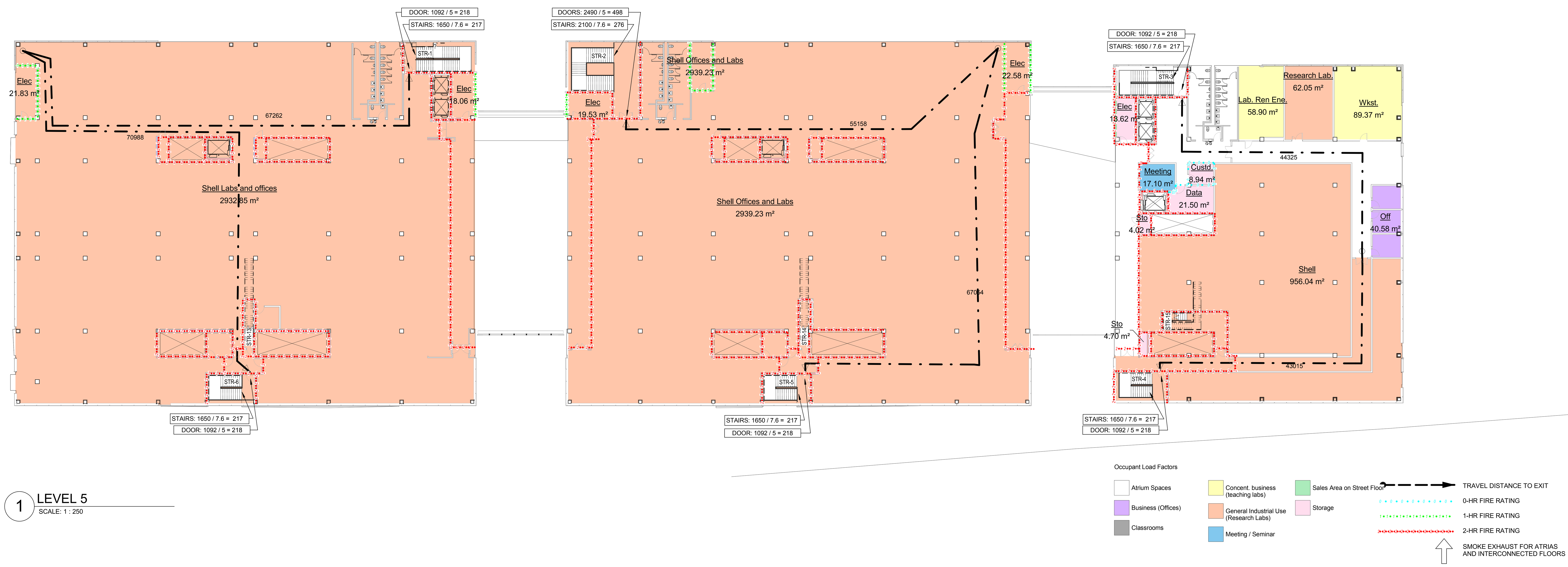
Sheet Number:

LS104

Occupant Load Level 5				
Level	Name	Area	Occupant Load Factor	Occupant Load (persons)
LEVEL 5	Lab. Ren Ene.	58.90 m²	4.60	13
LEVEL 5	Wkst.	89.37 m²	4.60	19
Concent. business (teaching labs)				32
LEVEL 5	Research Lab.	62.05 m²	9.30	7
LEVEL 5	Shell	956.04 m²	9.30	103
LEVEL 5	Shell Offices and Labs	2939.23 m²	9.30	316
LEVEL 5	Shell Labs and offices	2932.85 m²	9.30	315
General Industrial Use (Research Labs)				741
LEVEL 5	Elec	13.62 m²	46.50	0
LEVEL 5	Custd.	8.94 m²	46.50	0
LEVEL 5	Data	21.50 m²	46.50	0
LEVEL 5	Sto	4.02 m²	46.50	0
LEVEL 5	Sto	4.70 m²	46.50	0
Storage				1
Grand total: 11				774

Fixture Count Level 5					
Occupancy Classification	Occupant Load (persons)	Fixtures Required	Total Fixtures Proposed	NBC 2010 ref	Notes
Concentrated Business (Teaching Labs) - D	32	2		3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	
General Industrial Use (Research Labs) - F-3	741	18		3.7.2.2 (2) If a single universal toilet room is provided in accordance with the requirements of section 3.8., the total number of persons in the building used to determine the number of water closets to be provided, is permitted to be reduced by 10 before applying sentences (6),(7), (8), (12), (13) or (14)	Total occupant load on this item gets reduced by 30 due to the proposal of 3 universal toilets in this floor
Storage - F-3	1	0	27 regular, 3 universal	3.7.2.2 Tables 3.7.2.2A., 3.7.2.2B.and 3.7.2.2C.	Total count of proposed fixtures combined for all D, F-3 and A-2 areas on level 5

Fixture Breakdown Level 5						
Level	Total Fixtures Required	Lavatories	WC Female	WC Male	Urinals	Universal
LEVEL 5	20	18	15	6	6	3



1 LEVEL 5
SCALE: 1 : 250

Key Plan

MEMORIAL UNIVERSITY

Department of Facilities Management

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- Dedication plaque, Arts & Administration Building, St. John's Campus

Prepared For
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ST. JOHN'S, NEWFOUNDLAND

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Professional Seals

No.	Description	Date
	95% Design Development	May 1, 2015
	Issued for Pre-Tender Estimate	July 3, 2015
	Issued for CP-1A Review	August 4, 2015
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	Issued for 50% Printing	September 21, 2015
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Drawn by: Author Reviewed by: Checker

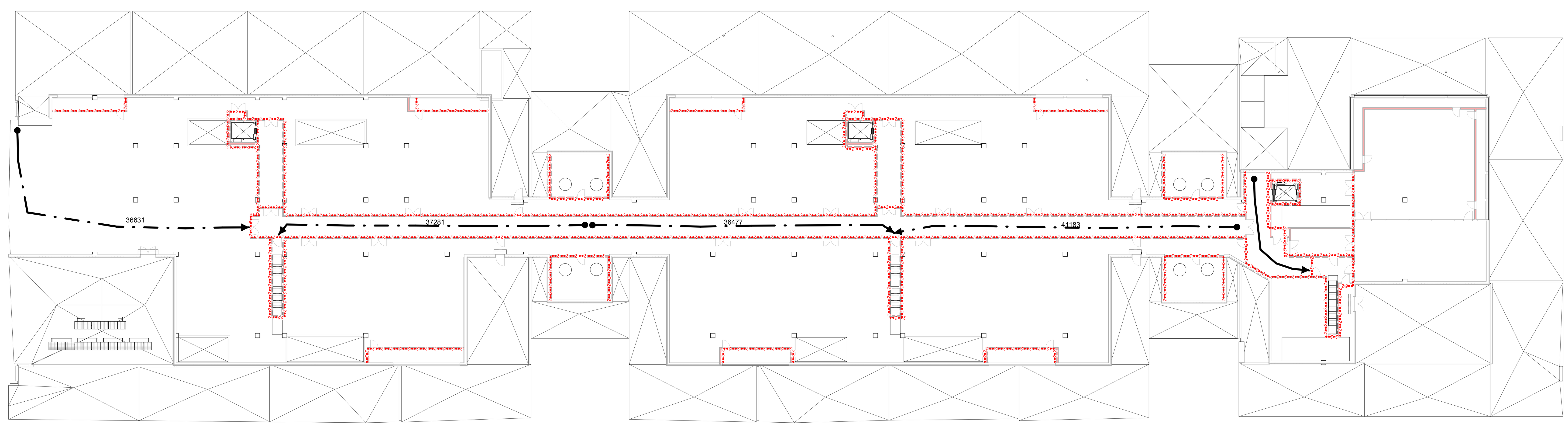
Project No: 14.32005.00

Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

Original drawing is A0. Do not scale contents of this drawing.

Sheet Number:
LS105



1 LEVEL PH
SCALE: 1 : 250

TRAVEL DISTANCE TO EXIT
0-HR FIRE RATING
1-HR FIRE RATING
2-HR FIRE RATING
SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan

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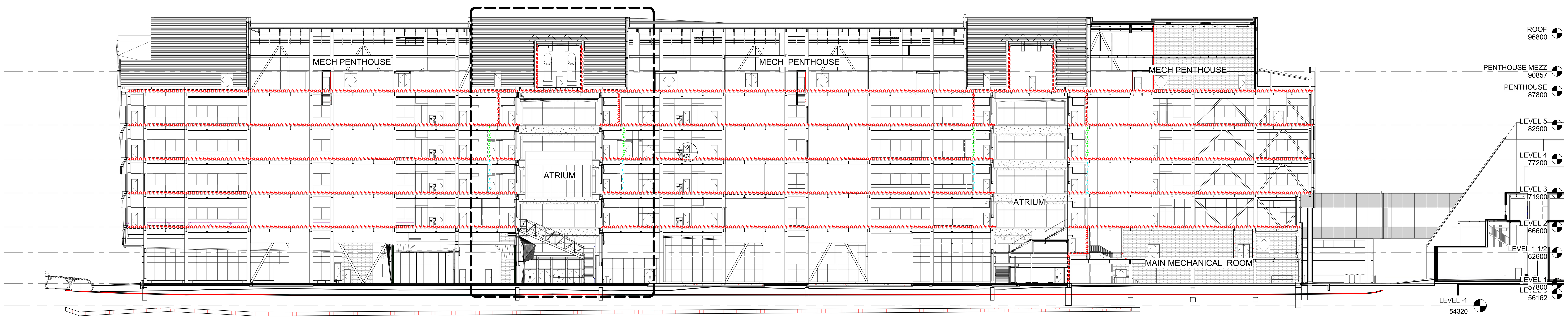
Project
CSF-001-12 Core Science Facility

Sheet Title:
LIFE SAFETY PLANS

Original drawing is A0. Do not scale contents of this drawing.

Sheet Number:
LS106



1 FIRE SEPARATION
SCALE: 1 : 250

TRAVEL DISTANCE TO EXIT
0-HR FIRE RATING
1-HR FIRE RATING
2-HR FIRE RATING
SMOKE EXHAUST FOR ATRIAS AND INTERCONNECTED FLOORS

Key Plan

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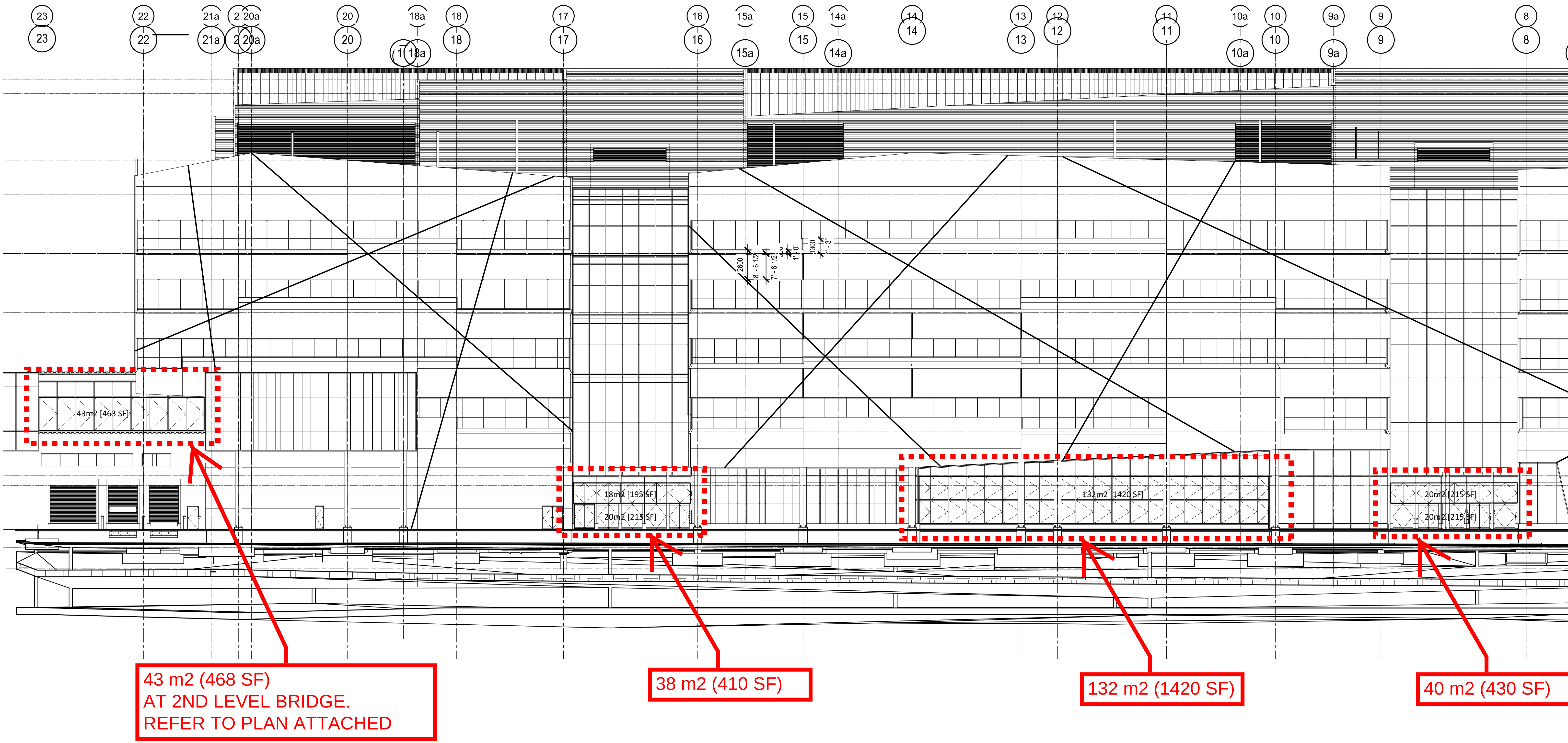
Project
CSF-001-12 Core Science Facility
Sheet Title:
LIFE SAFETY SECTIONS

Original drawing is A0. Do not scale contents of this drawing.
Sheet Number:
LS107



TOTAL ARE AOPERABLE FACDEAREA: 253 M2 [2,723 SF]

EFFECTIVE FREE-AREA OF 93% PER FRAMING: 235 m2 [2,539 SF]

Appendix B

Fire Safety Functional, Objective, and Intent Statements

The fire safety functional, objective, and intent statements associated with NBC Sentence and 3.2.8.1.(1) are as follows:

OS1 **OP1**

Objective	**OS1 Fire Safety**
Attribution	[F03,F06-OS1.2] [F05-OS1.5]

Application

Application 1:
Vertical *fire separation* or protection of portions of a floor area or a *mezzanine* that do not terminate at an exterior wall, a *firewall* or a vertical shaft, in *buildings* described in Sentence 1.3.3.2.(1) of Division A.

Application 2:
This also applies to *buildings* to which Part 9 applies [see Sentence 1.3.3.3.(1) of Division A for application of Part 9], where there are:
- openings through floors that are not protected by shafts or *closures*, as stated in Sentence 9.10.1.2.(6), or
- *interconnected floor spaces*, as stated in Sentence 9.10.9.5.(1).

Exceptions:
except as exempted in:
- Sentence 3.2.8.1.(3), which applies to *floor areas* containing sleeping rooms in a *building* of Group B, Division 2 *major occupancy* [exception to Clause 3.2.8.1.(1)(b)],
- Article 3.2.8.2., which applies to certain *occupancies* and situations,
- Sentence 3.3.4.2.(3), which applies to *dwelling units*, and
- Sentence 9.9.4.7.(1), which applies to *buildings*:
  - that are not more than 2 *storeys* in *building height*,
  - that are not more than 600 m² in *building area*, and
  - in which a stairway connects the *first storey* to the second *storey* of a *suite* of Group D or Group E *occupancy*.

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Intent

Intent 1:
To limit the probability that fire will spread:
- from a lower floor level to upper floor levels in a fire situation, or
- from a floor area into exit stairs in a fire situation.

This is to limit the probability of the spread of fire in the upper floor levels or in the exit stairs, which could lead to:
- delays or ineffectiveness in fire suppression operations, which could lead to the spread of fire, which could lead to harm to persons, and
- delays in the evacuation or movement of persons to a safe place, which could lead to harm to persons.

Intent 2:
To state the application of Articles 3.2.8.3. to 3.2.8.9.

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OS1 **OP1**

Objective	**OP1 Fire Protection of the Building**
Attribution	[F03,F06-OP1.2]

Application

Application 1:
Vertical *fire separation* or protection of portions of a floor area or a *mezzanine* that do not terminate at an exterior wall, a *firewall* or a vertical shaft, in *buildings* described in Sentence 1.3.3.2.(1) of Division A.

Application 2:
This also applies to *buildings* to which Part 9 applies [see Sentence 1.3.3.3.(1) of Division A for application of Part 9], where there are:
- openings through floors that are not protected by shafts or *closures*, as stated in Sentence 9.10.1.2.(6), or
- *interconnected floor spaces*, as stated in Sentence 9.10.9.5.(1).

Exceptions:
except as exempted in:
- Sentence 3.2.8.1.(3), which applies to *floor areas* containing sleeping rooms in a *building* of Group B, Division 2 *major occupancy* [exception to Clause 3.2.8.1.(1)(b)],
- Article 3.2.8.2., which applies to certain *occupancies* and situations,
- Sentence 3.3.4.2.(3), which applies to *dwelling units*, and
- Sentence 9.9.4.7.(1), which applies to *buildings*:
  - that are not more than 2 *storeys* in *building height*,
  - that are not more than 600 m² in *building area*, and
  - in which a stairway connects the *first storey* to the second *storey* of a *suite* of Group D or Group E *occupancy*.

Top of Page

Intent

Intent 1:
To limit the probability that fire will spread:
- from a lower floor level to upper floor levels in a fire situation, or
- from a floor area into exit stairs in a fire situation.

This is to limit the probability of the spread of fire in the upper floor levels or in the exit stairs, which could lead to:
- delays or ineffectiveness in fire suppression operations, which could lead to the spread of fire, which could lead to damage to the building, and
- damage to the building.

Intent 2:
To state the application of Articles 3.2.8.3. to 3.2.8.9.

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3.2.8.2.(6) Application Intent

+

Application	**Application 1:** *Interconnected floor spaces* where: • the *interconnected floor space* consists of the *first storey* and the *storey* next above or below it, but not both, • the openings through the floor are used only for stairways, escalators or moving walks, or the *interconnected floor space* is *sprinklered* throughout, • the *interconnected floor space* contains only Group A, Division 1, 2 or 3, Group D, Group E or Group F, Division 2 or Division 3 *major occupancies*, and • the *building area* is not more than one half of the area permitted by Subsection 3.2.2. This applies to *buildings* described in Sentence 1.3.3.2.(1) of Division A. **Application 2:** This also applies to *buildings* to which Part 9 applies [see Sentence 1.3.3.3.(1) of Division A for application of Part 9], where there are: • openings through floors that are not protected by shafts or *closures*, as stated in Sentence 9.10.1.2.(6), or • *interconnected floor spaces*, as stated in Sentence 9.10.9.5.(1). Top of Page

Intent	**Intent 1:**
	To exempt certain interconnected floor spaces from the requirements of Sentence 3.2.8.1.(1) and Articles 3.2.8.3. to 3.2.8.9., which would otherwise require a vertical fire separation or certain fire protection measures, if:
	• the location and number of interconnected floors is limited, which will minimize:
	    • vertical fire spread, and
	    • delays in emergency responder access and evacuation of occupants,
	• the openings through the floor are used only for stairways, escalators or moving walks, or the interconnected floor space is sprinklered, which will minimize vertical fire spread,
	• the interconnected floor space contains only certain major occupancies, which will minimize fire risks, and
	• the building area is limited, which will minimize delays in emergency responder access and evacuation of occupants.
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Appendix C

Tenability Limits

The tenability limits considered for this analysis are as follows:

Temperature/Heat Exposure

Human exposure to fire may lead to hyperthermia, blistering, skin burns, and respiratory tract burns [11]. Thermal endpoint criteria (tenability limit) specified by NFPA 101 is 49˚C for a smoke layer less than 1.5 m above the floor level [16]. NFPA 130 and NFPA 502 specify thermal endpoint criteria of 60˚C for short exposures (i.e. a few seconds) [17] [18].

A tenability limit of 49˚C at 2.0 m above floor level for temperature exposure has been conservatively considered along the egress paths for this analysis and was estimated through FDS simulations.

Visibility Threshold

The reduction of visibility in a fire due to smoke obscuration is an important consideration in tenability analyses. The degree of familiarity with the inside of the building affects an individual's ability to move through fire smoke. The British Standards Institution (BSI) indicates that a visibility distance of 2 m is acceptable minimum criteria for small rooms and 10 m for all other rooms [12]. The SFPE Handbook indicates that those who are familiar with the geometry of the building need a visibility distance of 4 m for safe evacuation, whereas those who are unfamiliar need a visibility distance of 13 m [19].

The ASHRAE Handbook of Smoke Control Engineering [10] puts forward that "*….in a University building consisting of classrooms and corridors with an atrium at the main entrance…it can be expected that most of the occupants would be familiar with the building and the few that are not could be expected to move with the rest of the population during evacuation…depending on the size of the building/corridors, a 4 m criteria may not be enough and 7.6 – 9.1 m might be appropriate…*".

A tenability limit of 7.6 m at 2 m above floor level for visibility reduction due to smoke has been considered along the egress paths for this analysis. The use of the ASHRAE criteria applicable to familiar occupants is based on the expected familiarity of most of building occupants with egress routes. The few occupants that may not be familiar with the building are expected to move with those who are. Visibility was estimated through FDS simulations.

Carbon Monoxide

As noted in NFPA 502, asphyxiant gases impair an individual's ability to self-evacuate by decreasing the amount of oxygen available, causing disorientation and possibly unconsciousness. Exposure to CO leads to the production of carboxyhemoglobin (COHb) in the blood, resulting primarily in a decrease in the blood's oxygen-carrying ability. Exposure to CO can cause harm as a result of sensory irritation (i.e. irritation of the eyes, upper respiratory tract, and lungs) and thus can inhibit the ability of an individual to evacuate. In addition, edema and inflammation may be induced, leading to post-fire difficulties or death [17] [18].

Endpoint criteria for asphyxiant gases are included in NFPA 101, 130, and 502. NFPA 130 and 502 specify the CO tenability limit of 800 parts/million (ppm), assuming a 30 min evacuation period. NFPA 101 specifies a CO tenability limit as a cumulative dose, 30,000 ppm/min, (i.e. a steady concentration of 1,000 ppm over a 30 min period). No limits are provided for irritant gases in these Standards.

A tenability limit of 800 ppm at 2 m above floor level for 30 min of CO exposure has been considered along the egress paths for this analysis and was estimated through FDS simulations.

Appendix D

**Timed Egress Model,
Pathfinder Input/Output and
Hand Calculations**

Egress Time Model

The RSET presented in this analysis has been based on an egress time model which is considered to be the sum of the individual times required for each of the following events to take place:

- Detection time and activation of the building's fire alarm system,
- Pre-movement time by building occupants to recognize and respond, and
- Travel time to exit locations, including queuing at transition locations.

Refer to Figure D1 for an outline of the timed egress model.

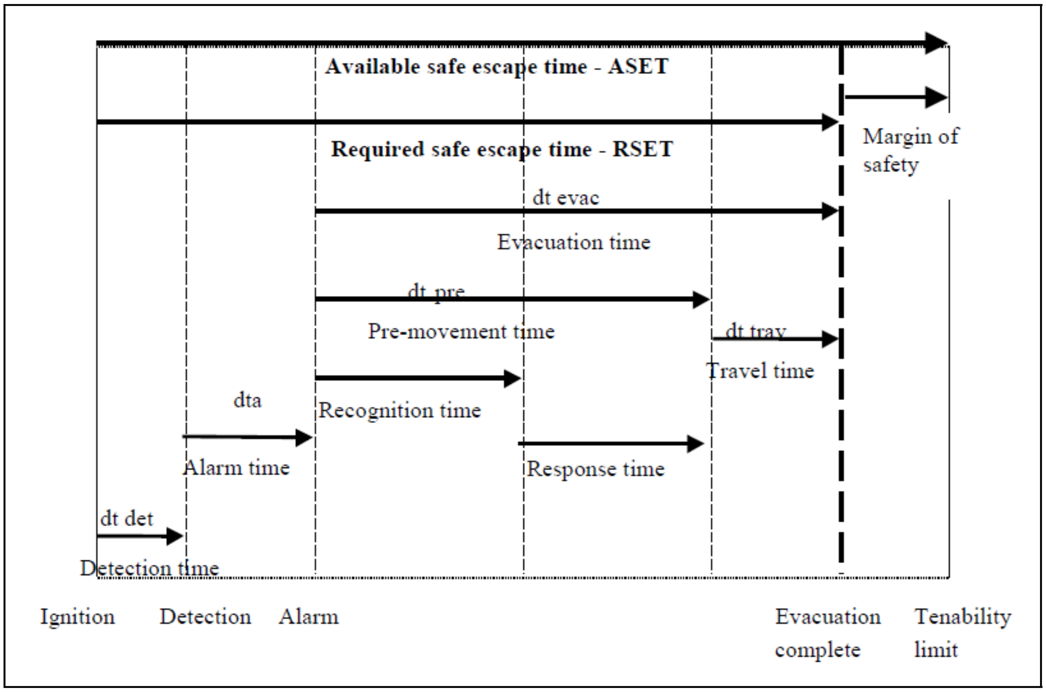

Figure D1: Timed Egress Model

Occupants were initially located throughout floor areas in accordance with calculated occupant load factors, and then distributed to the available exits based on their proximity (i.e. occupants travel to the closest exit).

Applicable research suggests a total pre-movement time of 63 sec [18]. This applies to occupants who are awake and familiar with the building, and where a fire alarm system is installed. This pre-movement time also requires a comprehensive fire safety plan that consists of trained staff to assist with occupant evacuation, maintenance practices, and regular fire drills.

The estimated detection time of the fire and life safety systems have been obtained by using subroutines within the FDS model.

The travel and queue time components of the egress time model have been estimated using the Pathfinder software which is based on human movement calculations that model occupant flows.

Additional margins of safety have been incorporated into the analysis through application of conservative assumptions including:

- Maximum occupant loading based on factors of the NBC,
- Concurrent evacuation of all storeys,
- Occupants travel at half the travel speed designated by the SFPE Handbook for flat surfaces (1.19 m/s) to account for persons requiring special assistance, and
- Maximum travel distances.

The Pathfinder simulations had been further validated with hand calculations.

Hand Calculations

Floor Area	Occupant Load (persons)	Egress Area (m²)	Corridor Width (m)
L3	105	40	2

Egress Components	Width (m)
Exit door width	1.09

a.) Total occupant load divided by 6 (number of exit stairs).
b.) Appromiate queuing area near exit door (assuming all occupants arrive at the door at the same time).

1.) Initial Speed/Flow

Population Density per Egress Door

D = Population / Area
D = 2.63 persons/m²

SFPE Table 3-13.2
k = 1.4
a = 0.266

Evacuation Speed

S = k - [a(k)(D_{aisle})]
S = 0.42 m/s

Half of SFPE Max
0.595

Specific Flow

Fs = [1-(a)(D)](k)(D)
Fs = 1.109 persons/sec/m

SFPE Table 3-13.5 F_{sm} = 1.30 persons/sec/m
The lesser of F_s and F_{sm} is chosen to determine the calculated flow.

The lesser value is: 1.109 persons/sec/m

Effective Width of Egress Area

W = W - $W_{boundary\_layer}$
W = 1.080 m

SFPE Table 3-13.1
$W_{boundary\_layer}$ = 0.46 m

Calculated Flow

Fc = [1-(a)(D)](k)(D)(W)
Fc = 1.198 persons/sec Initial Value

2.) Speed Through Exit Door

Effective Width

W_e = W - $W_{boundary\_layer}$
W_e = 0.91 m

From Table 3-13.1
$W_{boundary\_layer}$ (m) = 0.09

Specific Flow

F_{se} = (F_s*W)/W_e
F_{se} = 1.32 persons/sec/m

From Table 3-13.5 F_{sm} = 1.01 persons/sec/m
The lesser of F_{se} and F_{sm} is chosen to determine the calculated flow.

The lesser value is: 1.01 persons/sec/m

Calculated Flow

F_{ce} = F_{se}*W_e
F_{ce} = 0.919 persons/sec

Queuing

Queuing will occur if F_c Exceeds F_{ce}

F_{ce} - F_c = 0.28

Queuing will occur True

Queue Time 114.24 s
Travel Time (91 m) 152.94 s
Queue and Travel 267.18 s

A sample Pathfinder input/output files are follows:

Pathfinder Input

```
[version]
5

[param]
show_vis 0

dt_init     0.025
max_time    3600.0
dt_csv_data  1.0
dt_vis      0.25
dt_wall_meta 0.5
dt_snapshot  120.0

reactive_steering 1
inertia         1
handle_collisions 1
vel_from_density  0
density_max      1.88

specific_flowrate_max Infinity
door_flow_from_density     1
door_flow_density_min      1.9
door_flow_density_max      3.0
out_occ_time_history       "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt.pfd"
out_geom_time_history      "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt.pfg"
out_room_usage             "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt_rooms.csv"
out_door_usage             "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt_doors.csv"
out_summary                "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt_summary.txt"
out_performance            "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt_performance.txt"
out_snapshot_base          "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt"
out_results                "C:\Users\pathfinder.RJBARTLETTENG\Desktop\14024 Feb 1 Input File.txt.pfr"

license_server   ""
license_dir     "C:\ProgramData\Application Data\Pathfinder\license"

[floors]
0: "Floor 0.0 m" 0.0
```

1: "Floor 3.0 m" 3.0
2: "Floor 6.0 m" 6.0
3: "Floor 9.0 m" 9.0
4: "Floor 12.0 m" 12.0

[nodedisp]
0: 0.5529412 0.5137255 0.7490196 0.19607843
1: 0.5137255 0.5411765 0.6392157 0.19607843
2: 0.42745098 0.4 0.5176471 0.19607843
3: 0.5647059 0.42745098 0.6431373 0.19607843
4: 0.5294118 0.5294118 0.60784316 0.19607843
5: 0.52156866 0.47058824 0.79607844 0.19607843
6: 0.40392157 0.4392157 0.58431375 0.19607843
7: 0.57254905 0.49411765 0.52156866 0.19607843
8: 0.4862745 0.4509804 0.78431374 0.19607843
9: 0.58431375 0.5921569 0.6627451 0.19607843

[nodes]
0: "Floor 0.0 m->Room22" 0, -1
1: "Floor 0.0 m->Room24" 1, -1
2: "Floor 0.0 m->Room25" 2, -1
3: "Floor 0.0 m->Room26" 3, -1
4: "Floor 0.0 m->Room27" 4, -1
5: "Floor 0.0 m->Room28" 5, -1

Pathfinder Output

Simulation:
Mode: Steering
Total Occupants: 3632
Exit Times (s):
Min: 0.8
Max: 389.0
Average: 162.5
StdDev: 105.4

[Components] All: 1593
[Components] Doors: 841
Triangles: 11681
Startup Time: 0.1s
CPU Time: 347.5s

ROOM/DOOR	FIRST IN (s)	LAST OUT (s)	TOTAL USE (pers)	FLOW AVG. (pers/s)
Floor 0.0 m->Room22	0.0	6.6	2	
Floor 0.0 m->Room24	0.0	3.4	2	
Floor 0.0 m->Room25	0.0	2.3	1	
Floor 0.0 m->Room26	0.0	3.0	1	
Floor 0.0 m->Room27	0.0	1.7	1	
Floor 0.0 m->Room28	0.0	2.3	3	
Floor 0.0 m->Room29	0.0	8.4	6	
Floor 0.0 m->Room30	0.0	12.6	12	
Floor 0.0 m->Room07	0.0	92.5	161	
Floor 0.0 m->Room55	0.0	17.6	14	
Floor 0.0 m->Room64	0.0	167.2	145	
Floor 0.0 m->Room75	0.0	17.0	12	
Floor 0.0 m->Room76	0.0	10.6	6	
Floor 0.0 m->Room81	0.0	56.2	54	
Floor 0.0 m->Door161	3.5	352.6	488	1.40
Floor 0.0 m->Door162	2.9	3.7	2	
Floor 0.0 m->Door163	4.0	4.0	1	
Floor 0.0 m->Door164	2.0	3.2	2	1.67
Floor 0.0 m->Door165	3.1	6.3	4	1.24
Floor 0.0 m->Door166	3.4	4.4	2	
Floor 0.0 m->Door167	0.0	0.0	0	
Floor 0.0 m->Door168	0.0	0.0	0	
Floor 0.0 m->Door169	0.0	0.0	0	
Floor 0.0 m->Door170	0.9	3.3	3	1.24
Floor 0.0 m->Door171	1.9	7.0	4	0.79
Floor 0.0 m->Door172	1.4	3.4	3	1.48
Floor 0.0 m->Door173	4.7	348.1	386	1.12
Floor 0.0 m->Door175	0.8	336.8	459	1.37
Floor 0.0 m->Door176	3.0	350.3	428	1.23

Floor 0.0 m->Room151	0.0	350.3	1339	
Floor 12.0 m->Door151_1	0.0	0.0	0	
Floor 12.0 m->Door152_1	2.1	3.0	2	
Floor 12.0 m->Door153_1	1.6	2.6	2	1.95
Floor 12.0 m->Door154_1	0.0	0.0	0	
Floor 12.0 m->Door155_1	5.3	24.9	18	0.92
Floor 12.0 m->Door156_1	0.0	0.0	0	
Floor 12.0 m->Door157_1	2.1	7.1	4	0.79
Floor 12.0 m->Door158_1	2.4	16.1	12	0.87
Floor 12.0 m->Door159_1	3.1	5.6	2	0.81
Floor 12.0 m->Door160_1	1.3	5.6	4	0.93
Floor 12.0 m->Door563	3.5	81.3	34	0.44
Floor 12.0 m->Door564	1.9	1.9	1	
Floor 12.0 m->Door565	1.8	1.8	1	
Floor 12.0 m->Door566	2.6	4.8	3	1.40
Floor 12.0 m->Door567	0.0	0.0	0	
Floor 12.0 m->Door568	1.9	80.6	31	0.39
Floor 12.0 m->Room1413_1_1	0.0	236.8	113	
Floor 12.0 m->Room1120_1_1	2.0	245.4	142	
Floor 12.0 m->Room1305_1	0.0	309.1	799	
Floor 12.0 m->Room1305_11	0.0	19.9	17	
Floor 12.0 m->Door607	1.4	19.9	17	0.92
Floor 12.0 m->Door608	7.4	184.0	42	0.24
Floor 12.0 m->Door609	37.0	55.6	4	0.21
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Appendix E

Design Fire Development and FDS Input/Output

Development of Design Fires

The heat release rate profiles applied to the design fire scenarios are based on fuel loads consisting of content expected to be found in the areas of concern and the referenced full-scale fire test data.

The unsprinklered heat release rate of the full-scale test applied to Design Fire Scenario 1a and 1b is shown in Figure E1 shown as legend item "*Newsstand*".

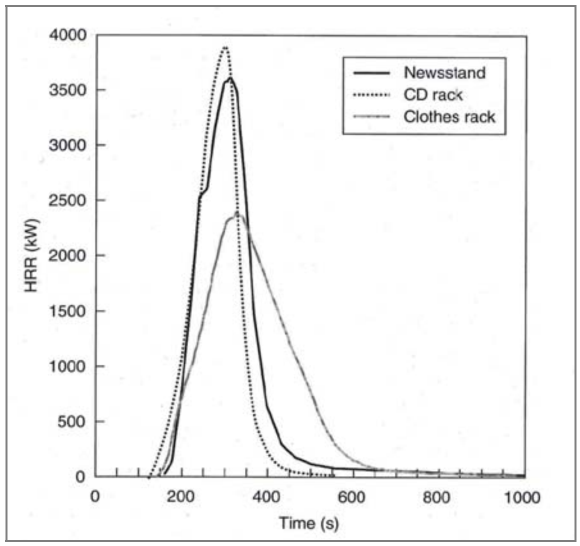

Figure E1: Design Fire Scenario 1a and 1b – Referenced Full-Scale Test

The unsprinklered heat-release rate of the full-scale test applied to Design Fire Scenario 2 is shown in Figure E2 shown as legend item "*C*". This corresponds to an office workstation.

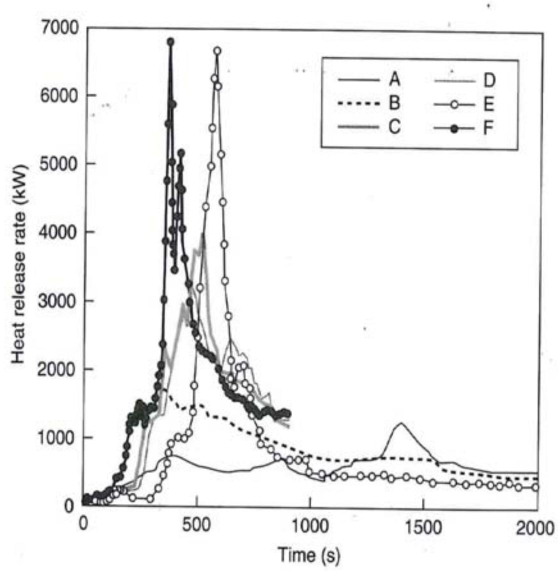

Figure E2: Design Fire Scenario 2 – Referenced Full-Scale Test

Design Fire Scenario 3 is intended to represent areas within the atria where combustible content would be expected to exceed those associated with transient fuel load values. The range of HRR per unit area varies from 555 – 1,250 kW/m^2 and is consistent for the range of expected combustibles as per reference [20][21][22].

The unsprinklered heat release rate of the full-scale test applied to Design Fire Scenario 4 is that of an upholstered sofa containing polyurethane foam padding and a fabric covering. (Refer to Figure E3, shown as legend item "F32"). This fire test reached a heat release rate of 1,000 kW in approximately 150 s. This corresponds to a fast t^2 growth rate.

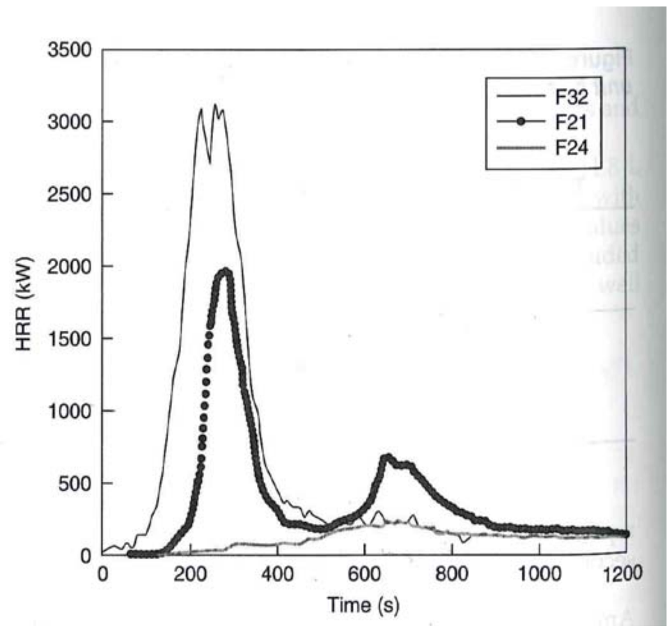

Figure E3: Design Fire Scenario 4 – Referenced Full-Scale Test

As ventilation plays a critical role in the development of design fire scenarios, in that it dictates the availability of oxygen to be consumed by the fire, openings have been incorporated in the simulation domain with dimensions and locations that reflect design conditions. For all of the design fire scenarios, sufficient oxygen has been provided to sustain the fire for the full duration of the simulation.

The FDS model domains have been based on dimensions and material finishes obtained from design drawings provided by the project architect, which can be found in Appendix A.

For the majority of the design fires considered, the heat release rates of the unsprinklered full-scale test data have not been modified within the FDS models to account for sprinkler activation. Where noted in Section 4.4, the full scale fire test data providing unsprinklered heat release rates was analyzed to estimate the heat release rate at the time of sprinkler activation. This was accomplished by using the detection subroutines in the FDS modeling software to determine the time at which the actuation would occur in that fire scenario (i.e. a function of compartment geometry, fire size and growth rate, sprinkler response time index and activation temperature, and sprinkler proximity to the fire). For this analysis, fast response sprinklers were located at the maximum spacing permitted by NFPA 13.

Where sprinkler controlled conditions have been considered, at the time of sprinkler actuation the corresponding heat release rate was capped and held constant for the duration of the simulation. This is considered a conservative approach as it corresponds to a situation where sprinklers control, but do not suppress the fire, and it also assumes there is an unlimited fuel load available (i.e. an unsprinklered fire would burn until the fuel package was consumed and then begin to decay and self-extinguish) [2] and does not account for any sort of fire department intervention.

A sample of FDS Input/Output is as follows:

FDS Input

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Generated by PyroSim - Version 2014.4.1105

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FDS Output

Fire Dynamics Simulator

Version : FDS 6.1.2
SVN Revision No. : 20564

MPI Disabled
OpenMP Enabled; Number of OpenMP Threads: 8

Job TITLE :
Job ID string : ModelOpenMakeupAirOtherA

Grid Dimensions, Mesh 1

Cells in the X Direction	61
Cells in the Y Direction	51
Cells in the Z Direction	35

Physical Dimensions, Mesh 1

Length (m)	61.000
Width (m)	51.000
Height (m)	35.000
Initial Time Step (s)	0.267

Grid Dimensions, Mesh 2

Cells in the X Direction	16
Cells in the Y Direction	51
Cells in the Z Direction	8

Physical Dimensions, Mesh 2

Length (m)	16.000
Width (m)	51.000
Height (m)	8.000
Initial Time Step (s)	0.267

Grid Dimensions, Mesh 3

Cells in the X Direction	16
Cells in the Y Direction	51
Cells in the Z Direction	22

Physical Dimensions, Mesh 3

Length (m)	16.000
Width (m)	51.000
Height (m)	22.000
Initial Time Step (s)	0.267

Grid Dimensions, Mesh 4

Cells in the X Direction	32
Cells in the Y Direction	102
Cells in the Z Direction	10

Physical Dimensions, Mesh 4

Length (m)	16.000
Width (m)	51.000
Height (m)	5.000
Initial Time Step (s)	0.134

Grid Dimensions, Mesh 5

Cells in the X Direction	62
Cells in the Y Direction	51
Cells in the Z Direction	35

Physical Dimensions, Mesh 5

Length (m)	62.000
Width (m)	51.000
Height (m)	35.000
Initial Time Step (s)	0.267

Grid Dimensions, Mesh 6

Cells in the X Direction	24
Cells in the Y Direction	102
Cells in the Z Direction	16

Physical Dimensions, Mesh 6

Length (m)	12.000
Width (m)	51.000
Height (m)	8.000
Initial Time Step (s)	0.134

Grid Dimensions, Mesh 7

Cells in the X Direction	12
Cells in the Y Direction	51
Cells in the Z Direction	22

Physical Dimensions, Mesh 7

Length (m)	12.000
Width (m)	51.000
Height (m)	22.000
Initial Time Step (s)	0.267

Grid Dimensions, Mesh 8

Cells in the X Direction	24
Cells in the Y Direction	102
Cells in the Z Direction	10

Physical Dimensions, Mesh 8

Length (m)	12.000
Width (m)	51.000
Height (m)	5.000
Initial Time Step (s)	0.134

Grid Dimensions, Mesh 9

Cells in the X Direction	49
Cells in the Y Direction	51
Cells in the Z Direction	35

Physical Dimensions, Mesh 9

Length (m)	49.000
Width (m)	51.000
Height (m)	35.000
Initial Time Step (s)	0.267

Miscellaneous Parameters

Simulation Start Time (s)	0.0
Simulation End Time (s)	1000.0
LES Calculation	

Deardorff Model (C_DEARDORFF) 0.10
Turbulent Prandtl Number 0.50
Turbulent Schmidt Number 0.50
Ambient Temperature (C) 24.00

Mass Fraction Transformation Matrix to Convert Species Mixtures (Columns) to Primitive Species (Rows)

	AIR	REAC_FUE	PRODUCTS
REAC_FUEL	0.000000	1.000000	0.000000
NITROGEN	0.761830	0.000000	0.684138
OXYGEN	0.230804	0.000000	0.000000
CARBON DIOXIDE	0.000591	0.000000	0.212196
CARBON MONOXIDE	0.000000	0.000000	0.004630
WATER VAPOR	0.006775	0.000000	0.091320
SOOT	0.000000	0.000000	0.007716

Primitive Species Information

REAC_FUEL
Gas Species
Molecular Weight (g/mol) 19.64455
Ambient Density (kg/m^3) 0.806
Enthalpy of Formation (J/kg) not specified

NITROGEN
Gas Species
Molecular Weight (g/mol) 28.01340
Ambient Density (kg/m^3) 1.149
Enthalpy of Formation (J/kg) 0.00E+00

OXYGEN
Gas Species
Molecular Weight (g/mol) 31.99880
Ambient Density (kg/m^3) 1.312
Enthalpy of Formation (J/kg) 0.00E+00

CARBON DIOXIDE
Gas Species
Molecular Weight (g/mol) 44.00950
Ambient Density (kg/m^3) 1.805
Enthalpy of Formation (J/kg) -8.94E+06

CARBON MONOXIDE
Gas Species
Molecular Weight (g/mol) 28.01010
Ambient Density (kg/m^3) 1.149

Enthalpy of Formation (J/kg) -3.95E+06

WATER VAPOR
Gas Species
Molecular Weight (g/mol) 18.01528
Ambient Density (kg/m^3) 0.739
Enthalpy of Formation (J/kg) -1.34E+07

SOOT
Gas Species
Molecular Weight (g/mol) 10.91042
Ambient Density (kg/m^3) 0.447
Enthalpy of Formation (J/kg) 0.00E+00

Tracked (Lumped) Species Information

AIR
Background Species
Molecular Weight (g/mol) 28.73761
Ambient Density (kg/m^3) 1.179
Initial Mass Fraction 1.000
Enthalpy of Formation (J/kg) -9.62E+04

Sub Species	Mass Fraction	Mole Fraction
NITROGEN	7.618301E-01	7.815252E-01
OXYGEN	2.308036E-01	2.072810E-01
CARBON DIOXIDE	5.909687E-04	3.858946E-04
WATER VAPOR	6.775343E-03	1.080789E-02

Viscosity (kg/m/s) Ambient (293 K): 1.81E-05
500 K: 2.60E-05
1000 K: 4.11E-05
1500 K: 5.36E-05
Therm. Cond. (W/m/K) Ambient (293 K): 3.66E-02
500 K: 5.41E-02
1000 K: 9.46E-02
1500 K: 1.32E-01
Spec. Heat (J/kg/K) Ambient (293 K): 1.01E+03
500 K: 1.04E+03
1000 K: 1.15E+03
1500 K: 1.22E+03
Diff. Coeff. (m^2/s) Ambient (293 K): 2.04E-05
500 K: 4.96E-05
1000 K: 1.58E-04
1500 K: 3.09E-04

REAC_FUEL
Molecular Weight (g/mol) 19.64455

Ambient Density (kg/m^3) 0.806
Initial Mass Fraction 0.000
Enthalpy of Formation (J/kg) -3.32E+06

Sub Species	Mass Fraction	Mole Fraction
REAC_FUEL	1.000000E+00	1.000000E+00

Viscosity (kg/m/s) Ambient (293 K): 1.51E-05
500 K: 2.17E-05
1000 K: 3.41E-05
1500 K: 4.44E-05
Therm. Cond. (W/m/K) Ambient (293 K): 4.47E-02
500 K: 6.42E-02
1000 K: 1.01E-01
1500 K: 1.32E-01
Spec. Heat (J/kg/K) Ambient (293 K): 1.48E+03
500 K: 1.48E+03
1000 K: 1.48E+03
1500 K: 1.48E+03
Diff. Coeff. (m^2/s) Ambient (293 K): 2.27E-05
500 K: 5.51E-05
1000 K: 1.75E-04
1500 K: 3.43E-04

PRODUCTS
Molecular Weight (g/mol) 28.42123
Ambient Density (kg/m^3) 1.166
Initial Mass Fraction 0.000
Enthalpy of Formation (J/kg) -3.14E+06

Sub Species	Mass Fraction	Mole Fraction
NITROGEN	6.841377E-01	6.940977E-01
CARBON DIOXIDE	2.121962E-01	1.370358E-01
CARBON MONOXIDE	4.629864E-03	4.697821E-03
WATER VAPOR	9.131980E-02	1.440677E-01
SOOT	7.716441E-03	2.010103E-02

Viscosity (kg/m/s) Ambient (293 K): 1.61E-05
500 K: 2.36E-05
1000 K: 3.86E-05
1500 K: 5.11E-05
Therm. Cond. (W/m/K) Ambient (293 K): 3.49E-02
500 K: 5.44E-02
1000 K: 1.03E-01
1500 K: 1.50E-01
Spec. Heat (J/kg/K) Ambient (293 K): 1.07E+03
500 K: 1.13E+03
1000 K: 1.29E+03
1500 K: 1.39E+03

Diff. Coeff. (m^2/s) Ambient (293 K): 1.95E-05
500 K: 4.80E-05
1000 K: 1.54E-04
1500 K: 3.03E-04

Gas Phase Reaction Information

SFPE Handbook, GM27

Reaction ID: POLYURETHANE_REAC

Fuel	Heat of Combustion (kJ/kg)
REAC_FUEL	24404.5159

Stoichiometry

Primitive Species

Species ID	Stoich. Coeff.
REAC_FUEL	-1.000000
NITROGEN	0.040000
OXYGEN	-1.143688
CARBON DIOXIDE	0.857110
CARBON MONOXIDE	0.029456
WATER VAPOR	0.843698
SOOT	0.126037

Tracked (Lumped) Species

Species ID	Stoich. Coeff.
AIR	-5.517571
REAC_FUEL	-1.000000
PRODUCTS	6.270185

Reaction Kinetics

Arrhenius Parameters
Pre-exponential: Infinite
Activation Energy: N/A

ODE Solver: EXPLICIT EULER
Extinction Model: EXTINCTION 2
Critical Flame Temperature (K): 1600.2

Material Information

Surface Conditions

0 INERT (DEFAULT)

1 Exhaust
Volume Flow (m^3/s) 2.36E+01
AIR Mass Fraction 1.000

2 Burner
HRR Per Unit Area (kW/m2) 555.0
REAC_FUEL Mass Flux (kg/s/m2) 2.27E-02

3 OPEN
Passive Vent to Atmosphere

4 MIRROR
Symmetry Plane

5 INTERPOLATED

6 PERIODIC

7 HVAC

8 MASSLESS TRACER

9 DROPLET

10 VEGETATION

11 EVACUATION_OUTFLOW
Normal Velocity (m/s) 0.000

12 MASSLESS TARGET

Device Properties

1 Cleary Ionization I1
Activation Obscuration (%/m) 3.24
Alpha_c or L 0.80
Beta_c -0.90
Alpha_e 2.50
Beta_e -0.70
Smokeview ID smoke_detector

Device Coordinates

1 Coords: 781.00 -1461.00 16.50, Make: null, ID: Device, Quantity: TEMPERATURE
2 Coords: 777.00 -1461.00 16.50, Make: null, ID: Device01, Quantity: TEMPERATURE

3 Coords: 773.00 -1461.00 16.50, Make: null, ID: Device02, Quantity: TEMPERATURE
4 Coords: 769.00 -1461.00 16.50, Make: null, ID: Device03, Quantity: TEMPERATURE
5 Coords: 765.00 -1461.00 16.50, Make: null, ID: Device04, Quantity: TEMPERATURE
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11 Coords: 741.00 -1461.00 16.50, Make: null, ID: Device10, Quantity: TEMPERATURE
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13 Coords: 733.00 -1461.00 16.50, Make: null, ID: Device12, Quantity: TEMPERATURE
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180 Coords: 905.00 -1435.00 16.50, Make: null, ID: Device186, Quantity: VISIBILITY, Species: SOOT
181 Coords: 905.00 -1439.00 16.50, Make: null, ID: Device187, Quantity: VISIBILITY, Species: SOOT
182 Coords: 905.00 -1443.00 16.50, Make: null, ID: Device188, Quantity: VISIBILITY, Species: SOOT
183 Coords: 905.00 -1447.00 16.50, Make: null, ID: Device189, Quantity: VISIBILITY, Species: SOOT
184 Coords: 905.00 -1451.00 16.50, Make: null, ID: Device190, Quantity: VISIBILITY, Species: SOOT
185 Coords: 905.00 -1455.00 16.50, Make: null, ID: Device191, Quantity: VISIBILITY, Species: SOOT

186 Coords: 905.00 -1459.00 16.50, Make: null, ID: Device192, Quantity: VISIBILITY, Species: SOOT
187 Coords: 876.00 -1461.00 16.50, Make: null, ID: Device193, Quantity: VISIBILITY, Species: SOOT
188 Coords: 880.00 -1461.00 16.50, Make: null, ID: Device194, Quantity: VISIBILITY, Species: SOOT
189 Coords: 884.00 -1461.00 16.50, Make: null, ID: Device195, Quantity: VISIBILITY, Species: SOOT
190 Coords: 888.00 -1461.00 16.50, Make: null, ID: Device196, Quantity: VISIBILITY, Species: SOOT
191 Coords: 892.00 -1461.00 16.50, Make: null, ID: Device197, Quantity: VISIBILITY, Species: SOOT
192 Coords: 896.00 -1461.00 16.50, Make: null, ID: Device198, Quantity: VISIBILITY, Species: SOOT
193 Coords: 900.00 -1461.00 16.50, Make: null, ID: Device199, Quantity: VISIBILITY, Species: SOOT
194 Coords: 904.00 -1461.00 16.50, Make: null, ID: Device200, Quantity: VISIBILITY, Species: SOOT
195 Coords: 875.00 -1435.00 16.50, Make: null, ID: Device201, Quantity: VISIBILITY, Species: SOOT
196 Coords: 875.00 -1439.00 16.50, Make: null, ID: Device202, Quantity: VISIBILITY, Species: SOOT
197 Coords: 875.00 -1443.00 16.50, Make: null, ID: Device203, Quantity: VISIBILITY, Species: SOOT
198 Coords: 875.00 -1447.00 16.50, Make: null, ID: Device204, Quantity: VISIBILITY, Species: SOOT
199 Coords: 875.00 -1451.00 16.50, Make: null, ID: Device205, Quantity: VISIBILITY, Species: SOOT
200 Coords: 875.00 -1455.00 16.50, Make: null, ID: Device206, Quantity: VISIBILITY, Species: SOOT
201 Coords: 875.00 -1459.00 16.50, Make: null, ID: Device207, Quantity: VISIBILITY, Species: SOOT
202 Coords: 905.00 -1435.00 16.50, Make: null, ID: Device224, Quantity: TEMPERATURE
203 Coords: 905.00 -1439.00 16.50, Make: null, ID: Device225, Quantity: DENSITY, Species: CARBON MONOXIDE
204 Coords: 905.00 -1443.00 16.50, Make: null, ID: Device226, Quantity: DENSITY, Species: CARBON MONOXIDE
205 Coords: 905.00 -1447.00 16.50, Make: null, ID: Device227, Quantity: DENSITY, Species: CARBON MONOXIDE
206 Coords: 905.00 -1451.00 16.50, Make: null, ID: Device228, Quantity: DENSITY, Species: CARBON MONOXIDE
207 Coords: 905.00 -1455.00 16.50, Make: null, ID: Device229, Quantity: DENSITY, Species: CARBON MONOXIDE
208 Coords: 905.00 -1459.00 16.50, Make: null, ID: Device230, Quantity: TEMPERATURE
209 Coords: 875.00 -1435.00 16.50, Make: null, ID: Device231, Quantity: TEMPERATURE
210 Coords: 875.00 -1439.00 16.50, Make: null, ID: Device232, Quantity: DENSITY, Species: CARBON MONOXIDE
211 Coords: 875.00 -1443.00 16.50, Make: null, ID: Device233, Quantity: DENSITY, Species: CARBON MONOXIDE

212 Coords: 875.00 -1447.00 16.50, Make: null, ID: Device234, Quantity: DENSITY, Species: CARBON MONOXIDE
213 Coords: 875.00 -1451.00 16.50, Make: null, ID: Device235, Quantity: DENSITY, Species: CARBON MONOXIDE
214 Coords: 875.00 -1455.00 16.50, Make: null, ID: Device236, Quantity: DENSITY, Species: CARBON MONOXIDE
215 Coords: 875.00 -1459.00 16.50, Make: null, ID: Device237, Quantity: TEMPERATURE
216 Coords: 876.00 -1433.00 16.50, Make: null, ID: Device208, Quantity: DENSITY, Species: CARBON MONOXIDE
217 Coords: 880.00 -1433.00 16.50, Make: null, ID: Device209, Quantity: DENSITY, Species: CARBON MONOXIDE
218 Coords: 884.00 -1433.00 16.50, Make: null, ID: Device210, Quantity: DENSITY, Species: CARBON MONOXIDE
219 Coords: 888.00 -1433.00 16.50, Make: null, ID: Device211, Quantity: DENSITY, Species: CARBON MONOXIDE
220 Coords: 892.00 -1433.00 16.50, Make: null, ID: Device212, Quantity: DENSITY, Species: CARBON MONOXIDE
221 Coords: 896.00 -1433.00 16.50, Make: null, ID: Device213, Quantity: DENSITY, Species: CARBON MONOXIDE
222 Coords: 900.00 -1433.00 16.50, Make: null, ID: Device214, Quantity: DENSITY, Species: CARBON MONOXIDE
223 Coords: 904.00 -1433.00 16.50, Make: null, ID: Device215, Quantity: DENSITY, Species: CARBON MONOXIDE
224 Coords: 876.00 -1461.00 16.50, Make: null, ID: Device216, Quantity: DENSITY, Species: CARBON MONOXIDE
225 Coords: 880.00 -1461.00 16.50, Make: null, ID: Device217, Quantity: DENSITY, Species: CARBON MONOXIDE
226 Coords: 884.00 -1461.00 16.50, Make: null, ID: Device218, Quantity: DENSITY, Species: CARBON MONOXIDE
227 Coords: 888.00 -1461.00 16.50, Make: null, ID: Device219, Quantity: DENSITY, Species: CARBON MONOXIDE
228 Coords: 892.00 -1461.00 16.50, Make: null, ID: Device220, Quantity: DENSITY, Species: CARBON MONOXIDE
229 Coords: 896.00 -1461.00 16.50, Make: null, ID: Device221, Quantity: DENSITY, Species: CARBON MONOXIDE
230 Coords: 900.00 -1461.00 16.50, Make: null, ID: Device222, Quantity: DENSITY, Species: CARBON MONOXIDE
231 Coords: 904.00 -1461.00 16.50, Make: null, ID: Device223, Quantity: DENSITY, Species: CARBON MONOXIDE
232 Coords: 787.00 -1454.00 33.00, Make: Cleary Ionization I1, ID: SD, Quantity: CHAMBER OBSCURATION, Species: SOOT
233 Coords: 787.00 -1444.00 33.00, Make: Cleary Ionization I1, ID: SD01, Quantity: CHAMBER OBSCURATION, Species: SOOT
234 Coords: 787.00 -1429.00 33.00, Make: Cleary Ionization I1, ID: SD02, Quantity: CHAMBER OBSCURATION, Species: SOOT
235 Coords: 791.00 -1454.00 33.00, Make: Cleary Ionization I1, ID: SD03, Quantity: CHAMBER OBSCURATION, Species: SOOT
236 Coords: 791.00 -1444.00 33.00, Make: Cleary Ionization I1, ID: SD04, Quantity: CHAMBER OBSCURATION, Species: SOOT

237 Coords: 791.00 -1429.00 33.00, Make: Cleary Ionization I1, ID: SD05, Quantity: CHAMBER OBSCURATION, Species: SOOT
238 Coords: 795.00 -1454.00 33.00, Make: Cleary Ionization I1, ID: SD06, Quantity: CHAMBER OBSCURATION, Species: SOOT
239 Coords: 795.00 -1444.00 33.00, Make: Cleary Ionization I1, ID: SD07, Quantity: CHAMBER OBSCURATION, Species: SOOT
240 Coords: 795.00 -1429.00 33.00, Make: Cleary Ionization I1, ID: SD08, Quantity: CHAMBER OBSCURATION, Species: SOOT
241 Coords: 864.00 -1455.00 33.00, Make: Cleary Ionization I1, ID: SD09, Quantity: CHAMBER OBSCURATION, Species: SOOT
242 Coords: 864.00 -1440.00 33.00, Make: Cleary Ionization I1, ID: SD10, Quantity: CHAMBER OBSCURATION, Species: SOOT
243 Coords: 864.00 -1425.00 33.00, Make: Cleary Ionization I1, ID: SD11, Quantity: CHAMBER OBSCURATION, Species: SOOT
244 Coords: 870.00 -1455.00 33.00, Make: Cleary Ionization I1, ID: SD12, Quantity: CHAMBER OBSCURATION, Species: SOOT
245 Coords: 870.00 -1440.00 33.00, Make: Cleary Ionization I1, ID: SD13, Quantity: CHAMBER OBSCURATION, Species: SOOT
246 Coords: 870.00 -1425.00 33.00, Make: Cleary Ionization I1, ID: SD14, Quantity: CHAMBER OBSCURATION, Species: SOOT

Slice File Information, Mesh 1

Sampling Interval (s) 1.000

1 Nodes: 0 61 35 35 0 35, Quantity: VELOCITY
2 Nodes: 0 61 35 35 0 35, Quantity: U-VELOCITY
3 Nodes: 0 61 35 35 0 35, Quantity: V-VELOCITY
4 Nodes: 0 61 35 35 0 35, Quantity: W-VELOCITY
5 Nodes: 0 61 15 15 0 35, Quantity: VELOCITY
6 Nodes: 0 61 15 15 0 35, Quantity: U-VELOCITY
7 Nodes: 0 61 15 15 0 35, Quantity: V-VELOCITY
8 Nodes: 0 61 15 15 0 35, Quantity: W-VELOCITY
9 Nodes: 0 61 42 42 0 35, Quantity: VELOCITY
10 Nodes: 0 61 42 42 0 35, Quantity: U-VELOCITY
11 Nodes: 0 61 42 42 0 35, Quantity: V-VELOCITY
12 Nodes: 0 61 42 42 0 35, Quantity: W-VELOCITY
13 Nodes: 0 61 38 38 0 35, Quantity: VELOCITY
14 Nodes: 0 61 38 38 0 35, Quantity: U-VELOCITY
15 Nodes: 0 61 38 38 0 35, Quantity: V-VELOCITY
16 Nodes: 0 61 38 38 0 35, Quantity: W-VELOCITY
17 Nodes: 0 61 0 51 17 17, Quantity: SOOT VISIBILITY
18 Nodes: 0 61 0 51 17 17, Quantity: U-VELOCITY
19 Nodes: 0 61 0 51 17 17, Quantity: V-VELOCITY
20 Nodes: 0 61 0 51 17 17, Quantity: W-VELOCITY

Radiation Model Information

Number of control angles 104
Time step increment 3
Angle increment 5
Theta band N_phi Solid angle
1: 4 0.12
2: 12 0.11
3: 16 0.13
4: 20 0.12
5: 20 0.12
6: 16 0.13
7: 12 0.11
8: 4 0.12
Using gray gas absorption.
Mean beam length 2.500 m

Run Time Diagnostics

Time Step 1
Pressure Iterations: 1
Maximum Velocity Error: 0.41E-02 on Mesh 5 at (63 39 15)

Mesh 1, Cycle 1
CPU/step: 0.207E+02 s, Total CPU: 20.69 s
Time step: 0.134E+00 s, Total time: 0.13 s
Max CFL number: 0.26E-02 at (18, 33, 3)
Max divergence: 0.12E-05 at (37, 12, 28)
Min divergence: -0.12E-05 at (30, 5, 5)
Max VN number: 0.19E-02 at (58, 4, 4)
Radiation Loss to Boundaries: -0.002 kW
Mesh 2, Cycle 1
CPU/step: 0.159E+01 s, Total CPU: 1.59 s
Time step: 0.134E+00 s, Total time: 0.13 s
Max CFL number: 0.24E-02 at (9, 3, 7)
Max divergence: 0.11E-05 at (13, 30, 7)
Min divergence: -0.12E-05 at (4, 36, 2)
Max VN number: 0.16E-02 at (14, 33, 7)
Mesh 3, Cycle 1
CPU/step: 0.281E+01 s, Total CPU: 2.81 s
Time step: 0.134E+00 s, Total time: 0.13 s
Max CFL number: 0.25E-02 at (13, 48, 11)
Max divergence: 0.12E-05 at (3, 32, 10)
Min divergence: -0.11E-05 at (6, 8, 6)
Max VN number: 0.18E-02 at (5, 35, 12)
Mesh 4, Cycle 1

```
CPU/step:     0.395E+01 s, Total CPU:       3.95 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.52E-02 at (  7,  5,  1)
Max divergence:  0.12E-05 at ( 13, 42,  3)
Min divergence: -0.11E-05 at ( 27, 52,  4)
Max VN  number:  0.37E-02 at ( 23, 13,  8)
Mesh    5, Cycle      1
CPU/step:     0.207E+02 s, Total CPU:      20.70 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.26E-02 at (  3, 20,  4)
Max divergence:  0.12E-05 at ( 17, 18,  4)
Min divergence: -0.13E-05 at ( 10, 17,  3)
Max VN  number:  0.19E-02 at ( 12, 45, 26)
Radiation Loss to Boundaries:       -0.002 kW
Mesh    6, Cycle      1
CPU/step:     0.402E+01 s, Total CPU:       4.02 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.51E-02 at ( 20, 57, 15)
Max divergence:  0.13E-05 at (  7, 47,  9)
Min divergence: -0.13E-05 at ( 22, 40, 10)
Max VN  number:  0.37E-02 at (  6, 35,  5)
Mesh    7, Cycle      1
CPU/step:     0.306E+01 s, Total CPU:       3.06 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.25E-02 at (  7,  3,  1)
Max divergence:  0.12E-05 at (  3, 20, 17)
Min divergence: -0.11E-05 at (  4, 36,  9)
Max VN  number:  0.17E-02 at (  4, 20,  7)
Mesh    8, Cycle      1
CPU/step:     0.334E+01 s, Total CPU:       3.34 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.50E-02 at (  9, 52,  3)
Max divergence:  0.12E-05 at ( 15, 59,  5)
Min divergence: -0.11E-05 at ( 21, 97,  6)
Max VN  number:  0.38E-02 at (  4, 67,  5)
Mesh    9, Cycle      1
CPU/step:     0.164E+02 s, Total CPU:      16.39 s
Time step:    0.134E+00 s, Total time:      0.13 s
Max CFL number:  0.26E-02 at (  9, 27, 10)
Max divergence:  0.13E-05 at (  6, 46, 29)
Min divergence: -0.13E-05 at (  6, 20,  3)
Max VN  number:  0.19E-02 at (  6, 20,  3)
Radiation Loss to Boundaries:       -0.002 kW

Time Step       2
Pressure Iterations:     1
Maximum Velocity Error:  0.24E-02 on Mesh   9 at (  39  35  12)
-------------------------------------------------------------
.......
```

DEVICE Activation Times

232	SD	569.6 s
233	SD01	468.2 s
234	SD02	441.9 s
235	SD03	572.8 s
236	SD04	397.6 s
237	SD05	443.9 s
238	SD06	481.5 s
239	SD07	392.2 s
240	SD08	442.8 s
241	SD09	64.9 s
242	SD10	56.2 s
243	SD11	85.6 s
244	SD12	63.5 s
245	SD13	57.2 s
246	SD14	87.0 s

CONTROL Activation Times

1	Exhaust Atrium	T	116.3 s
2	latch	T	56.2 s
3	or	T	56.2 s
4	Exhaust Other	T	116.3 s
5	latch2	T	56.2 s
6	or2	T	56.2 s

CPU Time Usage, Mesh 1

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	4664.79	5.02
MASS	2236.58	2.41
VELO	4146.52	4.46
PRES	986.65	1.06
WALL	2673.86	2.88
DUMP	482.15	0.52
PART	0.00	0.00
RADI	8624.57	9.29
FIRE	52.26	0.06
COMM	1324.61	1.43
SubTot	25192.00	27.13

CPU Time Usage, Mesh 2

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	216.12	0.23
MASS	101.66	0.11
VELO	265.23	0.29
PRES	73.38	0.08
WALL	121.21	0.13
DUMP	22.44	0.02
PART	0.00	0.00
RADI	412.21	0.44
FIRE	3.61	0.00
COMM	1324.61	1.43
SubTot	2540.47	2.74

CPU Time Usage, Mesh 3

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	608.90	0.66
MASS	289.84	0.31
VELO	615.26	0.66
PRES	175.32	0.19
WALL	322.63	0.35
DUMP	57.14	0.06
PART	0.00	0.00
RADI	878.10	0.95
FIRE	9.42	0.01
COMM	1324.61	1.43
SubTot	4281.21	4.61

CPU Time Usage, Mesh 4

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	1076.50	1.16
MASS	474.19	0.51
VELO	1006.90	1.08
PRES	287.61	0.31
WALL	562.66	0.61
DUMP	103.11	0.11
PART	0.00	0.00

RADI	1378.03	1.48
FIRE	15.54	0.02
COMM	1324.61	1.43
SubTot	6229.15	6.71

CPU Time Usage, Mesh 5

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	4890.26	5.27
MASS	2347.63	2.53
VELO	4456.67	4.80
PRES	1043.12	1.12
WALL	2827.34	3.04
DUMP	548.63	0.59
PART	0.00	0.00
RADI	8933.87	9.62
FIRE	70.90	0.08
COMM	1324.61	1.43
SubTot	26443.04	28.47

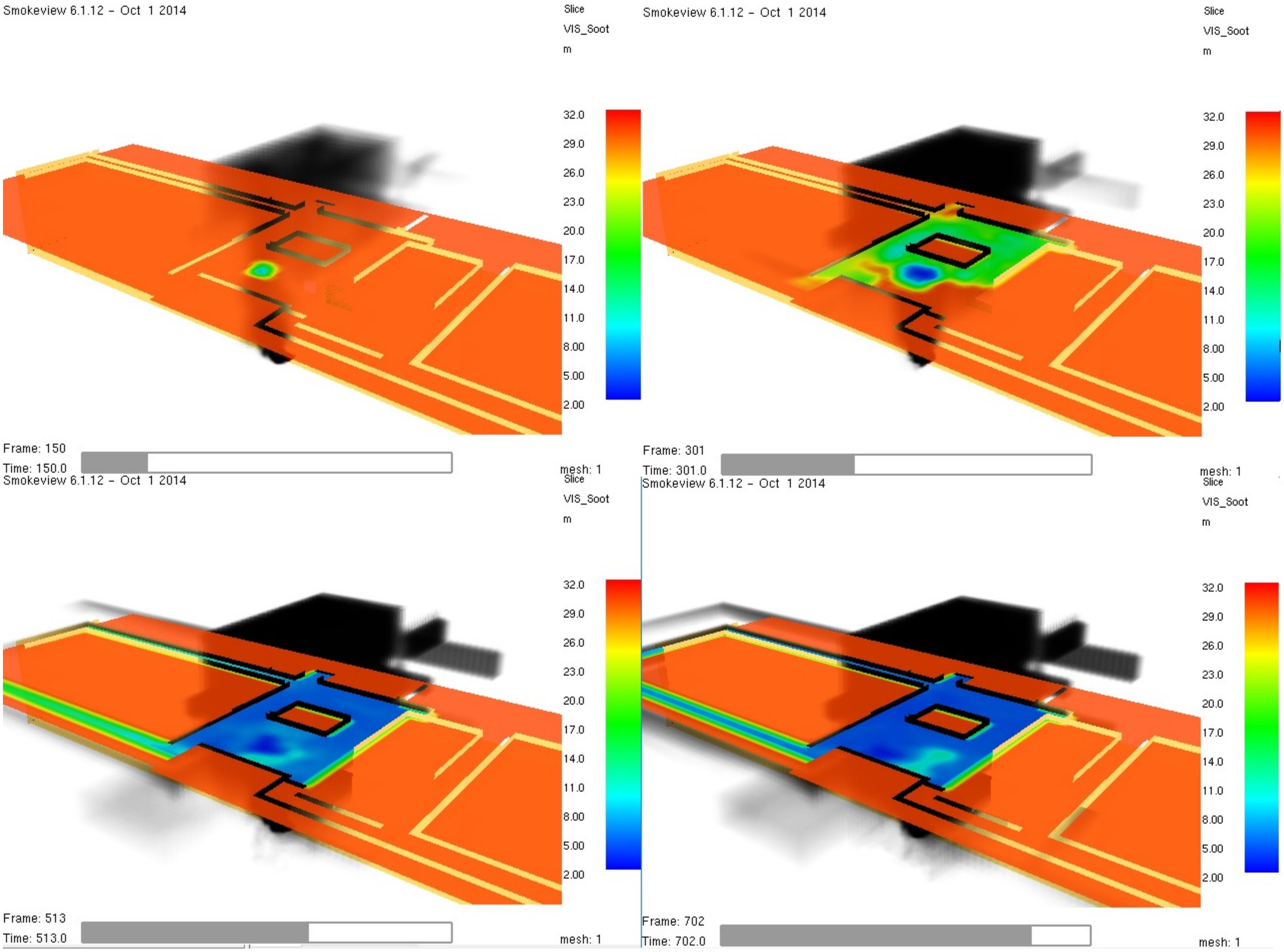
CPU Time Usage, Mesh 6

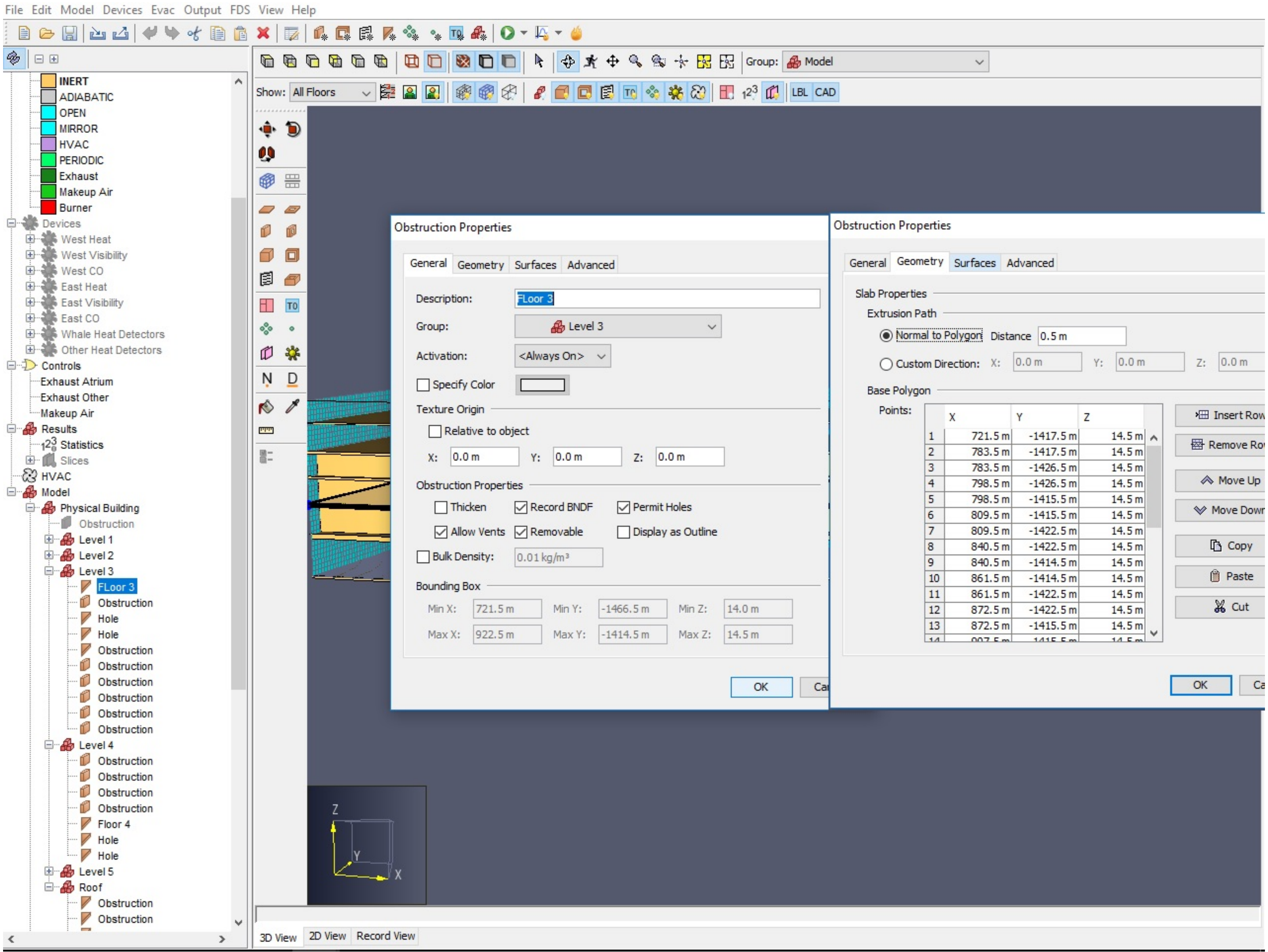
	CPU (s)	%
MAIN	92871.99	100.00
DIVG	1046.47	1.13
MASS	480.65	0.52
VELO	974.09	1.05
PRES	299.50	0.32
WALL	470.82	0.51
DUMP	99.22	0.11
PART	0.00	0.00
RADI	1420.35	1.53
FIRE	84.64	0.09
COMM	1324.61	1.43
SubTot	6200.35	6.68

CPU Time Usage, Mesh 7

	CPU (s)	%
MAIN	92871.99	100.00
DIVG	528.07	0.57
MASS	255.01	0.27

```
    VELO      547.93      0.59
    PRES      148.91      0.16
    WALL      299.48      0.32
    DUMP       55.24      0.06
    PART        0.00      0.00
    RADI      878.99      0.95
    FIRE       13.57      0.01
    COMM     1324.61      1.43
    SubTot   4051.81      4.36

CPU Time Usage, Mesh   8

           CPU (s)        %
    ----------------------------
    MAIN    92871.99    100.00
    DIVG      866.65      0.93
    MASS      387.25      0.42
    VELO      827.00      0.89
    PRES      229.63      0.25
    WALL      465.23      0.50
    DUMP       88.94      0.10
    PART        0.00      0.00
    RADI     1235.52      1.33
    FIRE       11.38      0.01
    COMM     1324.61      1.43
    SubTot   5436.21      5.85

CPU Time Usage, Mesh   9

           CPU (s)        %
    ----------------------------
    MAIN    92871.99    100.00
    DIVG     3825.28      4.12
    MASS     1841.71      1.98
    VELO     3413.08      3.68
    PRES      808.43      0.87
    WALL     2195.98      2.36
    DUMP      428.28      0.46
    PART        0.00      0.00
    RADI     7023.33      7.56
    FIRE       44.43      0.05
    COMM     1324.61      1.43
    SubTot  20905.13     22.51

Time Stepping Wall Clock Time (s):    92818.490
Total Elapsed Wall Clock Time (s):    92890.930

STOP: FDS completed successfully (CHID: ModelOpenMakeupAirOtherA)
```


Smokeview 6.1.12 - Oct 1 2014
Slice
VIS_Soot
m
32.0
29.0
26.0
23.0
20.0
17.0
14.0
11.0
8.00
5.00
2.00
Frame: 150
Time: 150.0
mesh: 1
Smokeview 6.1.12 - Oct 1 2014
Slice
VIS_Soot
m
Frame: 301
Time: 301.0
mesh: 1
Smokeview 6.1.12 - Oct 1 2014
Slice
VIS_Soot
m
Frame: 513
Time: 513.0
mesh: 1
Smokeview 6.1.12 - Oct 1 2014
Slice
VIS_Soot
m
Frame: 702
Time: 702.0
mesh: 1


File Edit Model Devices Evac Output FDS View Help
Obstruction Properties
General Geometry Surfaces Advanced
Description: FLoor 3
Group: Level 3
Activation: <Always On>
Specify Color
Texture Origin
Relative to object
X: 0.0 m Y: 0.0 m Z: 0.0 m
Obstruction Properties
Thicken Record BNDF Permit Holes
Allow Vents Removable Display as Outline
Bulk Density: 0.01 kg/m³
Bounding Box
Min X: 721.5 m Min Y: -1466.5 m Min Z: 14.0 m
Max X: 922.5 m Max Y: -1414.5 m Max Z: 14.5 m
OK
Obstruction Properties
General Geometry Surfaces Advanced
Slab Properties
Extrusion Path
Normal to Polygon Distance 0.5 m
Custom Direction: X: 0.0 m Y: 0.0 m Z: 0.0 m
Base Polygon
Points:
1 721.5 m -1417.5 m 14.5 m
2 783.5 m -1417.5 m 14.5 m
3 783.5 m -1426.5 m 14.5 m
4 798.5 m -1426.5 m 14.5 m
5 798.5 m -1415.5 m 14.5 m
6 809.5 m -1415.5 m 14.5 m
7 809.5 m -1422.5 m 14.5 m
8 840.5 m -1422.5 m 14.5 m
9 840.5 m -1414.5 m 14.5 m
10 861.5 m -1414.5 m 14.5 m
11 861.5 m -1422.5 m 14.5 m
12 872.5 m -1422.5 m 14.5 m
13 872.5 m -1415.5 m 14.5 m
Insert Row
Move Up
Copy
Paste
Cut
OK
Devices
West Heat
West Visibility
West CO
East Heat
East Visibility
East CO
Whale Heat Detectors
Other Heat Detectors
Controls
Exhaust Atrium
Exhaust Other
Makeup Air
Results
Statistics
Slices
HVAC
Model
Physical Building
Level 1
Level 2
Level 3
FLoor 3
Level 4
Floor 4
Level 5
Roof
3D View 2D View Record View

Appendix F

RWDI Wind Assessment

Tel: 519.823.1311
Fax: 519.823.1316

Rowan Williams Davies & Irwin Inc.
650 Woodlawn Road West
Guelph, Ontario, Canada
N1K 1B8

CONSULTING ENGINEERS
& SCIENTISTS

December 5, 2014

Mr. Joseph Ostafi IV, AIA, LEED AP BD+C
Vice President, Practice Leader, Science + Technology
HOK
211 North Broadway
Suite 700
St. Louis, MO 63102

Re: Exhaust Re-entrainment Design Review
Core Science Building
Memorial University of Newfoundland (MUN)
RWDI Reference No. 1401993

Email: joseph.ostafi@hok.com

Dear Joseph,

This document provides feedback and recommendations from RWDI's review of exhaust re-entrainment potential related to exhaust and intakes on the new Core Science Building at the St. John's campus of Memorial University of Newfoundland (MUN). The feedback provided herein is based on our review of information provided to RWDI between November 24th and December 4th, 2014, including architectural drawings, civil site plan, mechanical roof plan, and concept design report. We also consulted in-house information and results from previous wind tunnel studies for nearby sites on campus. The purpose of this review is to provide early feedback on the design of exhausts and intakes for the Core Science building, and to provide recommendations regarding the sources and receptors that should be modelled in the wind tunnel as part of RWDI's scope of work in support of detailed design.

BACKGROUND AND BUILDING INFORMATION

We understand that the new MUN Core Sciences Building will be constructed to address the need for additional space for the Faculty of Engineering and Applied Science. The building will include biology, chemistry, and computer science & engineering components. The proposed site is situated west of the Smallwood Centre (University Centre) in what is currently occupied by Parking Lots 16 and 16A, as illustrated in Figure 1.

Figure 1: Site Plan

The proposed building will be approximately 39m tall, and will be divided into three pavilions, connected by two large atria. Mechanical systems, including building exhausts and air intakes, will be located within the penthouse. The following exhaust sources of potential concern for re-entrainment were identified from floor plans and a penthouse plan provided to RWDI by Vanderweil Engineers:

- Fume Hood Exhaust Stacks (8 @ 20' high)
- Atrium Smoke Exhausts (4 with horizontal discharge)
- Perchloric Acid Exhaust (1 @ 20' high)
- Radioisotope Exhaust (1 @ 20' high)
- Cooling Towers (4 cells)
- Loading Dock

A layout of these exhausts, air intakes, and other potentially sensitive receptors on the Core Science Building as we currently understand them is shown in Figure 2. The locations of make-up air intakes are not shown, but we understand that the intent is to draw air from openings at or near ground level.

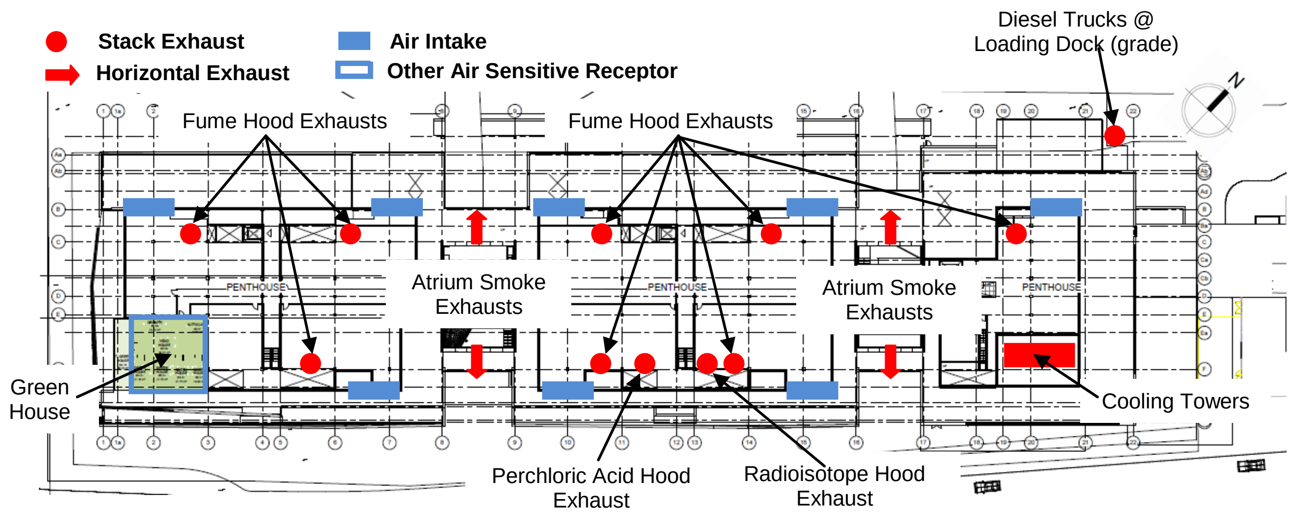


Figure 2: Layout of Key Core Science Exhaust Sources and Air Sensitive Receptors

In addition to exhausts on the Core Science penthouse, the project will also add two 1,500kW emergency diesel generators to the Utilities Annex, located north of the project. Other exhaust sources or air-sensitive receptors of potential concern for re-entrainment may exist at immediately surrounding existing buildings. Any such sources or receptors will be identified during a December 9th site visit by RWDI.

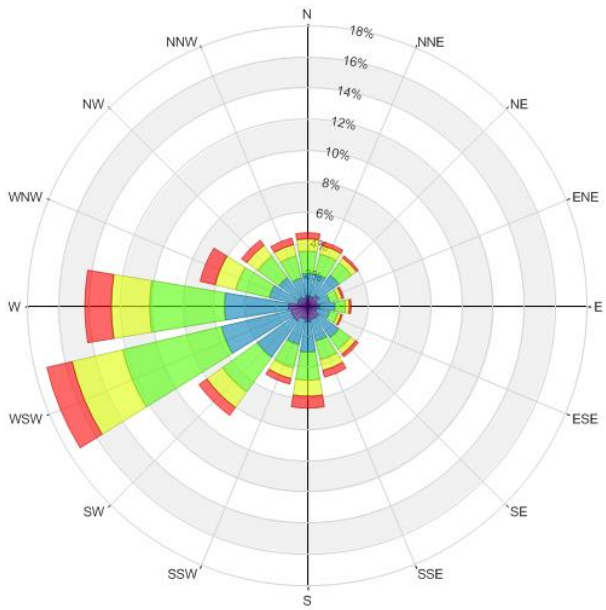
Note: We understand that the penthouse roof may also be home to a renewable energy demonstration laboratory including solar collectors and small wind turbines (under review by design team). RWDI does not have sufficient information to provide guidance for the placement of, or impact to the laboratory. If there is a need to consider impacts from the roof exhausts onto staff and students accessing the lab (presuming it is an outdoor space), this could have a significant impact on our results and design recommendations. We would like to specifically discuss this with you during the December 10th design team meeting.

RWDI's feedback regarding the penthouse exhausts and intakes, the loading dock, and utilities annex generators is provided below.

PREVAILING WIND CONDITIONS

Prevailing winds at the site originate from the west and west-southwest directions, as shown in the annual wind rose from St. John's International Airport (Figure 3). Winds from most other directions occur much less frequently. Although not shown, there is a slight shift in prevailing winds from west-southwest to west in the winter months.

Although all wind conditions should be considered for re-entrainment potential, the frequency of wind conditions leading to potential issues can be important in determining appropriate mitigation measures.



Wind Speed (km/h)	Probability (%)
Calm	2.1
1-10	13.2
11-20	30.2
21-30	30.4
31-40	15.4
>40	8.7

Figure 3: Wind Distribution Rose for St. John's International Airport (1953-2014)

SUMMARY OF FEEDBACK

We understand that due to the large physical size of the proposed air handling units, the locations of the Core Science penthouse air intakes must remain fixed. Therefore, our design feedback is focused on the design of the exhaust sources. RWDI will conduct a visit to the site on December 9th, 2014 in order to collect information on exhaust sources and air intakes on existing surrounding buildings which may be of significance from an exhaust re-entrainment perspective. Findings from the site visit will be used to further inform the detailed wind tunnel modelling phase of our work.

Manifolded Fume Hood Exhausts

- Positive design with each of eight stacks discharging from vertical, 20' tall stacks above the penthouse roof at flow rates between 18,000cfm and 29,000 cfm (min. velocity of 2,545 fpm).
- Recommended dilution criterion for fume hood exhaust expected to be met at all air intakes. It may be possible to reduce stack heights, and/or reduce minimum flow rates to further energy savings potential.
- Lower dilution levels are possible at greenhouse. Although a low probability event given prevailing westerly winds, greenhouse should be considered as a receptor.
- Recommend that manifolded fume hood exhausts be tested in the wind tunnel to evaluate:
    - Re-entrainment at intakes and greenhouse; and,
    - Potential to reduce stack height and flow rate (for greater fan energy savings).

Atrium Smoke Exhausts

- Concern is re-entrainment of smoke to make-up air intakes, reducing visibility and hindering egress. Also potential concern at stair pressurization intakes, depending on their location.
- We understand that make-up air will be supplied from openings at ground level, but understand that additional active air intakes may be required.
- Horizontal discharge configuration may result in undesirable level of re-entrainment at low-level natural openings during a fire, and will result in high levels of re-entrainment at active penthouse intakes (see Figure 4).

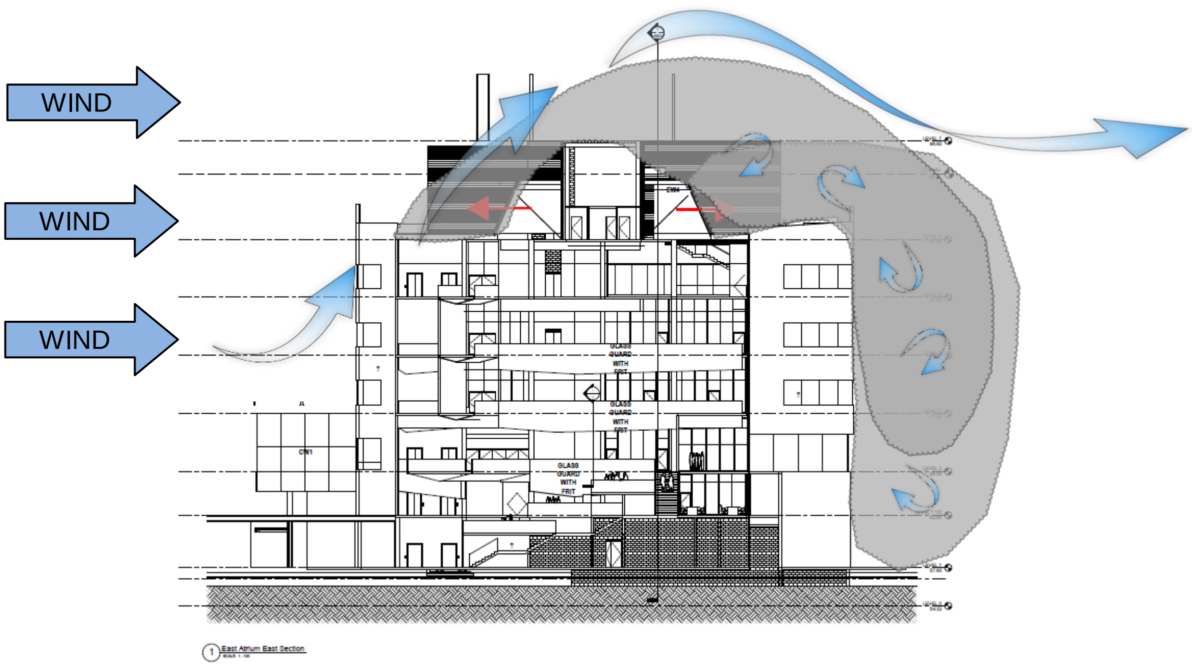


Figure 4: Illustration showing potential for re-entrainment of atrium smoke exhaust to lower levels with horizontal configuration – exhaust trapped in re-circulation zones

- Mitigation in the form of vertical stacks terminating at, or above the penthouse roof likely to be required.
- Normal mode intakes which do not provide make-up air to the atrium or for stair pressurization should be either shut down during a fire, or be equipped with smoke-activated dampers which close air supply when smoke is detected.
- We recommend that the proposed exhaust design be evaluated in wind tunnel to determine magnitude and wind frequency of undesirable levels of re-entrainment at make-up and pressurization intakes during a fire event. Vertical stack solution should also be evaluated. Atria are not connected, so can be treated as independent of one another.
- Locations for make-up air and pressurization intakes need to be clarified with design team.

Perchloric Acid and Radioisotope Hood Exhausts

- Concern with perchloric and radioisotope hood exhausts is re-entrainment of evaporative chemical emissions. We understand that radioactive emissions are being controlled by other means.
- Dedicated (i.e., non-manifolded) stacks have less exhaust flow and momentum; and are more likely to be overcome by wind and less able to escape roof wakes (see Figure 5).

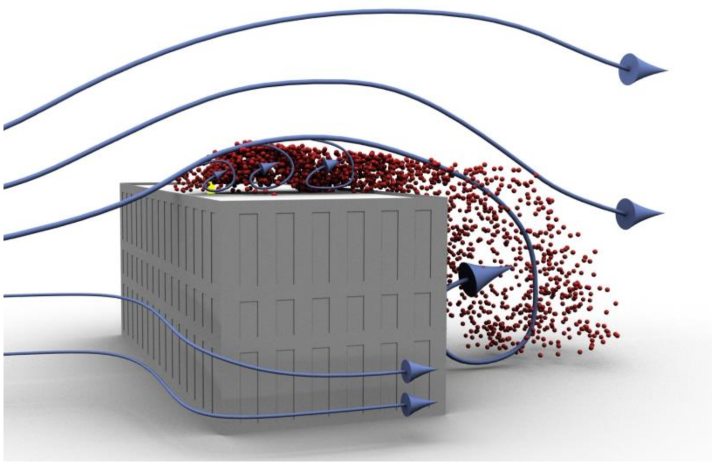


Figure 5: Exhaust from low momentum stack overcome by roof wakes which are formed due to aerodynamic effects of building

- The proposed 20' stacks are a positive design feature and will help exhaust escape roof wakes, but need to verify that stack height is adequate to meet dilution criteria.
- Significant dispersive benefit is possible by tightly clustering dedicated stacks with adjacent larger flow manifolded fume hood exhausts. To gain benefit, smaller stacks should be placed within one diameter of the larger, be at the same height, and discharge at similar exit velocities.
- We recommend that one representative dedicated fume hood exhaust be modelled in the wind tunnel to provide stack design recommendations for both the perchloric and radioisotope hood exhausts. Proposed design (stand-alone stack) and clustered solution should both be considered.

Cooling Towers

- No significant concern for re-entrainment at air intakes.
- Cooling towers should discharge at least even with penthouse roof to reduce potential for plume downwash and self-re-entrainment.
- Not recommended for additional detailed wind tunnel modelling.

Loading Dock

- No significant re-entrainment concerns identified to air intakes.
- Intakes are set back on the penthouse which is beneficial and provides greater protection from truck exhaust at grade.
- Limit idling of diesel vehicles to reduce potential for localized diesel odours.
- Not recommended for additional detailed wind tunnel modelling.

Generators at Utilities Annex

- Addition of two 1,500 kW emergency diesel generators to the Utilities Annex essentially doubles generator capacity at the existing building (currently there are four 800 kW units). Figure 6 illustrates their location.

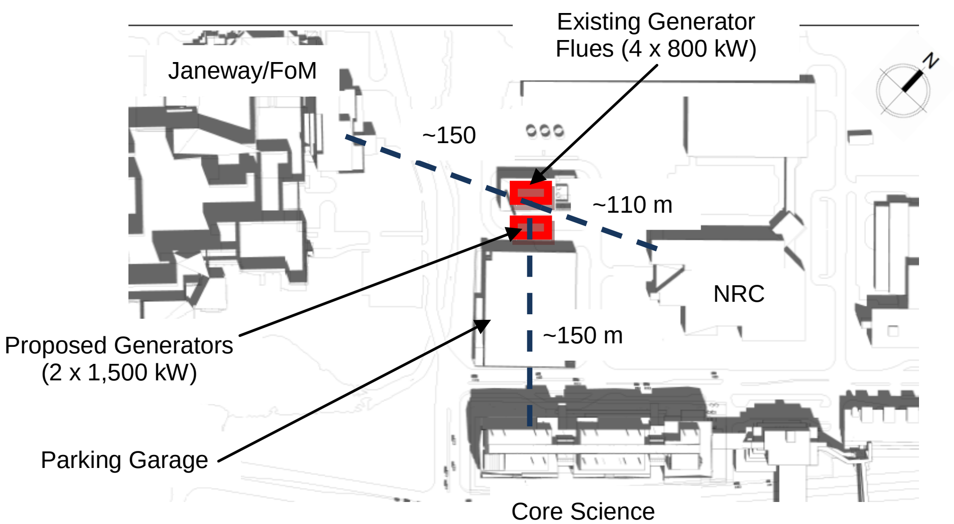


Figure 6: Location of Existing and Proposed Emergency Diesel Generators

- In order to reduce significant plume impacts on the adjacent parking garage, we recommend raising the stacks to discharge above the annex roof (similar to existing condition).
- Based on our review of wind tunnel data from previous RWDI study for the Faculty of Medicine (FoM) addition (RWDI Project #0940864), addition of the new generators is not expected to cause concern for pollutant levels at the existing FoM or Janeway Hospital, the existing NRC, or the proposed Core Science Building.
- Addition of new 1,500 kW generators will result in the potential for stronger odours at FoM/Janeway in the event of a campus power outage (i.e., all generators operate), but the overall probability for detectable and objectionable odours is not expected in increase significantly.

- There is potential for odour impacts at the proposed Core Science intakes which face the Utilities Annex. Worst-case impacts are expected to be similar in magnitude to those at FoM/Janeway, but the probability for detectable and objectionable odours will be somewhat higher due to northwest winds (blowing towards Core Science) being more frequent compared to northeast winds (that blow towards the Hospital).
- Highest potential for odour impacts may be at the NRC building due to alignment with prevailing westerly winds and closer proximity to the Utilities Annex. The locations of air intakes and/or other air sensitive receptors on this building will be verified during RWDI's December 9th visit to the site. Addition of the new generators will only be of greater concern to NRC if there is the potential for all generators to operate simultaneously during a campus outage. Otherwise, impacts will be similar to what is currently being experienced.
- In order to minimize the potential for odour complaints during normal operation, the new Core Science generators should be exercised separately from the existing units.
- We recommend that the proposed Utilities Annex generators be evaluated if:
    - There is a desire to quantify the probability for detectable and objectionable odours at the Core Science air intakes; or,
    - There is potential for both the proposed 1,500kW and all existing 800kW generators to operate simultaneously, either during a scheduled test or a power outage.

Comments on Renewable Energy Laboratory

We understand that the penthouse roof may also be home to a renewable energy demonstration laboratory including solar collectors and small wind turbines (under review by design team). RWDI does not have sufficient information to provide guidance for the placement of, or impact to the laboratory. If there is a need to consider impacts from the roof exhausts onto staff and students accessing the lab (presuming it is an outdoor space), this could have a significant impact on our results and design recommendations. We would like to specifically discuss this with you during the December 10th design team meeting.

NEXT STEPS AND RECOMMENDATIONS FOR DETAILED MODELLING

Our next step is to visit the project site on December 9th to survey immediately adjacent building and identify exhausts and intakes which may be of importance for our study. On December 10th, we will meet with the design team in St. John's to review our feedback and help progress the design. Following that meeting, we will proceed with the next phase of exhaust re-entrainment services which involves detailed wind tunnel tracer gas testing at one of RWDI's facilities. Based on our review of the current design, the following exhaust sources and scenarios are recommended for further modelling in the wind tunnel:

1. Manifolded Fume Hood Exhausts
    - Evaluate re-entrainment at Core Science intakes and greenhouse; and,
    - Evaluate potential to reduce stack height and flow rate (for greater fan energy savings).

2. Dedicated Fume Hood Exhausts (Perchloric/Radioisotope)
    - Evaluate proposed design (stand-alone stack, 20' tall); and,
    - Evaluate benefit of clustering with larger manifolded fume hood exhausts.
3. Atrium Smoke Exhausts
    - Evaluate proposed design to determine magnitude and frequency of undesirable levels of re-entrainment at make-up and pressurization intakes; and,
    - Evaluate vertical stack solution.
4. Utilities Annex Generators (optional):
    - Evaluate in the wind tunnel if there is a desire to quantify the probability for detectable and objectionable odours at the Core Science and other nearby existing air intakes; or,
    - Evaluate in the wind tunnel if there is potential for both the proposed 1,500kW and all existing 800kW generators to operate simultaneously.

CLOSING

We hope that the feedback presented in this design review report is helpful for the continued development of the Core Science design. Please do not hesitate to contact us should you have any questions or wish to discuss RWDI's feedback.

Yours very truly,

ROWAN WILLIAMS DAVIES & IRWIN Inc.

Martin Stangl, P.Eng.
Senior Engineer / Exhaust Re-entrainment Team Leader

Aimee Smith, M.Eng., P.Eng.
Project Director / Principal

c.c. Ken Jewer, P. Eng., Jewer Bailey Consultants Ltd. (email: ken.jewer@jewerbailey.com)

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CONSULTING ENGINEERS
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December 5, 2014

Mr. Joseph Ostafi IV, AIA, LEED AP BD+C
Vice President, Practice Leader, Science + Technology
HOK
211 North Broadway
Suite 700
St. Louis, MO 63102

Re: Pedestrian Wind Assessment
Core Science Building
Memorial University of Newfoundland (MUN)
St. John's, NL
RWDI Reference No. 1401993

Email: joseph.ostafi@hok.com

Dear Joseph,

Please find below a summary of the potential pedestrian wind comfort and safety conditions around the proposed Core Science Facility at Memorial University of Newfoundland (MUN) in St. John's, NL.

Wind Data

- The wind data for the area are summarized in Figure 1.
- The prevailing winds in the summer that will affect pedestrian comfort are primarily from the southwest through west.
- The prevailing winds in the winter are from the west-southwest through west-northwest. These winds are notably stronger in the winter than in the summer, and are the winds that could affect pedestrian safety.

General Wind Conditions

- The Core Science Facility will be located along the northwest side of Prince Philip Drive surrounded by campus buildings to the west and north. The site of the new facility will exposed to the prevailing west-southwesterly winds.
- The existing parking garage to the northwest is shorter than the new facility and will offer little protection from prevailing west-northwesterly winds in the winter.

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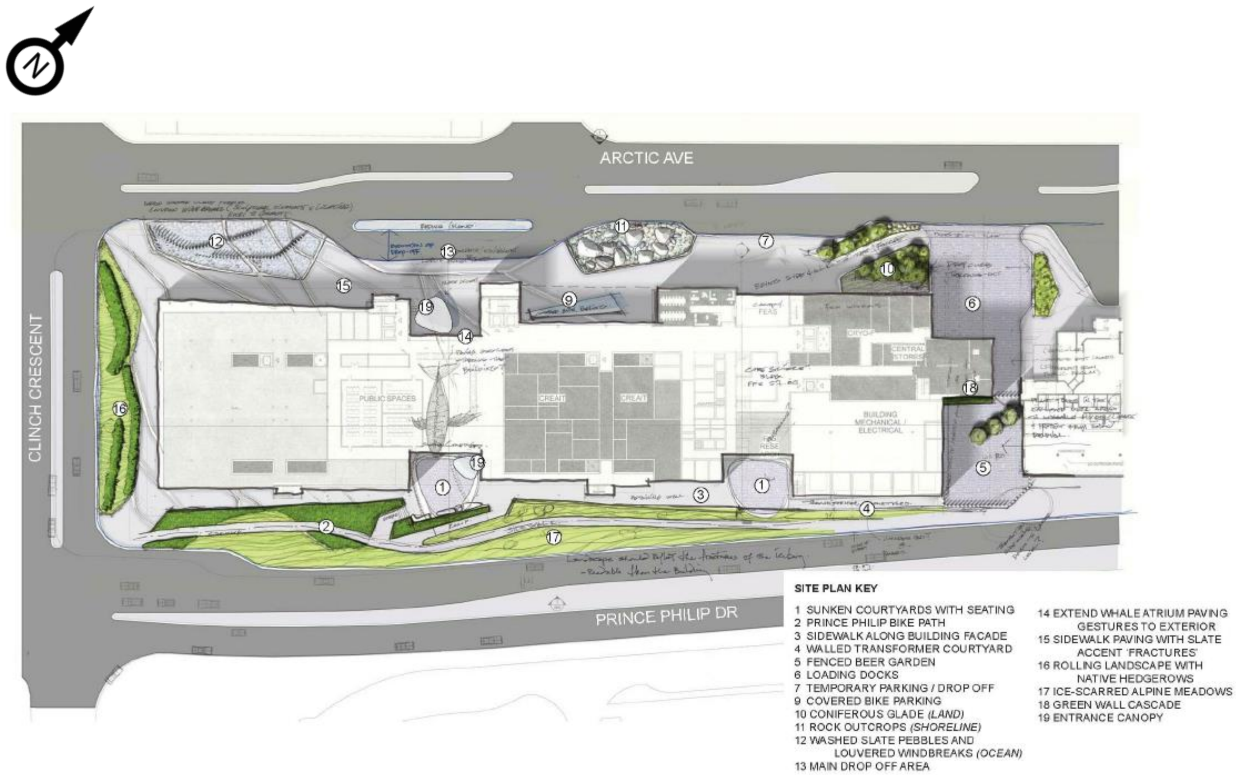
- There will be localized areas of accelerated winds along Arctic Avenue and Clinch Crescent that are discussed in more detail below.

- Building corners will experience the strongest winds particularly those at: the south building corner near Clinch Crescent and Prince Philip Drive (see Figure 2); the west building corner near Arctic Avenue and Clinch Crescent; and the north building corner west of the loading dock. The winds may be strong enough on occasion in the winter to be unsafe for pedestrians.

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	2.4	2.2
1-10	14.8	11.9
11-20	33.7	26.2
21-30	32.5	28.7
31-40	12.7	17.8
>40	3.9	13.2

Figure 1 – Directional Distribution of Winds at St. John’s International Airport (1953-2014)



L101 LANDSCAPE CONCEPT PLAN

Figure 2 – Site Plan and Landscape Concept Plan

Pedestrian Areas facing Prince Philip Drive

- There are numerous outdoor pedestrian areas facing Prince Philip Drive including: Sunken Courtyards with Entrances (Location 1 in the Site Plan in Figure 2), Prince Philip Bike Path (Location 2), Sidewalk along the Building Façade (Location 3), and Beer Garden (Location 5).
- These locations are well located in the downwind side of the new facility for the prevailing winds and two sunken courtyards are recessed from the main building facade. Acceptable wind conditions are predicted to occur throughout the year.
- The beer garden is generally sheltered by the proposed building from the prevailing winds. Increased wind activity may occasionally be experienced when winds are from the south, southeast, north, and northwest directions. The proposed trees are a positive wind control feature and underplants will reduce potential wind flow accelerations under canopy-type trees.

Pedestrian Areas Facing Clinch Crescent

- The building corners of the new facility along Clinch Crescent will be exposed to the prevailing westerly winds. Strong and uncomfortable winds are predicted to occur along pedestrian walkways adjacent to the new facility. In the winter time, the winds may be unsafe particularly at the corners of the buildings near the intersection of Clinch Crescent and Prince Philip Drive, and Clinch Crescent and Arctic Avenue.

- It is recommended that any pedestrian walkway be moved away from the building (e.g., reverse the proposed Rolling Landscape (Location 16 in Figure 2) with the walkways so the Rolling Landscape is nearest the building.

- Pedestrian access at the two building corners should be avoided. Installing landscaping (e.g., coniferous trees, rock garden similar to that proposed for Location 11, etc.) to prevent access is recommended.

Pedestrian Areas Facing Arctic Avenue

- There are numerous outdoor pedestrian areas facing Arctic Avenue including the two main entrances and pedestrian walkways.

- These areas will be exposed to prevailing west-southwesterly winds. However, there are a number of positive design features that will help mitigate strong winds including: the entrances are recessed from the main building façade, overhead canopies, colonnades, and extensive landscaping throughout the area will help create an environment suitable for active pedestrian activity.

- The north corner of the building adjacent to the loading area (between Locations 6 and 10 in Figure 2) will experience strong winds particularly in the winter time. The proposed Coniferous Glade (Location 10) will help to break up some of these winds. It is recommended that the landscaping be extended toward the building to prevent pedestrians walking between the new building and the Glade. Also, the area that will be most impacted is the Loading Area (Location 6), which is a non-pedestrian area.

Closing

We hope the enclosed information is helpful. Martin Stangl can discuss the enclosed with the design in more detail at next week's meeting.

As your design progresses, please do not hesitate to contact us for our input on pedestrian wind issues.

ROWAN WILLIAMS DAVIES & IRWIN Inc.

John J. Alberico, M.Sc., CCEP
Senior Project Manager / Principal

JJA/mdlc

c.c. Ken Jewer, P. Eng., Jewer Bailey Consultants Ltd. (email: ken.jewer@jewerbailey.com)

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CONSULTING ENGINEERS
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December 5, 2014

Mr. Joseph Ostafi IV, AIA, LEED AP BD+C
Vice President, Practice Leader, Science + Technology
HOK
211 North Broadway
Suite 700
St. Louis, MO 63102

Re: Roof Mechanical Snow Infiltration Design Review
MUN Core Science Building
St. John's, NL
RWDI Reference No. 1401993

Email: joseph.ostafi@hok.com

Dear Joseph,

Please find below a commentary on the proposed mechanical intake design as it relates to infiltration of snow for the proposed Core Science Facility at Memorial University of Newfoundland (MUN) in St. John's, NL.

Wind Data

- The winter wind data related to snow and drifting snow for the area are summarized in Figure 1.
- Winds stronger than 15 km/h (associated with drifting) in St. John's are primarily from the west-southwest through west-northwest.
- Snowfall is generally associated with stronger winds from northerly directions although the strongest winds during snowstorms can approach from a wide range of directions.
- Winds associated with recorded blowing snow conditions are most often from the northwest quadrant.
- Related to snow transport, winter winds in St. John's are generally strong and their impact on building air intake design is an important consideration.

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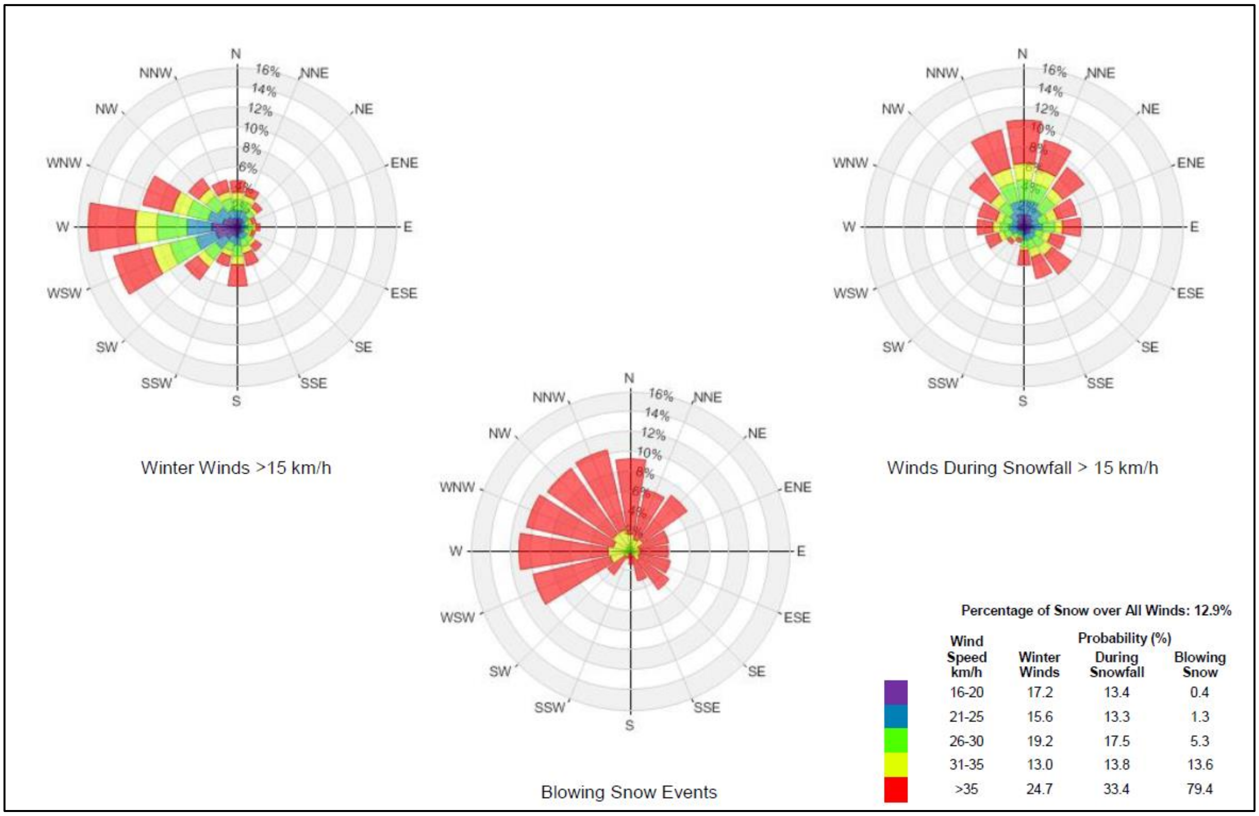

Figure 1 – Directional Distribution of Winds Associated with Snow at St. John's International Airport (1953-2014)

General Observations Regarding Proposed Design

- The Core Science Facility will be located along the north side of Prince Philip Drive surrounded by campus buildings to the west and north. The site of the new facility will be exposed to the prevailing west-southwesterly through northerly winter winds (see Figure 2).
- The primary axes of the roof plan are orientated with the long dimension aligned approximately with the northeast-southwest directions, making the broad side face many of the predominant snow and wind directions.
- Northwest-facing intakes will be exposed to wind-driven snow and roof surface drifting.
- Southeast-facing intakes will be exposed to drifting from roof of mechanical penthouse.

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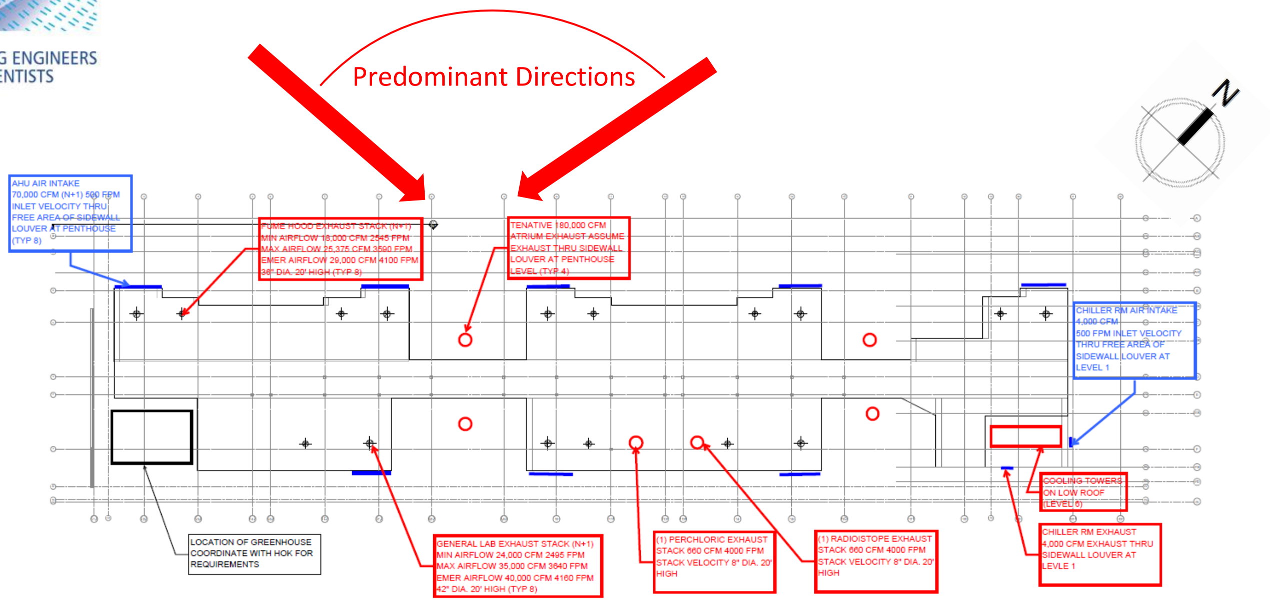


Figure 2 – Roof Plan Showing Air Intakes and Exhausts

Aerodynamics of Air Intakes

- A rule of thumb that has been employed sucessfully in the past is to keep the face velocity of intakes to a low value; face velocities well below 500 fpm are often targeted. The reason behind this is that higher velocities are capable of suspending greater amounts of snow and carrying it into the intake where it must be dealt with. The possible snow melt system suggested in your section shown in Figure 3 is an example.

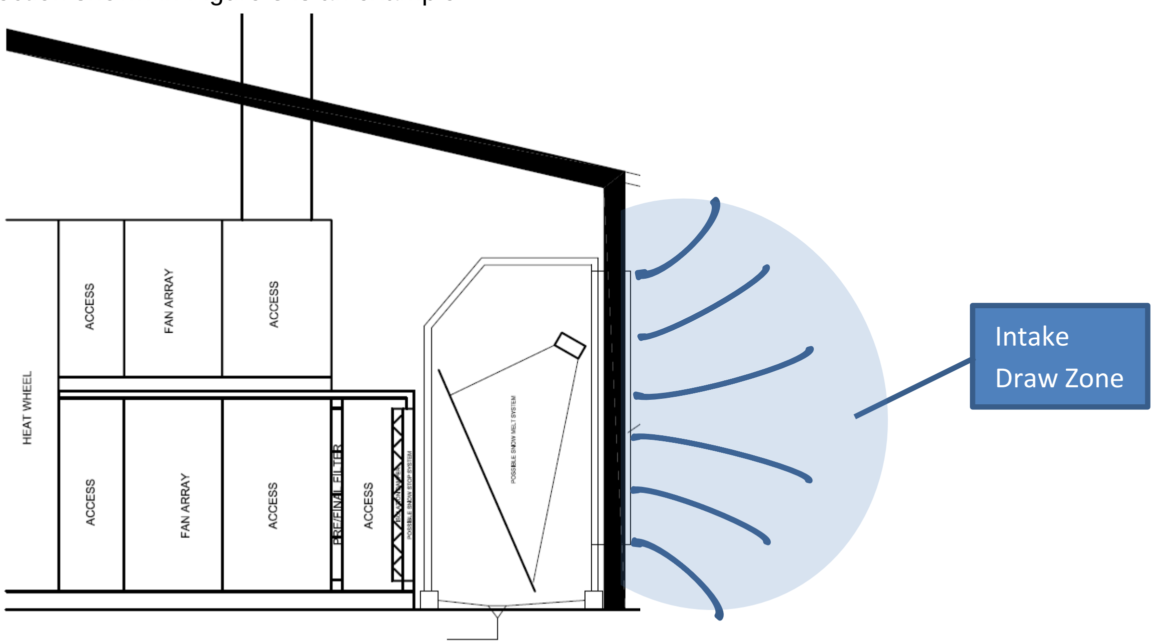


Figure 3 – Simple Louvre Example

An additional effect of high face velocity is to increase the volume of snow-laden air outside of the intake face that can be drawn into the intake, which means more snow is available to be entrained.

- An effective improvement is the weather shield that you have already shown in the section reproduced in Figure 4. From an airflow perspective, the combination of high curvature of the flow path and a critical portion of the flow travelling vertically upward can reduce the volume of snow reaching the interior of the plenum. It also serves as a physical separation of the intake from wind-driven snow in addition to snow drifting off of the roof above thus reducing the effective intake draw zone. The caveat, however, is that the draw of outside air is squeezed through the gap between the shield and the roof, which provides a reduced cross-sectional area and therefore higher local air velocities. This means that snow migrating to this region by drifting across the roof surface is readily able to be pulled upward toward the intake. Drifting snow concentrates near the roof surface.

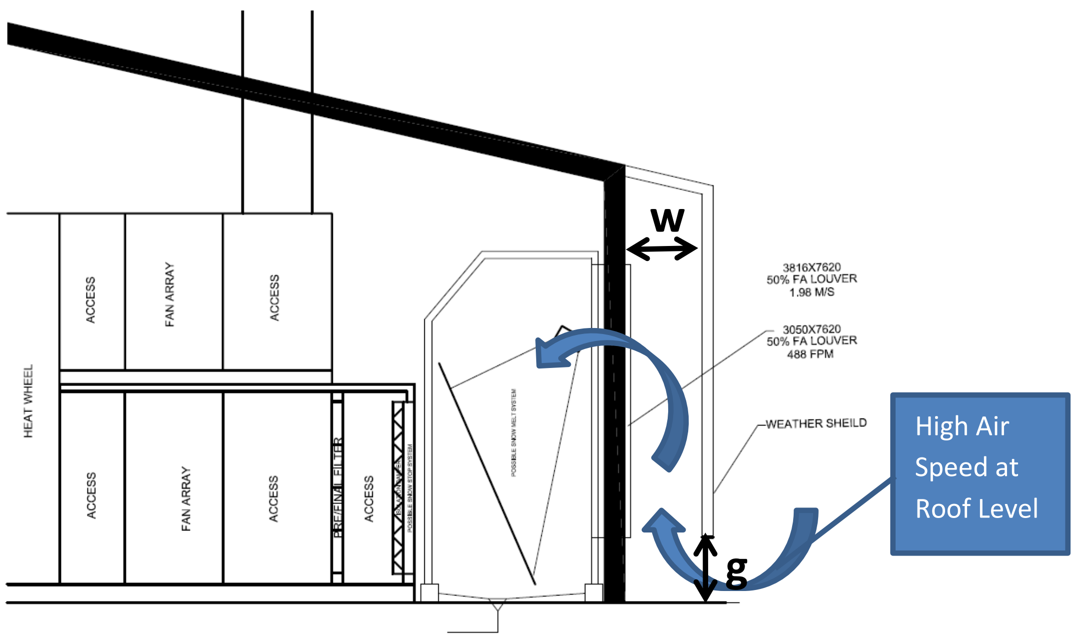


Figure 4 – Proposed Weather Shield on Intake

- To minimize this effect, the following is recommended:
  - The gap (g) should be kept higher than the depth of the snow pack associated with the design load for the roof. We recommend 1.5 m in this case.
  - The weather shield should stand off of the louvre face by an amount greater than the gap (w > g) to provide a slowing of the air speed through this region.

Roof Geometry

- The approach to minimizing snow entrained can also involve the geometry and aerodynamics of the roof itself. While there is generally little that can be done to reduce the direct impingement of wind-driven snow on the intake face, the effect of drifting can be modified. Intakes are typically situated on the wall of a mechanical unit, or penthouse as in the current design. These locations are also those that are prone to accumulation of drifting snow, either by being a wind-sheltered zone on a leeward face or a being a windward facing blockage to drifting. The concentration of drifting can be reduced by:
  - Minimizing the size of the penthouse roof that is a collector for snow available to drift;
  - Minimizing the size of the lower roof that the intake faces;
  - Incorporating parapets above the intake to intercept some of the snow drifting from the penthouse roof; and/or
  - Incorporating parapets or deflector walls on the lower roof to guide the drifted snow along paths farther away from the intake.

- As seen in the sample cross-section in Figure 5, your current design already includes parapets on the lower roof that the intakes face. These are a good feature and are expected to elevate the roof edge vortices as illustrated. This should produce the effect of drawing the drifting snow away from the intake face and causing it to accumulate closer to the roof edge behind the parapet.

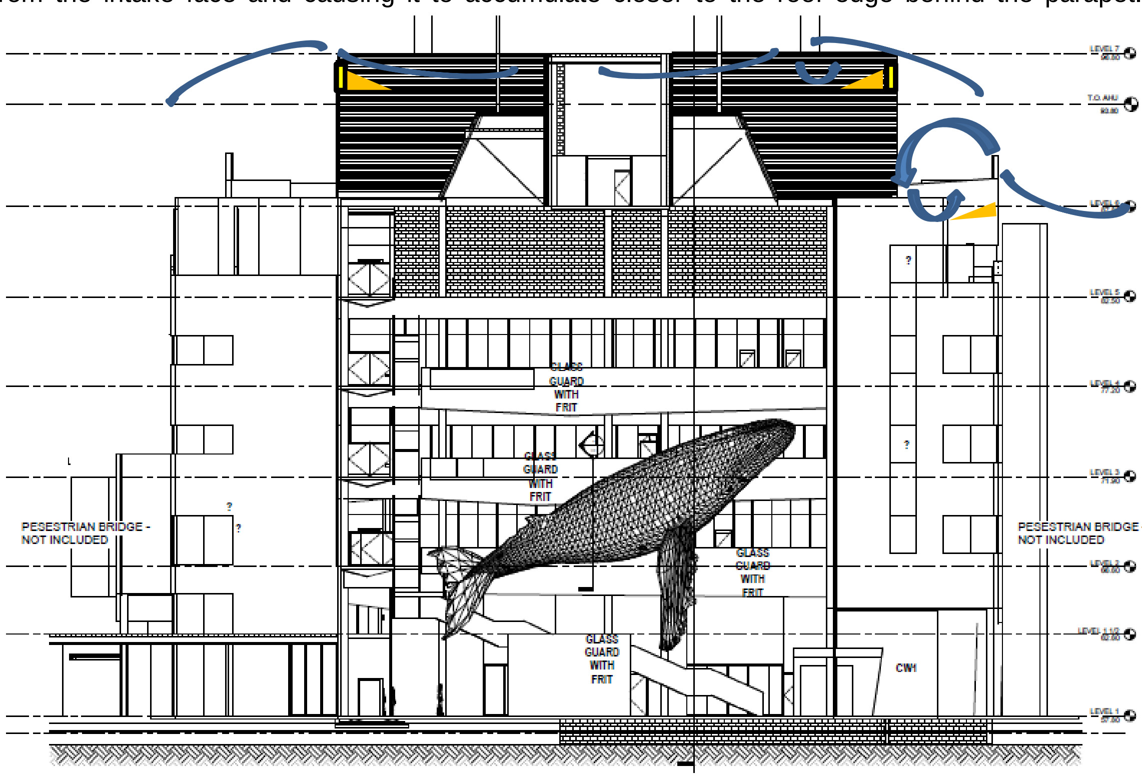


Figure 5 – Effect of Parapets on Roof Snow Drifting

- Also illustrated in Figure 5 is the possible addition of parapets on the penthouse roof edge to retain drifting snow and to help guide snow that drifts over the top of the parapet to travel farther from the intake face below. This is for general information since the proposed weather shields should be effective at reducing the entrainment for this source of snow.

- Additionally, the approach of predominant winds from angles not perpendicular to the intake faces will tend to drive drifting snow along the lower roof in a direction parallel to the face. The as-designed feature of breaking this roof surface up into non-continuous sections where it meets the atria should be effective in minimizing this drifting mechanism.

Closing

In a winter climate such as St. John's, there will be snow in the air near the intakes for a significant percentage of the time through snowfall, drifting and suspension. It is not realistic to expect that snow can be completely excluded from entering the plenum. However, we feel that the basic layout of the penthouse, the geometry of the top of the building and the incorporation of parapets and weather shields into the design are likely to perform as well as reasonably possible within normal architectural and mechanical design constraints. Modifications to the air intake design have been presented to further reduce the potential for snow infiltration into the building's penthouse air intakes.

Should you choose to alter these features as the design progresses, verification and optimization of alternatives could be possible through scale model testing.

ROWAN WILLIAMS DAVIES & IRWIN Inc.

Scott Gamble, P.Eng.
Technical Director / Principal

SLG/mdlc

c.c. Ken Jewer, P. Eng., Jewer Bailey Consultants Ltd. (email: ken.jewer@jewerbailey.com)

CONSULTING ENGINEERS
& SCIENTISTS

Memorandum

Tel: 519.823.1311
Fax: 519.823.1316
Rowan Williams Davies & Irwin Inc.
650 Woodlawn Road West
Guelph, Ontario, Canada N1K 1B8

Date: January 9, 2015 RWDI Reference #: 1401993

To: Joseph Ostafi IV, HOK — E-Mail: joseph.ostafi@hok.com
Ken Jewer, Jewer Bailey Consultants Ltd. — ken.jewer@jewerbailey.com

From: Mark Hallman, RWDI — E-Mail: mark.hallman@rwdi.com
Martin Stangl, RWDI — martin.stangl@rwdi.com
Aimée Smith, RWDI — aimee.smith@rwdi.com

RE: Exhaust Re-Entrainment Wind Tunnel Test Plan
Memorial University of Newfoundland – Core Science Facility
RWDI Reference No. 1401993

This memorandum outlines our wind tunnel exhaust re-entrainment test plan for the proposed Core Science Facility (CSF) at the Memorial University of Newfoundland. RWDI was retained to conduct this assessment to evaluate impacts from selected exhausts on the CSF at nearby proposed and existing air-sensitive locations.

This test plan communicates the details of the exhaust sources and receptor locations recommended for wind tunnel testing, as discussed in RWDI's December 5 design review report and December 22 conference call. The details of the recommended sources and receptors are summarized in Tables 1 and 3 and illustrated in Figure 1. Exhaust sources warranting further discussion with the design team are summarized in Table 2. The parameters in this document are based on the 60% Design Development drawing package received on January 6.

EXHAUST SOURCES TO BE EVALUATED

The exhaust sources recommended for evaluation in the wind tunnel are summarized in Table 1. The locations of these exhaust sources are depicted in Figure 1. **Please review and confirm that the parameters in Table 1 and locations in Figure 1 are correct.**

Table 1: Summary of Exhaust Sources Recommended for Testing

Exhaust Source Label & Description	Exhaust Flow Rate	Outlet Diameter	Outlet Velocity	Initial Stack Height
A1-A8 Manifolded Fume Hood Exhausts (F1.1 to F1.8)	29,010 cfm (13,690 L/s) each	35 in. (900 mm) each	4,240 fpm (22 m/s) each	20 ft (6 m) above roof penetration

- Three representative fume hood exhausts (one on each of the three pavilions) will be assessed in the wind tunnel, and recommendations will be applicable to all eight exhaust fans.
- Fan turndown to a minimum of 18,000 cfm each will be assessed for energy savings during low occupancy periods, should baseline results be favorable. Additionally, shorter stack heights will also be assessed if baseline results are positive.
- Additional stack height and increased exit velocity are two mitigation options that can be assessed in the wind tunnel, should mitigation be required.

Exhaust Source Label & Description	Exhaust Flow Rate	Outlet Diameter	Outlet Velocity	Initial Stack Height
B1-B2 Specialty Hood Exhausts (Represents F4.1 & F5.1)	660 cfm (310 L/s) each	8 in. (200 mm) each	1,890 fpm (10 m/s) each	20 ft (6 m) above roof penetration
• One exhaust stack representing the perchloric acid and radioisotope hood exhaust fans will be modeled in the wind tunnel. Results will be applicable to both exhausts and compared to the appropriate criteria based on chemical use in the hoods. These criteria do not address radionuclide particle emissions. • Additional stack height or clustering the dedicated exhausts near the larger manifolded fume hood exhaust stacks (e.g. A6 or A7 in Figure 1) can be pursued as mitigation options as necessary to improve dispersion. **Please confirm whether clustering the dedicated exhausts near the larger fans is a feasible option.**				

EXHAUST SOURCES FOR DISCUSSION

Eight atrium smoke exhaust fans (four per atrium – C1 to C8 in Figure 1) are currently proposed for the CSF, discharging at roof level above the two atria. The current understanding is that the exhausts will discharge from uncapped vertical stacks with parameters as summarized in Table 2. If this configuration will be maintained in the design, then RWDI does not anticipate re-entrainment concerns at make-up air locations and does not recommend these exhausts for further assessment. However, if the design team wishes to pursue horizontal exhaust louvers in lieu of vertical stacks, then RWDI recommends wind tunnel evaluation to determine if any re-entrainment concerns may exist with this configuration.

Two 1,500 kW diesel generators (D1-D2 in Figure 1, parameters listed in Table 2) will be added at the Utilities Annex, which will nearly double its emergency generator capacity (currently 4 x 800 kW = 3,200 kW). It is understood there are currently no existing complaints associated with the generators at nearby buildings, including the nearby NRC building.

Elevated pollutant levels of concern are not anticipated from these two generators at nearby air-sensitive locations, given their good separation distance. However, these exhausts can be assessed if there is a desire to understand the potential for undesirable diesel odor levels at nearby locations.

We would like to discuss these exhaust sources further with you. Please confirm if these sources should be included in the wind tunnel test plan and if so, please review and confirm that the parameters in Table 2 and locations in Figure 1 are correct.

Table 2: Optional Exhaust Sources for Wind Tunnel Testing

Exhaust Source Label & Description	Exhaust Flow Rate	Outlet Diameter	Outlet Velocity	Initial Stack Height
C1-C8 Atrium Smoke Exhausts (F3.1 to F3.8)	20,000 cfm (9,440 L/s) each	35 in. (900 mm) each (assumed)	3,000 fpm (15 m/s) each	10 ft (3 m) above roof penetration

Exhaust Source Label & Description	Exhaust Flow Rate	Outlet Diameter	Outlet Velocity	Initial Stack Height
• A 5 MW polyurethane foam fire burning in one of the atria represents the baseline condition, with all eight exhaust fans operating together. • It is understood that stair pressurization systems are not required for this building. It is also understood that make-up air will be supplied only by operable windows and doors at grade level, as depicted in Figure 2.				
D1-D2 2 x 1,500 kW Diesel Emergency Generators at Utilities Annex	11,060 cfm (5,220 L/s) each	16 in. (400 mm) each (assumed)	7,920 fpm	Flush with adjacent building roof
• The two generators will be assessed together at 100% of rated capacity as a worst-case operating scenario. • We understand that a scenario where all generators located in the Utilities Annex operate simultaneously is unlikely and therefore will not be assessed.				

RECEPTOR LOCATIONS RECOMMENDED FOR EVALUATION

The receptor locations currently recommended for wind tunnel testing are summarized in Table 3 and depicted in Figures 1 and 2. **Please review these receptors and confirm any other air-sensitive locations that may have been omitted.** The majority of existing buildings are well separated from the CSF such that exhaust re-entrainment concerns are not anticipated, apart from the potential at operable windows on the University Centre. Additionally, it is understood that the renewable energy laboratory proposed for the roof of the CSF will not normally be occupied by staff/students, which is why receptors have not been included.

Table 3: Summary of Receptor Locations Recommended for Testing

Receptor Label	Location	Description	Exhaust Sources Assessed at Receptor(s)
R1-R8	CSF Penthouse, Various Locations	Proposed Air Intake Louvers (Serving AHUs 1.1 to 1.8)	A1-A8, B1-B2, D1-D2
R9	Rooftop Greenhouse on CSF West Pavilion	Representative operable vent	A1-A8, B1-B2, D1-D2
R10	Rooftop of CSF East Pavilion	Representative air-sensitive location on proposed cooling towers	B1-B2
R11-R18	Ground level of CSF, north and south facades	Representative operable doors & windows providing atrium make-up air	C1-C8
R19	Penthouse level of University Centre, West façade	Representative operable window	A1-A8, B1-B2, D1-D2

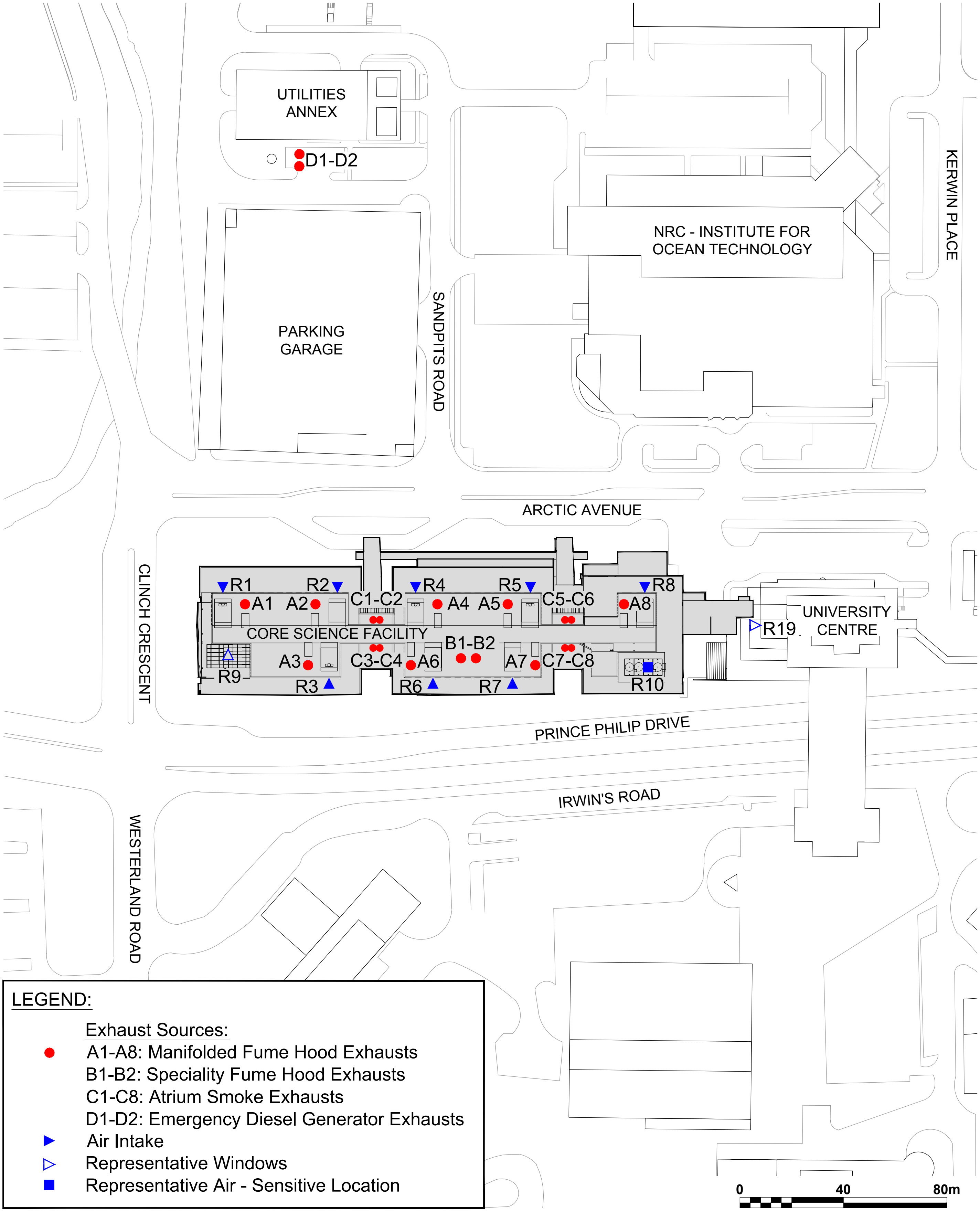
SUMMARY

The following items should be confirmed by the design team prior to wind tunnel testing:

1. Exhaust parameters summarized in Tables 1 and 2 and locations listed in Figure 1;
2. Whether or not clustering of the dedicated hood exhausts near the larger fans is a feasible option;
3. Receptor locations listed in Table 3 and Figures 1 and 2; and
4. Whether or not Sources C1-C8 and D1-D2 should be included in the wind tunnel testing program.

We will be able to discuss the contents of the test plan in more detail during the January 12 team coordination meeting. In the interim, please do not hesitate to contact us should you have any questions or concerns.

FIGURES



Location of Exhaust Sources and Receptors

Project North

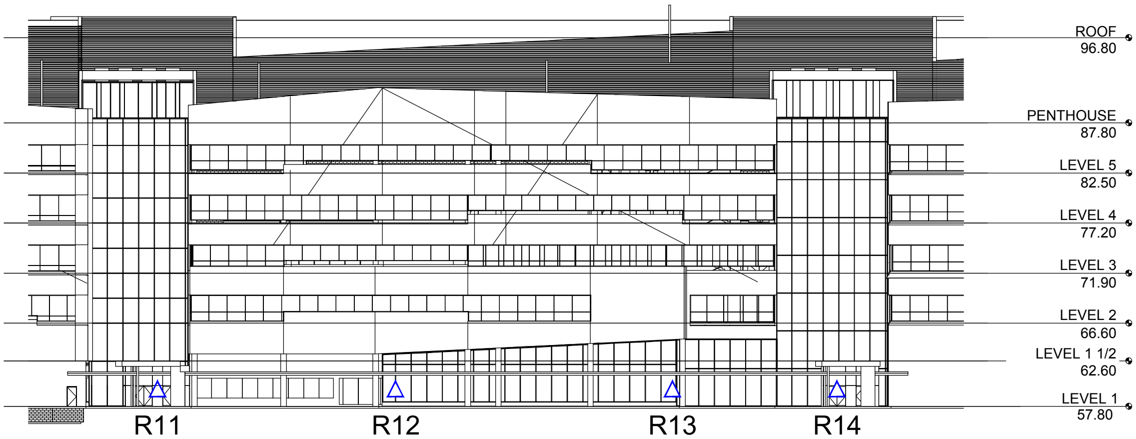
True North

Memorial University of Newfoundland Core Science Facility - St. John's, NL

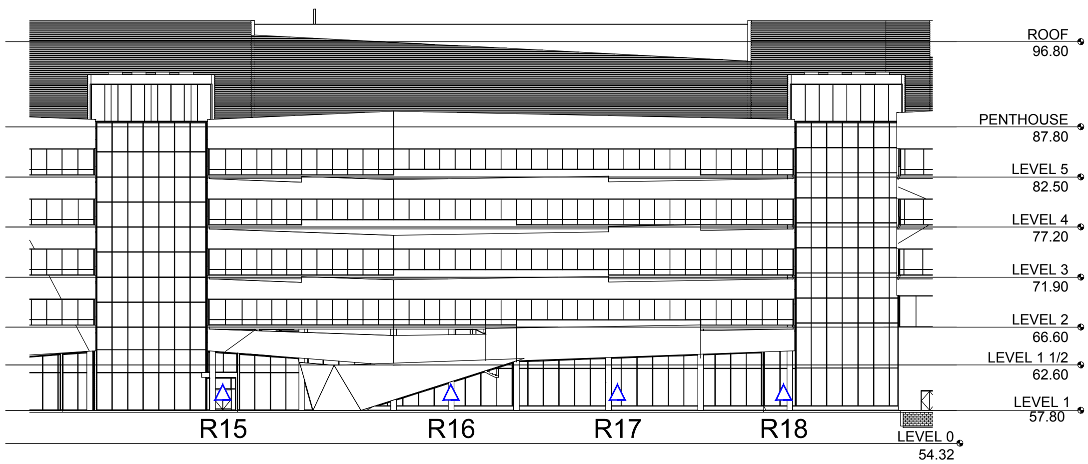
Project #1401993

Drawn by: ARM	Figure: 1
Approx. Scale:	1:2000
Date Revised:	Jan. 9, 2015

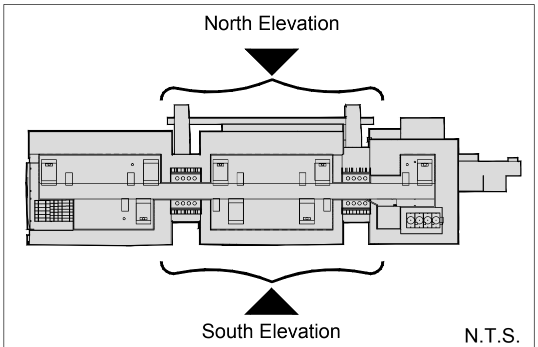
RWDI



NORTH ELEVATION



SOUTH ELEVATION



LEGEND:

▷ Representative Windows/Doors

0 10 30m

North and South Elevations of Centre Pavilion	Project North	True North	Drawn by: ARM	Figure: 2
			Approx. Scale:	1:800
Memorial University of Newfoundland Core Science Facility - St. John's, NL	Project #1401993		Date Revised:	Jan 9, 2015

RWDI

Appendix E

RJBEL Minutes of Meeting No. 1 dated December 11, 2014

RJ Bartlett Engineering Ltd

- Fire Protection Engineering
- Building and Fire Code Consulting

RJB Forensic
- Investigative Engineering

May 19, 2015

14024 L150519
Via: Email

Mr. Jeff Churchill
HOK
720 King Street West, Suite 505
Toronto, ON
M5V 2T3

Subject: Review of 95% Design Development Submission
MUN Core Science Facility
St. John's, NL

Dear Mr. Churchill:

RJ Bartlett Engineering Ltd (RJBEL) has conducted a general review of the 95% design development submission for the MUN Core Science facility, located in St. John's, NL, for compliance with the RJBEL " *95% Design Development Building Code Analysis"* dated May 19, 2015.

Comments specific to review of fire alarm and detection systems, sprinkler systems and fire department access will follow.

The following potential discrepancies are to be reviewed by the design team for further discussion.

Architectural

- The West Pavilion is currently served by a single exit from the L1 shell space and is required to have an additional exit in order to satisfy the maximum travel distance of 76 m. It is recommended a door be added along the north wall between Gridlines B-C and 5-6.

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- The rationale for the spatial separation, located in Table 2 of the aforementioned code analysis report, between the pedway/link and adjacent UC exit stair is based on a required 3 m distance for exit protection facilities to the UC exit stair. The pedway/link distance to the exit stair is less than the 3 m required, however the construction of the north face of the exit stair is block wall, achieving compliance with NBC Articles 3.2.3.1. and 3.2.3.13.

- The penthouse level is provided with elevated maintenance (steel grating) platforms and is not considered a storey for the purpose of building height in accordance with NBC Sentence 3.2.1.1.(6).

- The doors providing exit capacity through the pedway/link are to swing in the direction of travel to an exit. These doors can also be of double egress type (NFPA Clause 7.2.1.4.2.2.)

- The meeting space on L1 and classrooms on L2 (teaching lab in the centre pavilion and the sen. des. stud. in the east pavilion) have a calculated occupant load greater than 50 persons and therefore are to be considered assembly spaces. Subsequently, a major occupancy classification of Assembly is to be used for these spaces. This classification could potentially be considered as a subsidiary space to the primary function of the level. The intended use for the space is to be confirmed.

- Gas stores on L1 may be required to be provided with a door directly to the exterior depending on quantities stored. Refer to Section 4.10.1 of the aforementioned code analysis report.

- Common path of travel requirements are not achieved within two rooms of the penthouse level. The west pavilion room along gridlines B-D and 19-21 and the east pavilion room between gridlines B-E and 1b-4 are in excess of the 30 m requirement.

- In lieu of an enclosure at the upper termination of a vertical service shaft, these shafts could be permitted to terminate in a room or space having a use related to the purpose of the shaft, provided that the room or space is separated from the remainder of the building by construction having a minimum 1 h fire-resistance rating as discussed in Section 4.3.2. of the aforementioned code analysis report. This approach is not recognized by the NBC and is to be presented to the AHJ in the context of an alternative solution.

- There are multiple locations on L1 where the exterior wall of an exit enclosure could be exposed to fire from an opening in the exterior wall of the building. The opening in either wall is to be protected where the opening in the exterior wall is within 3 m horizontally. Protection of openings can be achieved by glass block, wired glass assembly, or other listed closures (NBC Article 3.2.3.13.).

- The chemical dispensing system intended for the L1 MCS central stores is currently under development for the existing chemistry building. Base building requirements are still to be finalized and coordinated with the MCS design team. This approach will be used to relieve the need for explosion venting from the space.

- The fire separation drawings are to be updated to reflect the requirements in Table 3 of the aforementioned code analysis report.

- The applicable references in terms of barrier-free/ADA requirements are governed by the NBC/CSA except as amended by the Consolidated Newfoundland and Labrador Regulation 1140/96.

- Level 1.5 exceeds the 10% area limitation permitted for a mezzanine space in a building with a total area of approximately 1,700 m^2 (equal to 20% of building footprint). Due to the presence of 2 h floor assemblies, this does not pose a concern with regards to building fire and life safety however the MCS is therefore considered to be a six storey building.

- It is understood that above-ground propane and diesel (emergency generator) storage tanks will be located adjacent the building in compliance with the requirements from Section 4.12 of the aforementioned code analysis report.

- Given the chemical quantities and inventory provided by MUN, it is understood that the Owner intends to operate the building within the Maximum Allowable Quantity parameters set forth in Section 4.10 of the aforementioned code analysis report. It is therefore the Owner's responsibility to manage the quantities stored therein. There is no expectation of any blast relief panels in the building with respect to flammable liquid storage.

If you have any questions, please contact our office.

Prepared By,

Kevin McCarthy, EIT

Reviewed By,

Ben Coles, M.Sc.E., MBA, P. Eng. (NL), PE
Fire Protection Engineer

KDM/hmc

Appendix F

NFPA 55 Table 6.3.1.1.

Table 6.3.1.1 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area

			Storage			Use — Closed Systems			Use — Open Systems	
Material	Class	High Hazard Protection Level	Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons
Cryogenic fluid	Flammable	2	NA	45[b, c]	NA	NA	45[b,c]	NA	NA	45[b,c]
	Oxidizing	3	NA	45[d, e]	NA	NA	45[d,e]	NA	NA	45[d,e]
	Inert	NA	NA	NL	NA	NA	NL	NA	NA	NL
Flammable, gas[f]	Gaseous	2	NA	NA	1000[d,e]	NA	NA	1000[d,e]	NA	NA
	Liquefied	2	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	LP	2	NA	NA	(300)[g,h,i]	NA	NA	(300)[g]	NA	NA
Inert gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA
Oxidizing gas	Gaseous	3	NA	NA	1500[d,e]	NA	NA	1500[d,e]	NA	NA
	Liquefied	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Pyrophoric gas	Gaseous	2	NA	NA	50[d,j]	NA	NA	50[d,j]	NA	NA
	Liquefied	2	NA	NA	(4)[d,j]	NA	NA	(4)[d,j]	NA	NA
Unstable (reactive) gas	Gaseous									
	4 or 3 detonable	1	NA	NA	10[d,j]	NA	NA	10[d,j]	NA	NA
	3 nondetonable	2	NA	NA	50[d,e]	NA	NA	50[d,e]	NA	NA
	2	3	NA	NA	750[d,e]	NA	NA	750[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Unstable (reactive) gas	Liquefied									
	4 or 3 detonable	1	NA	NA	(1)[d,j]	NA	NA	(1)[d,j]	NA	NA
	3 nondetonable	2	NA	NA	(2)[d,e]	NA	NA	(2)[d,e]	NA	NA
	2	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Corrosive gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Highly toxic gas	Gaseous	4	NA	NA	20[e,k]	NA	NA	20[e,k]	NA	NA
	Liquefied		NA	NA	(4)[e,k]	NA	NA	(4)[e,k]	NA	NA
Toxic gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA

NA: Not applicable within the context of NFPA 55 (refer to the applicable building or fire code for additional information on these materials).
NL: Not limited in quantity.
Notes:
(1) For use of control areas, see Section 6.2.
(2) Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column.
(3) The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in the building code.
[a]Measured at NTP [70°F (20°C) and 14.7 psi (101.3 kPa)].
[b]None allowed in unsprinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.
[c]With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood.
[d]Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms, as appropriate for the material stored. Where Footnote e also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.
[e]Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.* Where Footnote d also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.
[f]Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the applicable fire code.
[g]See NFPA 58, *Liquefied Petroleum Gas Code,* for requirements for liquefied petroleum gas (LP-Gas). LP-Gas is not within the scope of NFPA 55.
[h]Additional storage locations are required to be separated by a minimum of 300 ft (92 m).
[i]In mercantile occupancies, storage of LP-Gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-Gas containers.
[j]Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.
[k]Allowed only where stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.

Appendix G

Reported Chemical Quantities

Appendix A: Chemical Inventory of Room C-1016D

Liquid	Quantity
acetone	320L
hexanes	90L
pentane	20L
ethanol, anhy	110L
ethanol, 95%	100L
ethyl acetate	40L
ethyl ether	60L
methanol	80L
petroleum ether	30L
2 propanol	40L
toluene	26L
xylenes	20L
cyclohexane	30L
dichloromethane	50L
chloroform	50L
silicone oil	20L
acetaldehyde	4L
acetonitrile	40L
n amyl alcohol	12L
tert amyl alcohol	4L
benzene	20L
benzyl alcohol	500ml
1 bromopentane	6L
1 butanol	20L
iso butanol	10L
sec butanol	2L
2 butanone	4L
2 methyl 1 propanol	10L
tert butanol	10L
2 butoxyethanol	2L
butyl amine	500ml
1 chloroctane	500ml
carbon tetrachloride	10L
cyclopentanol	500ml
decane	100ml
cyclohexanol	1L
cyclohexene	2L
1,2 dichloroethane	1L
acetone d4	100g

Appendix A: Chemical Inventory of Room C-1016D

Liquid	Quantity
benzene d6	25G
chloroform d	3Kg
deuterium oxide	600g
dimethyl sulfoxide d6	100G
methanol d4	100G
dichloromethane d2	60G
toluene d8	20G
diethyl maleate	1L
diethylethylenediamine	2L
dimethylformamide	10L
dimethylsulfoxide	4L
ethyl acetoacetate	1L
ethyl benzoate	1L
ethylenediamine	1L
formaldehyde	1L
formic acid	4L
heptane	1L
methyl acetate	10L
methylamine	2L
methyl benzoate	2L
2 hexanol	100ml
3 hexanol	100ml
hexadecane	100ml
1 octanol	1L
2 octanol	1L
piperidine	100ml
propionic acid	500ml
salicylaldehyde	500ml
p tolualdehyde	100ml
triethanolamine	500ml
bath oil, high temp	8L

Chemical Inventory Physical Sciences Stores

Chemical Name	Hazard Class	Location	Max. Qty.
acetic acid, glacial, 99%	Corrosive	C1016C	30L
ammonium hydroxide, 30%			30L
hydrochloric acid, 38%			60L
nitric acid, 70%			25L
sulfuric acid, 98%			30L
acetic anhydride			1L
acetyl chloride			1L
aluminum chloride			2Kg
benzoyl chloride			500G
bromine			2L
calcium oxide			3Kg
hydrobromic acid			1L
iodine			500g
hydrochloric acid, conc. to make 0.1N			20ea
hydrochloric acid, conc. to make 1N			12ea
phosphoric acid, 85%			5L
phosphorous pentoxide			2Kg
potassium hydrogen flouride			500G
potassium hydrogen sulfate			1Kg
potassium hydroxide			20Kg
sodium hydroxide, conc. to make 0.1N			36ea
sodium hydroxide, conc. to make 1N			12ea
sodium hydroxide			24Kg
stannous chloride			1Kg
zinc chloride			3Kg
vinegar			20L
bleach, 6% hypochlorite			20L
ammonium ceric nitrate	Oxidizer	C1016C	500G
ammonium nitrate			2Kg
barium nitrate			2Kg
calcium nitrate			2Kg
copper II nitrate			3Kg
lead III nitrate			4Kg
hydrogen peroxide, 30%			15L
mercury II nitrate			200G
periodic acid			200G
potassium chlorate			500G
potassium iodate			500G
zinc nitrate			3Kg
potassium permanganate			4Kg
silver nitrate			2Kg

sodium nitrate			1Kg
sodium peroxide			500G
strontium nitrate			500G
barium chloride	Poison	C1016C	1Kg
2,2-dipyridal			25G
molybdenum hexacarbonyl			100G
ethyl iodide			500ML
lead IV oxide			500G
mercury II oxide, red			25G
nickel II bromide			500G
phenol			500G
potassium binoxalate			6Kg
potassium cyanide			500G
sodium cyanide			500G
potassium oxalate			1Kg
potassium bitartrate	General Storage	C1016C	1Kg
potassium carbonate, anhy			4Kg
potassium carbonate			2Kg
potassium chloride			5Kg
potassium iodide			9Kg
potassium sulfate			500G
silver acetate			100G
silver chloride			500G
silver iodide			100G
sodium acetate			12Kg
sodium bicarbonate			10Kg
sodium bisulfite			3Kg
sodium borate			3Kg
sodium bromide			1Kg
sodium carbonate, anhy			4Kg
sodium carbonate			3Kg
sodium chloride			5Kg
sodium meta-bisulfite			4Kg
sodium iodide			1KG
sodium sulfate			2Kg
sodium sulfate, anhy			6Kg
sodium sulfite			1Kg
sodium thiosulfate			15Kg
sulfur, lumps			2Kg
tin, metal			1Kg
tin, foil			500G
zinc, foil			1Kg
zinc, mossy			1Kg
zinc bromide			1Kg

zinc sulfate			2Kg
salt, table			100Kg
sparkleen			50Kg
silica gel, 230-400 mesh, 60A			30Kg
aluminum sulfate			1Kg
ammonium bicarbonate			1KG
ammonium bromide			3KG
ammonium carbonate			500G
ammonium chloride			4Kg
boiling chips			1Kg
boric acid			1Kg
bromothymol blue			10G
buffer salt, pH 4.01			12PK
buffer salt, pH 6.86			12PK
calcium carbonate			1Kg
calcium chloride, anhy			8Kg
calcium chloride			2Kg
calcium sulfate			1Kg
butylated hydroxytoluene			100G
copper, metal sheet			500G
copper, wire, 18ga			4ea
copper II sulfate			3Kg
2,3 dimethoxybenzaldehyde			100G
3,5 dinitrobenzoic acid			500G
ethylene glycol			6L
drierite, indicating			10Kg
drierite, non-indicating			10Kg
ferrous ammonium sulfate			8Kg
ferrous sulfate			1Kg
fluorescein			25G
graphite, powder			500G
lead, metal sheet			500G
naphthalene			500G
potassium acetate			500G
potassium biphthalate			3Kg
phenolphalein			100G
mineral oil			8L
magnesium sulfate			4Kg
magnesium sulfate, anhy			5Kg
sand, acid washed			6Kg
calcium hydride	Flammable Solid	C1016C	300G
magnesium, ribbon			200G
sodium, metal			100G
sodium methoxide			500G
charcoal, lumps			2KG

zinc, dust			3KG
charcoal, lumps			2Kg
zinc, dust			3Kg
acetone	Flammable Liquid	C1016D	260L
hexanes			90L
pentane			20L
ethanol, anhy			90L
ethanol, 95%			75L
ethyl acetate			35L
ethyl ether			60L
methanol			80L
petroleum ether			30L
2 propanol			20L
toluene			24L
xylenes			20L
cyclohexane			20L
dichloromethane			40L
chloroform			40L
silicone oil			20L
acetaldehyde			3L
acetonitrile			40L
n amyl alcohol			4L
tert amyl alcohol			4L
benzene			20L
benzyl alcohol			500ml
1 bromopentane			1L
1 butanol			4L
iso butanol (2 methyl 1 propanol)			10L
sec butanol			2L
2 butanone			4L
tert butanol			4L
2 butoxyethanol			2L
butyl amine			500ml
1 chlorooctane			500ml
carbon tetrachloride			10L
cyclopentanol			500ml
decane			100ml
cyclohexanol			1L
cyclohexene			2L
1,2 dichloroethane			1L
acetone d6			150g
benzene d6			30G
chloroform d			3000G
deuterium oxide			600g
dimethyl sulfoxide d6			100G
methanol d4			100G

dichloromethane d2			60G
toluene d8			20G
diethyl maleate			1L
diethylethylenediamine			1L
dimethylformamide			10L
dimethylsulfoxide			4L
ethyl acetoacetate			1L
ethyl benzoate			1L
ethylenediamine			1L
formaldehyde			1L
formic acid			4L
heptane			1L
methyl acetate			6L
methylamine			2L
methyl benzoate			2L
2 hexanol			100ml
3 hexanol			100ml
hexadecane			100ml
1 octanol			1L
2 octanol			1L
propionic acid			500ml
salicylaldehyde			500ml
p tolualdehyde			100ml
triethanolamine			500ml
bath oil, high temp			8L
nitrogen, size 50	Non Flam Gas	FL1000	16ea
helium, size 50			3ea
argon, size 50			2ea
medical air, size 44			2ea
oxygen, size 44			2ea
ammonia, size 2	Corrosive Gas	FL1000	1ea
nitrogen/hydrogen mixture, size 44	Flam Gas	FL1000A	2ea
hydrogen, size 16			1ea
iso butane, size 2			1ea
acetone	Flammable Liquid	FL1001	600L
ethanol, 95%			250L
ethanol, anhy			150L
cyclohexane			40L
ethyl acetate			240L
ethyl ether, anhy			200L
hexanes			300L

methanol		200L
pentane		20L
petroleum ether, 30-60		40L
2 propanol		60L
toluene		20L
xylenes		20L
tetrahydrofuran		80L
dichloromethane	Combust. Liquid	300L
chloroform	Non-Flam liquid	120L
Misc. Waste for Disposal		1400L
		4060L

Life Sciences Store - Outside Cylinder Storage - Area 6

Part Number	Gas Name	Company	Date put in stock	QTY	Min	Max	Hazard Class
R1000	Air Medical - USP	N/A	Ongoing	3	2	5	2.2 - Non Flam Gas
R1050	95%O2+5%CO2	N/A	Ongoing	8	6	10	2.2 - Non Flam Gas
R1100	Carbon Dioxide Industrial	N/A	Ongoing	7	7	10	2.2 - Non Flam Gas
R1150	Helium UHP	N/A	Ongoing	11	6	12	2.2 - Non Flam Gas
R1200	Nitrogen K Grade	N/A	Ongoing	8	10	15	2.2 - Non Flam Gas
R1350	Hydrogen U.H.P.	N/A	Ongoing	1	0	1	2.1 - Flam Gas
R1580	Medical Oxygen USP Size 44	N/A	Ongoing	3	2	4	2.2 - Non Flam Gas
R1600	Oxygen UHP 99.9%	N/A	Ongoing	3	1	3	2.2 - Non Flam Gas
Not LSS	Propane	Biology	Unknown	1	na	na	2.1 - Flam Gas
Not LSS	Nitrogen (small tank)	Biology	Unknown	1	na	na	2.2 - Non Flam Gas
Not LSS	Carbon Dioxide	Biology	Unknown	2	na	na	2.2 - Non Flam Gas
Not LSS	Ethane (label hard to read)	Biology	Unknown	1	na	na	2.1 - Flam Gas

http://www.airliquide.ca/en/gases-for-our-customers/msds/gases-msds-10.html

Biochemistry - SN-1104C - Chemical Storage Inventory - SN1104C

Name	Chemical Name	Company	Date put in stock	Amount in Storage	Hazard Class	WHIMS & MSDS on Hand	Container - Extra Information & Barcode #s
V. Booth	Acetonitrile A998-4 HPLC Grade	Fisher	June.26.2013	(1 of 4L) 8 L	3 - Flammable Liquids	B2,D1A,D2B	9,353
	Acetonitrile A998-4 HPLC Grade	Fisher	Sept13.2013	(4 of 4L) 16L	3 - Flammable Liquids	B2,D1A,D2B	9355;9356;9357;9358
	Chloroform C574-4, certified ACS	Fisher	Dec, 2004	(2 of 4L) 8 L	6.1 - Toxic substances	D1B,D2A,D2B	Spectranalysed 9359;9360
	N,N-Dimethylformamide , D119-4	Fisher	June.26.2013	(3 of 4L) 12L	3 - Flammable Liquids	B3,D1B,D2A,D2B	9364;9365;9366
	N,N-Dimethylformamide , D119-4	Fisher	April 22 2013	(2 of 4L) 8 L	3 - Flammable Liquids	B3,D1B,D2A,D2B	9363;9361
	Methanol A412P-4 ACS						
Student Labs	Methanol A454-4	Fisher	Aug 4/06	(4 of 4L) 16L	3 - Flammable liquids	B2,D1B,D2B	9367;9368;9375;9376
	Methanol A454-4	Fisher	Sept 7/07	(6 of 4L) 24 L	3 - Flammable liquids	B2,D1B,D2B	9369;9370;9371;9372;9373;9374
	Chloroform C607-4	Fisher	July 6/07	4L	6.1 - Toxic substances	D2A,D2B,D1B	10229
	Chloroform C298-4	Fisher	Aug 4-06	(7 of 4L) 28L	6.1 - Toxic substances	D1B,D2A,D2B	10222;10223;10224;10225;10226; 10227;10228
	Ethylene Glycol Monoethyl Ether	Fisher	??	(2 of 1L) 2L	Not regulated	D1B,D2A	Pat Mansfield EXPIRED 1990 10230;10231
Rob Brown	Ethyl Acetate E 196-4	Fisher	Mar 21/11	(1 of 4L) 4L	3 - Flammable liquids	B2	9380
	Petroleum Ether E120-4	Fisher	Mar21/11	(1 of 4L) 4L	3 - Flammable liquids	B2,D2A	9381
	N-Hexane H307-4	Fisher	Mar21/11	(1 of 4L) 4L	3 - Flammable liquids	B2,D2A,D2B	9382
	Chloroform C607-4 HPLC	Fisher	Mar21/11	(3 of 4L) 12 L	6.1 - Toxic substances	D1B,D2A,D2B	9377;9378;9379
	Methanol A456-4	Fisher			3 - Flammable liquids	B2,D1B,D2B	
JT Brosnan	Hexane ACS	BDH	2012	4L	3 - Flammable liquids	B2,D2A,D2B	Given by Les McFadden 9327
	Methanol A456-4	Fisher		0	3 - Flammable liquids	B2,D1B,D2B	
	methanol A452SK-4, HPLC	Fisher		0	3 - Flammable liquids	B2,D1B,D2B	
	Scinti verse™ SX16-4	Fisher	April 24/09	(3 of 4L) 12L	3 - Flammable liquids	B2,D2B	E Cocktail 9338;9339;9340
	Acetonitrile A998-4 HPLC	Fisher	Jan-11	(1 of 4L) 4L	3 - Flammable liquids	B2,D1A,D2B	9336
	Acetonitrile A998-4 HPLC	Fisher	ND	(4 of 4L) 16L	3 - Flammable liquids	B2,D1A,D2B	3 of these Dr. Liu crossed out 9332;9333;34135
	Acetonitrile A996-4 Optima	Fisher	ND	(1 of 4L) 4L	3 - Flammable liquids	B2,D1A,D2B	Dr. Liu crossed out 9330
	Acetonitrile A996B-4 Optima	Fisher	ND	(1 of 4L) 4L	3 - Flammable liquids	B2,D1A,D2B	9331
	Toluene T313-4	Fisher	Mar-03	(1 of 4L) 4L	3 - Flammable liquids	B2,D2A,D2B	Scintanalyzed 9329
	Acetonitrile CHROMOsolv PLUS HPLC	Sigma	Dec-08	(12 of 4L) 48L	3 - Flammable Liquids	B2,D1A,D2B	9341;9342;9343;9344;9345;9346; 9347;9348;9349;9350;9351;9352
Brunton/Bertolo	Scinti Verse SX16-4	Fisher			3 - Flammable liquids	B2,D2B	
	Acetonitrile A998-4	Fisher	Oct 1.2013	(2 of 4L) 8L	3 - Flammable liquids	B2,D1A,D2B	10198;10201
	Acetonitrile A998-4	Fisher	Dec 02,2013	(2 of 4L) 8L	3 - Flammable liquids	B2,D1A,D2B	30244;30245
	2-propanol HPLC A451-4	Fisher	Aug.12.2013	(2 of 4L) 8L	3 - Flammable liquids	B2,D2B	10207;10208
	Methanol A452SK-4 HPLC	Fisher	Oct 4.2013	(1 of 4L) 4L	3 - Flammable liquids	B2,D1B,D2B	10206
Heeley	Scintiverse	Fisher	May 06 ; April 2/07	(2 of 4L) 8L	3 - Flammable liquids	B2,D2B	9325/9326
Christian Lab	Methanol A412-4- ACS	Fisher	May-12	(10 of 4L) 40 L	3 - Flammable liquids	B2,D1B,D2B	9315;9316;9317;9318;9319;9320; 9321;9322;9323;9324
	Methanol A452-4	Fisher	2012	(3 of 4L) 12L	3 - Flammable liquids	B2,D1B,D2B	Lang in brackets 9312;9313;9314

Biology - SN-1104C - Chemical Storage Inventory - SN1104C

Name	Chemical Name	Company	Date put in stock	Amount in Storage	Hazard Class	WHIMS & MSDS on Hand	Container - Extra Information & Barcode #s
Kapil Tahlan	Acetonitrile HPLC	MP Biomedical	May-11	(3x4L btl) 12L	3 - Flammable Liquids	B2, D1A, D2B	Spectro Grade 10185;10186;10187
	Methyl-Alcohol HPLC	MP Biomedical	May-11	(3x4L btl) 12L	3 - Flammable liquids	B2, D1B, D2B	Spectro Grade 10188;10189;10190
Andrew Lang	Methanol A411-4	Fisher	Aug-12	(1x4L btl) 4L	3 - Flammable liquids	B2,D1B,D2B	Laboratory Grade 10194
	Isoamyl Alcohol I-9392	Sigma	Aug-12	500ml	3 - Combustible Liquid	B3,D2B	Dated 31.1.96 10195
	Dimethyl Sulfoxide	MP	Aug-12	2x100ml			10196;10197
Dawn Bignell	Acetonitrile A998-4	Fisher	Oct 1.2013	(3x4L) 12L			10212;10213;10214
	Chloroform 31998-4	Sigma	17-Dec-12	(3x4L) 12L	6.1 Toxic	D1B,D2A,D2B	10215;10216;10217
	Chloroform C298-4	Fisher	Oct 1.2013	(1X4L) 4L			10218
	Ethyl Acetate ACS 319902-4	Sigma	4-Jan-13	(3x4L) 12L	3 - Flammable Liquid	B2, D2B	10219;10220;10221
	Methanol Chromosolv 34860-4	Sigma	17-Dec-12	(3x4L) 12L	3 - Flammable Liquid	B2,D1B,D2B	10191;10192;10193

Biology Teaching - SN-1104D - Ch

Chemical Name	Container Volume	Quantity	Hazard Class
95% Ethanol	25L	4	3 - Flammable liquids
100% Ethanol	25L	3	3 - Flammable liquids
Iso propyl alcohol	20l	1	3 - Flammable liquids
Propylene glycol	4L	4	Not regulated
Propylene glycol	500ml	1	Not regulated
n-Propanol	1L	1	3 - Flammable liquids
1-Propanol	4L	1	3 - Flammable liquids
Ethyl Acetate	4L	3	3 - Flammable liquids
Glycerin	4L	7	Not regulated
2 Propanol	1L	1	3 - Flammable liquids
Propyl alcohol	4L	1	3 - Flammable liquids
2-Propanol	4L	3	3 - Flammable liquids
Methanol	1L	3	3 - Flammable liquids
Methanol	4L	4	3 - Flammable liquids
n-Amyl alcohol	4L	1	3 - Flammable liquids
Paraffin	4L	3	Not regulated
Trizol reagent	5ooml	1	Not regulated
Petroleum Ether 60-80 deg	1L	3	3 - Flammable liquids
Reagent alcohol	4L	1	3 - Flammable liquids
Xylenes	4L	7	3 - Flammable liquids
Chloroform	4L	6	6.1 - Toxic substances
Chloroform	1L	1	6.1 - Toxic substances
Gasoline	Unknown		3 - Flammable liquids

emical Storage Inventory

WHIMS	G-Glass M-Metal P-Plastic	Container - Extra Information
	M	
	M	
B2,D2B	M	
Non-controlled	G	
Non-controlled	G	
B2, D2B	G	
B2, D2B	G	
B2	G	
Non-controlled	G	
B2,D2B	G	
B2,D2B	G	
B2,D2B	G	
B2,D1B,D2B	G	
B2,D1B,D2B	G	
B2,D1B,D2B	G	
	G	
	G	
B2,D2A	G	
B2,D1B,D2A,D2B	G	
B2,D2A, D2B	G	
D1B,D2A,D2B	G	
D1B,D2A,D2B	G	
	P	Bob Hooper - Outboard Motor Gas