Government of Alberta
Infrastructure

Technical Design Requirements for Alberta Infrastructure Facilities

"The Red Book"
Fourteenth Edition Revised

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Technical Design Requirements for Alberta Infrastructure Facilities is intended to help consultants provide appropriate technical designs for Alberta Infrastructure facilities. It applies to the design of new buildings and the design for upgrading and renovation of existing buildings. These design requirements need to be used in conjunction with professional judgment to ensure that they are followed only to the extent they are appropriate. Consultants remain ultimately responsible for design.

More specifically, the intent of each section of this document is to:

- describe the minimum requirements for various building components, assemblies and systems that have an impact on serviceability and anticipated life cycle of the facility,
- alert consultants to design aspects that are problematic,
- provide solutions or problem avoidance techniques that have been developed through experience and have proven to be practical and effective,
- provide a vehicle for communicating departmental design standards to consultants in an effective and expedient manner, and indirectly,
- provide a basis for evaluating designs.

Content is generally organized into sections related to professional disciplines. Consultants are expected to familiarize themselves with each section and to coordinate design among the disciplines involved.

No attempt is made to address every conceivable condition. Rather, common sense solutions are provided where experience has indicated that problems commonly arise. This experience can be applied to new designs as a preventive measure, and to existing buildings to address problems that are attributable to design and/or execution that does not conform to these technical design requirements.

Where this document does not address a technical design issue that arises on a project, it is the consultant's responsibility to address it. When a requirement, though normally applicable, may not be appropriate for a specific project, the consultant should propose an alternative for consideration by the project team. This may include design of facilities for temporary or short term use.

Innovative designs or products are encouraged after thorough consideration of potential benefits and risks, value analysis and life cycle cost. Consult project team members and persons with expertise in facility operation and maintenance.

Designs are required to comply with all applicable codes and regulations. Where the technical design requirements contained herein differ from building codes and other applicable codes and standards, apply the more stringent requirements.

The most significant change in this edition is the inclusion of a section on Sustainability to reflect the department's adoption of LEED Silver as a standard for government funded buildings.

Design guidance is also included in Data Sheets prefacing many Alberta Infrastructure Master Specifications (for buildings). These elaborate on some of the content in this document. Review Data Sheets of applicable specifications as early as possible during document development.

This latest version of *Technical Design Requirements for Alberta Infrastructure Facilities* and the Alberta Infrastructure Master Specifications (for buildings) may be viewed or downloaded in electronic format from the "Technical Resource Centre" on the Alberta Infrastructure website (http://www.infrastructure.alberta.ca/507.htm).

Consultants' input to the progressive updating of this document is invited. Please direct comments to the:

Executive Director
Technical Services Branch
Alberta Infrastructure
3rd Floor, 6950 - 113 Street
Edmonton, AB T6H 5V7
tel: 780-422-7447
fax: 780-422-7479

Tom O'Neill, P.Eng.
Executive Director
Technical Services Branch

1.1 Reference

.1 *LEED Green Building Rating System for New Construction and Major Renovations,* Canada Green Building Council, 2004.

.2 *Commercial Building Incentive Program Technical Guide,* Natural Resources Canada, Ottawa, 2000.

1.2 General

.2 Alberta Infrastructure endeavours to promote health, productivity and safety of Albertans through the design and maintenance of the built environment. Each new project should be used to demonstrate institutional practices that promote sustainability, including measures to increase efficiency and use of renewable resources, and to decrease production of waste and hazardous materials.

.2 All new buildings and major renovations shall be certified to a minimum LEED Silver rating. Alberta Infrastructure encourages higher levels of certification. In the absence of sustainable opportunities, where the mandatory credits can't be achieved, or where sufficient optional credits can't be economically achieved, projects with a capital budget less than $2.5 million may be exempted at the discretion of the project team, however, integrated and sustainable design practices should be incorporated.

.3 LEED Green Building Rating System is a voluntary, consensus-based standard for developing healthy and high performance buildings with reduced environmental impacts. The rating system evaluates “greenness” from a whole-building and whole-life perspective in five categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality. LEED promotes integrated and sustainable design practices.

.4 Alberta Infrastructure requires a number of LEED credits to be treated as mandatory for it’s projects. These credits will address energy, metering, and regional materials credits. Alberta Infrastructure’s Mandatory Credits include:

- Energy & Atmosphere Credit 1, Optimize Energy Performance. Project design will target at least 6 out of 10 points for energy reduction.
- Energy and Atmosphere Credit 3, Best Practice Commissioning
- Energy and Atmosphere Credit 5, Measurement and Verification
- Materials & Resources Credit 5.1, Regional Materials

.5 Life Cycle Costing assessment is to be conducted throughout the project to ensure that operations and maintenance cost projections are established and effective comparative analyses are conducted for targeted building elements.

.6 "Integrated design" is a collaborative process between the client group including occupants, operating staff and a multi-disciplinary design team, focusing on the design, construction, operation, and occupancy of a building over its complete life cycle. Functional, environmental, and economic goals are defined and realized by proceeding from whole building system strategies, through increasing levels of specificity, to achieve more optimally integrated solutions.

.7 "Sustainable design" is an integrated approach to building design, construction and operation that focuses on the efficient use and choice of resources and materials in such a way as to be economical while not compromising the health of the environment or the associated health and well being of the building's occupants, builders, the general public, or future generations.

.8 All projects should incorporate, as much as possible, sustainable design concepts using the integrated design process throughout the project. Studies indicate that the impact of greater occupant satisfaction and comfort resulting from increased individual control over the indoor environment: temperature, air movement, noise, lighting, exterior views and daylight, improves productivity, wellness and retention.

.9 Major renovations must incorporate substantial revisions to building envelope, heating, ventilation and air conditioning, and lighting before LEED silver rating is required.

.10 Should manufactured wood products be used, LEED Canada NC, Version 1, Materials and Resources Credit 7 makes specific reference to wood products certification. The use of forest, wood or engineered wood products locally manufactured under all recognized certification systems is encouraged. For reference purposes and without endorsement, the forest and wood product certification systems available in Alberta include Forest Stewardship Council (FSC), Canadian Standards Association (CSA), Sustainable Forestry Initiative (SFI), and Forest Care.

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2.1 References

.1 *ASHRAE Handbook of Fundamentals*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, 1993.

.2 Brand, Ronald, *Part 2*, *Architectural Details For Insulated Buildings*, Van Nostrand Reinhold, 1990.

.3 *CSC TEK-AID AIR BARRIERS - DIGEST*, Construction Specifications Canada, Toronto, March 1990. This publication includes a comprehensive listing of other publications (including the above) presents basic design principles and addresses building envelope problems that have concerned designers and building forensic experts.

.4 CSA S478-95, *Guideline on Durability of Buildings*, CSA, Etobicoke, ON, 1995.

.5 Hutcheon, N, Handegord, G, *Building Science for a Cold Climate*, John Wiley & Sons, 1984, ISBN-0471797634.

.6 Model National Energy Code for Buildings. National Research Council Canada, Ottawa, ON, 1997.

2.2 General

.1 Building envelope assemblies separate spaces requiring differing environmental conditions by controlling the flow of air, water and energy.

.2 The design approach generally recommended may be described as the “Pressure Equalized Rain Screen Insulated Structure Technique”, or “PERSIST”. This approach is characterized by the following:

  .1 exterior cladding covering an air space pressure equalized with the exterior.

  .2 insulation:

    .1 mainly located to the exterior of structural components.
    .2 in direct contact with an air barrier system.
    .3 exterior of an air barrier system.

  .3 an air barrier system which can also function as a vapour retarder.

.3 While other design approaches are possible, Alberta Infrastructure recommends the PERSIST approach because, properly implemented, it is relatively forgiving and minimizes the following:

  .1 moisture deteriorating the building envelope due to ingress of exterior bulk moisture and trapping of condensation from relatively humid air introduced into the envelope by air exfiltration.

.2 detrimental effects on air barrier from exposure to:

.1 UV radiation
.2 extreme temperature fluctuations
.3 moisture

.3 thermally induced movement of structural elements and any connected air barrier.

.4 Detail the building envelope to ensure that water, snow and ice sheds safely from exterior surfaces and is not trapped in the assembly to cause deterioration or staining.

.5 Materials used in the building envelope assembly should be suitable for the environmental conditions to which each will be exposed, including during the construction period. Materials should provide a service life consistent with accessibility for maintenance of building components and planned building life.

.6 Obtain prior Alberta Infrastructure approval before using exterior cladding materials requiring frequent maintenance.

.7 Avoid combining design approaches, e.g. the Airtight Drywall Approach (ADA) in combination with the PERSIST approach.

2.3 High Interior Humidity

.1 Indoor relative humidity of 30% or greater can result in excessive condensation on or within the building envelope during the winter.

.2 Where feasible, provide lower humidity “buffer spaces” to separate spaces with high relative humidity from the building envelope. To make such separation effective, design partitions and mechanical system air pressure differentials to minimize humid air transfer to the buffer spaces.

.3 Where high humidity space cannot be "buffered" from the building envelope, design building envelope assembly to prevent surface condensation.

2.4 Air Barrier

.1 Design building envelope components to meet the characteristics of an air barrier system as discussed in Construction Specifications Canada's *TEK-AID AIR BARRIERS - DIGEST*.

.2 Locate the plane of the sealing element (usually a membrane) exterior to the major structural elements.

.3 The air barrier typically consists of a number of materials acting together as a system. Minimize the number of materials used to form this system. Do not consider plastic film or spun-woven fibre film as an air sealing element.

.4 Minimize changes of plane in the air barrier system. Where practicable, avoid changes of plane at air barrier membrane connection to window frames.

.5 Air barrier detail continuity and constructibility must be given particular attention at:

- .1 window and door frames
- .2 mechanical and electrical penetrations
- .3 wall/roof connections
- .4 changes in plane
- .5 joints between like and dissimilar materials

.6 Provide large scale details to show how air barrier continuity will be achieved and how differential movements and construction sequences will be accommodated.

2.5 Insulation

.1 Design insulation to be secured mechanically and in direct contact with the air barrier system.

.2 Except as noted otherwise, insulate walls to a minimum RSI value of 2.1 (R12), roofs and soffits to 2.44 (R14) and foundation perimeters to 1.76 (R10). These values are based on life cycle costing using natural gas as the energy source. When other fuels are to be used, it may be appropriate to propose an adjustment of the thickness and RSI value.

.3 Additional insulation is recommended to prevent ice damming on steep roofs (refer to “Steep Roof” article). RSI 3.52 (R20) insulation is recommended. Minimize thermal bridging.

.4 Minimum insulation thicknesses for typical situations are specified in Alberta Infrastructure Master Specifications.

.5 Design to prevent condensation on interior surfaces due to thermal bridging. For example, along concrete fins projecting from the interior of the insulated structural plane, extend insulation out four times fin thickness, use structural neoprene thermal breaks for minor projecting steel elements and use insulated double Z-bars or thermal clips to support cladding and metal roofing.

2.6 Roofs

2.6.1 General

.1 Design to accommodate built-up, elastomeric or modified bitumen roofing membranes. Where feasible, specifications shall let contractors choose from specified membrane types.

.2 Prepare roof plans showing elevations for slopes to drain. Indicate locations of drains, roof mounted equipment and roof penetrations. Reference roofing detail drawings to the roof plan.

.3 Provide roofing membrane below all metal roofing and flashings. Consider metal roofing and flashings to be watershedding only, not waterproofing.

.4 Provide main access to rooftop from inside building. Where practicable, connect additional separate roof levels with external wall-mounted ladders, designed to meet or exceed safety regulations. Where external access is not practicable, provide access from inside building.

.5 For additional requirements related to roof drainage, refer to Section 4.0 - Mechanical.

2.6.2 Near-Flat Roofs

.1 Slope roof surfaces to drains, including valleys and transverse slopes across top of parapets. Provide minimum slope to drain of 1:50 for field of roof.

.2 The above requirements for roof slopes may not be practicable for existing buildings, e.g., where existing flashing heights limit maximum thickness of sloped insulation. In such cases, consider adding drains to reduce maximum insulation heights. Where adding drains is not practicable they may be omitted. It is acknowledged that this may result in reduced roof slopes and ponding.

.3 Provide overflow scuppers where only one roof drain is provided for a contained drainage area and where structural hazard would result from blocked drainage. Do not locate scuppers at roof expansion joints.

.4 Use scuppers only as overflow devices, typically located 25 to 50 mm above membrane at roof perimeters. Do not use scuppers to replace roof drains. Minimum size of scupper to be determined by a rational analysis of expected maximum one day rainfall. Minimum of 150 mm x 300 mm.

.5 Form roof drainage slopes with the structure, not with insulation.

.6 Backslopes may be formed using sloped insulation, provided a continuous vapour retarder membrane is applied below and above the backslope insulation, and these membranes are joined at both low and high points of backslopes.

.7 Where practicable, maintain a constant elevation along the perimeter of contained roof areas. If a varying perimeter elevation can not be avoided, provide dimensioned details indicating low and high perimeter conditions.

.8 Provide curbs at all roof penetrations other than drains. Detail top of curbs at minimum 200 mm above the adjacent roof membrane. Provide minimum 1.0 m clearance around curbs to facilitate roofing application and drainage.

.9 Where a roof joins a wall extending above the roof, locate wall cladding, window sills, door thresholds, louvers and other wall penetrations a minimum of 300 mm above the roofing assembly.

.10 Design transitions from roofs to walls projecting above roofs as protected membrane transitions.

.11 Normally use gravel ballast with filter fabric for protected membrane systems. Provide removable precast paver units around roof perimeters, around curbs (greater than 3 m any side) and for access paths and plaza decks.

.12 When the exposed surface of a roof assembly, e.g. plaza-type decks, is required to be cast-in-place concrete, provide the following:

  .1 Drains at both deck and membrane levels, designed to allow for differential movement between those levels.

  .2 Venting of insulation layer and concrete above roof membrane.

  .3 Geotechnical type filter fabric between concrete and insulation below, to prevent concrete penetrating into insulation layer.

2.6.3 Steep Roofs

.1 Design steep roofs (slopes greater than 1:6) with the plane of waterproofing membrane/air barrier following the plane of ventilated cladding. Use the PERSIST approach. Avoid ventilated attics.

.2 Configure steep roofs and perimeters so that snow, ice and rainwater will not create safety, maintenance or appearance problems. Design to prevent ice and snow from sliding onto areas intended for use by vehicles or pedestrians.

.3 Size eavestroughs to accommodate water from contributory roof and wall areas and to resist expected snow and ice loads. Off-the-shelf eavestroughs typically do not provide adequate resistance to dynamic loads from ice and snow. Eavestroughs to be a minimum of 125 mm wide.

.4 Locate rainwater leaders and direct discharge at grade so that water does not flow onto walks or paved areas where it could freeze, or onto areas where it could cause erosion damage.

.5 Locate eavestroughs so they are accessible for maintenance and will not cause leakage into the building.

.6 Observe the following minimum slopes for applications of shingles and shakes:

.1 1:3 for normal triple tab strip shingle application.
.2 1:2.4 for cedar shingles.
.3 1:2 for cedar shakes.

Consult with Alberta Infrastructure before using lower slopes.

2.7 Re-Roofing

.1 Re-roofing decisions should be based on a well documented report from a knowledgeable roofing consultant. The report conclusions and recommendations should be reviewed by Alberta Infrastructure Technical Services Branch staff before proceeding with re-roof specifications and details.

.2 Re-roofing generally should only be done after actual repairs and trouble shooting has confirmed that further repairs would not be cost effective, or the deteriorated condition of the roofing system makes repairs difficult or impossible to complete.

.3 If a roof requires replacement prior to the normal life expectancy, the roof condition report should summarize the cause of the failure, i.e. poor initial installation, material failure, design defect, etc.

.4 On structurally sloped roofs the re-roofing design may consider leaving existing primary insulation and cover panels in place if they are found to be in a dry condition. The existing vapour barrier which should be equivalent to two plies of built up roofing must be tied into adjacent wall air seals or vapour barriers. The metal decks are to be protected with a code approved leveling surface.

.5 New parapet construction should be built with a minimum of 38 mm x 140 mm wood framing sloped towards the roof.

.6 Under normal building humidity and operation PWF lumber should be specified only for ARCA sleepers supporting mechanical roof top equipment.

.7 Roof curbs for hot pipes, as in standby engine exhaust or other hot roof penetrations, should have metal curbs and additional clearances to combustible construction.

.8 Re-roofing should include slopes of 1:50 unless there are restrictions of wall details or limitations of raising parapets to accommodate the new sloped insulation.

.9 The sloped insulation should have a minimum depth of 50 mm at the roof drains.

.10 Maximum thickness of sloped insulation should be approximately 150 mm. The limitation of sloped roofing primary insulation maximum thickness may require additional roof drains.

.11 Review actual depths of ponding water on roof, generally over 50 mm, and locations of roof deck depressions prior to designing a new sloped insulation roofing system.

.12 Provide a minimum of two 100 mm roof drains per roof zone. Exceptions could include small canopy roofs with low parapets. Provide overflow scuppers where plugged roof drains could create ponding water depths over 150 mm. The overflow scuppers should be approximately 25 to 50 mm above the roofing membrane and not located over entrances or other locations that could become a hazard during overflow conditions. Size of opening to be determined by a rational analysis of expected maximum one day rainfall. Minimum opening size 150 mm x 300 mm.

.13 All re-roofing drawing details and specifications should meet or exceed the ARCA's Manual On Good Roofing Practice and Accepted Roofing Systems.

.14 Cut tests should be done on all roof zones prior to preparation of re-roofing specifications and drawing details.

.15 Determine if the roof to wall tie-ins have an adequate air seal. If the existing wall air seal membrane is weak or none existent, provide the roof to wall connection membrane stripping that could be tied into if the wall is re-cladded at a later date.

.16 Provide a protected roofing membrane detail to include exterior insulation and metal flashing at the base of all walls.

.17 Generally the re-roofing membrane would consist of two ply SBS modified bituminous membrane (MBM). Where there is a potential fire hazard with the original building construction or building occupancy creates an unacceptable fire risk, a four ply asphalt and gravel re-roofing system should be specified.

.18 Review controlled flow roof drainage system with a Mechanical Engineer to investigate alternate water drainage options. Review size of overflow scuppers to prevent overloading the building structure.

.19 Generally provide for new four bolt clamping ring cast iron roof drain, conventional roof drain complete with sump receiver, aluminum dome, and underdeck clamping rings. Sleeved re-roof drains with u-flow connectors are not to be used. Check if existing roof drain piping or underside of the existing roof drain are covered with insulation containing asbestos. Test that the insulation is asbestos free, or make arrangements to remove the asbestos materials before the re-roofing is tendered.

.20 If the existing rainwater leaders direct water to grade through an exterior wall, check that there are no freezing problems associated with the existing construction. Correct construction as required.

.21 Remove and reinstall all mechanical roof top equipment to accommodate re-roofing. Raise curbs, ductwork, mechanical piping and electrical services to accommodate sloped insulation.

.22 Reinstall mechanical roof top units and pipe supports on precast pavers set on 25 mm type 4 extruded polystyrene insulation. Install a loose laid 250 granular cap sheet under the new mechanical supports.

.23 Install 250 granular MBM cap sheet in a contrasting colour walkways around and mechanical roof top units and in direct lines to stairwell or roof hatches. Leave 25 mm gaps in the MBM cap sheet walkway every meter to not impede drainage to the roof drains.

.24 Eliminate pitch pans by installing curbed roof openings with metal enclosures that have removable tops to add or delete mechanical equipment.

.25 Provide a minimum of 610 mm clearance between mechanical curbs.

.26 Add mechanical instructions for removal and replacement of roof top units.

.27 Add mechanical plumbing instructions for adding and removing roof drains and associated piping.

.28 Generally specify removal of all redundant rainwater leader piping and hangers if any roof drains are abandoned during the re-roof.

2.8 Walls

.1 Design exterior walls as "PERSIST" assemblies consisting of:

.1 Exterior cladding
.2 Air space
.3 Thermal insulation
.4 Air barrier system

.2 Size wall cavities to provide minimum 25 mm clearance between maximum thickness of insulation allowed in the specifications and exterior cladding (this would typically be at least 100 mm). Provide additional clearance as required to suit construction tolerances, e.g. for concrete structures and high-rise buildings.

.3 Provide openings in the cladding to permit drainage and pressure equalization of the air space.

.4 Compartmentalize air spaces in the wall cavity to restrict air flow around corners and not more than 4 m in any direction within the cavity generally. Detail and show the location of control joints and compartmentalization baffles in cladding.

2.9 Windows, Doors and Glass

.1 Specify window performance using Alberta Infrastructure Master Specifications to prevent condensation from forming on window frames or glass at design criteria specified in Section 4.0 - Mechanical. The specification is based on the use of an exterior glazed small box curtainwall section. Contact Alberta Infrastructure Building Sciences Section for isometric details.

.2 The design of the curtainwall would have mechanically keyed gaskets in the box section and pressure plate. Anchors for the framing would be located within the vertical tube sections or as strap anchors so they DO NOT INTERFERE with adhesion of the membrane from the wall directly to the tube face of the aluminum frame. Mechanically retain the membrane with the anti-rotation channel.

.3 Do not project the main mass of window frames beyond the exterior plane of the air barrier. Bridge the cavity of the wall by means of flashing (not the frame or covercap). DO NOT CAULK covercaps to flashings.

.4 Design windows, window treatment and interior surrounds to allow uniform, unobstructed movement of heated room air across glass and frame.

.5 Provide vestibules at building entrances, intended for public access, where interior humidity may otherwise result in frost buildup on doors and frames, and to minimize cold drafts. All other doors require adequate mechanical treatment to minimize ice buildup.

.6 Coordinate the selection of glazing with lighting and mechanical systems to avoid glare and solar overheating.

.7 Specify low emissivity coating on surface #2 for insulating glass units.

2.10 Skylights and Sloped Glazing

.2 When light is to be introduced through the roof, vertical clerestory glazing is preferred over skylights and sloped glazing. Such designs allow for better control of overheating, condensation control and solar glare.

.2 Skylights and sloped glazing systems frequently become building envelope problems, triggering significant operation and maintenance costs to building owners. If either of these systems are going to be incorporated into a design, involve Alberta Infrastructure early in the design and detailing stages.

.3 If, after considering the risks and alternatives, designers still opt for skylights or sloped glazing and clients accept the risks associated with them, the following design notes are offered to help minimize adverse consequences:

  .2 Slope glazing minimum 30 degrees from horizontal.

  .2 Design air seal connections to skylight and sloped glazing curbs and adjacent walls to be fully accessible and not dependent on construction sequence.

  .3 Design skylights and sloped glazing so that they are accessible for maintenance and cleaning from building interior and exterior.

  .4 Make provision to drain water entering the glazing rabbet of the system back to the exterior, during all seasons. Water may enter the glazing system from the exterior. The skylight system should be designed to contain water in the glazing rabbet and drain it in an overlapped shingled fashion. Water should **not** contact caulked joints or seals.

  .5 Provide an interior condensation gutter system. In high humidity buildings it may be necessary to drain the collected condensation at the sill to the mechanical system rather than relying on evaporation. This requirement should be addressed at the initial design stage.

.6 Use mechanically keyed in dry glazing seals for the interior and exterior of the system. Do not depend on sealants.

.7 Glazing should be **minimum** heat strengthened exterior lite, 12 mm airspace, 0.060 PVB laminated interior lite.

2.11 Concealed Spaces

.1 Avoid sealed cavities and "dead space" in and adjacent to building envelope. Vent to the exterior, unheated cavities created by minor architectural features.

.2 Provide access to heated concealed spaces, e.g. heated overhangs, from the building interior.

.3 Provide access to concealed spaces ventilated to the exterior, e.g. unheated soffits with recessed lights, from the building exterior.

End of Building Envelope Section

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3.1 Design Loads

.1 Multi-service facilities (e.g. Provincial Buildings): minimum floor occupancy live load 3.5 kPa or 9 kN concentrated, whichever produces the more critical effect.

.2 General Office Areas: minimum floor occupancy live load 3.0 kPa or 9 kN concentrated, whichever produces the more critical effect.

.3 Records Storage Areas: design live load to be based on type and layout of the proposed storage system, but not less than 7.2 kPa.

.4 Floors of Interstitial Spaces: minimum live load 1.5 kPa or 1.5 kN concentrated, whichever produces the more critical effect, plus equipment loads.

.5 Mechanical Loads: obtain loads from mechanical consultant. In mechanical rooms, allow for a minimum of 100 mm thick concrete housekeeping pads or 100 mm thick concrete floating slab. Refer to requirements in the Acoustics and Structural Sections, and coordinate with mechanical consultant. Ensure that the structure contains adequate access routes for heavy equipment.

.6 Minimum Roof Design Live Load: 1.5 kPa or 1.5 kN concentrated, whichever produces the more critical effect. For roofs over mechanical rooms, increase the concentrated load to 4.5 kN for all elements except metal deck. Roof structures shall be designed with special consideration for plugged roof drains.

.7 For buildings that are to be close to property lines on urban sites, assume the neighbouring property will be built higher than the building, to the extent permitted by the local zoning by-law. This typically will produce a triangular snow load with an accumulation factor, C_a, of 3.75 at the property line.

.8 When there is a known plan to change the usage of an area in the future, design for the more stringent of current and future live loads.

3.2 Foundations

.1 Have a Geotechnical Engineer review and approve aspects of design and construction that depend on soil or ground water conditions.

.2 Maintain the integrity of existing structures and service lines on adjacent properties.

.3 Do not incorporate "tie-back" earth retaining system as an essential part of the permanent structure.

.4 The weight of soil fill and associated pressure shall be rated as a live load, with a load factor of 1.5. If the weight of the soil resists uplift, overturning or stress reversal, it shall be treated as a dead load, with a load factor of 0.85.

3.3 Structure

.1 Do not use unbonded post-tensioned reinforcement as an essential reinforcing element of a structural member.

.2 Design cantilever or continuous steel beams according to *Roof Framing With Cantilever (Gerber) Girders and Open Web Steel Joists*, published by the Canadian Institute of Steel Construction, July 1989.

.3 Design exterior slabs at doorways to avoid interference with outward door swings as a result of upward movement of slab caused by frost. Provide structural stoop where necessary.

.4 Structural Systems for Car Parking: design according to CSA S413M, *Parking Structures*. Provide protection against corrosion of reinforcing steel, including a positive slope and drainage system with adequate allowances for construction tolerances and deflections.

.5 Provide protection against corrosion for structural elements that may be subject to spills or leaks of corrosive solutions (e.g. mechanical floors supporting brine tanks and water softeners).

.6 Design expansion joints, including those between existing and new structures, so that an abrupt change in floor elevation is prevented. Wheelchairs and carts must be able to pass over these joints with ease.

.7 In major renovations of existing buildings, investigate safety with respect to current seismic loading in areas where this is applicable. Upgrade as deemed appropriate for the specific project. At a minimum, ensure adequate lateral support for all non-structural components.

.8 Provide drain holes to allow the release of water in all HSS sections subject to freezing.

.9 Design structural steel floors to prevent transient footstep induced vibration from exceeding the annoyance threshold. *Refer to CISC Handbook of Steel Construction – Appendix G, Guide for Floor Vibrations and the National Building Code of Canada - Commentary A - Serviceability Criteria for Deflection and Vibrations.*

3.4 Coordination with Other Disciplines

.1 Structurally design and detail the fastening, support, and back-up systems for exterior walls, brick veneers, cladding, and attachments. Specify galvanizing of steel connections outside the air barrier and shop welding of welded connections.

.2 Where possible, avoid thermal bridging. Where this is not possible, incorporate measures to minimize its effect. Refer to Building Envelope Section, Insulation.

.3 In the design of exterior wall back-up systems, limit deflections according to the properties of the cladding or veneer material being used.

.4 Provide details that allow for all building movements including deflections.

.5 For roof slopes, refer to Building Envelope Section, Roofs. Take into account the resulting non-uniform loads caused by accumulation of rain water. Account for a 24 hr rain and the effects of a plugged roof drain.

.6 For vibration control, refer to Acoustics Section, Structural.

.7 Check the structural adequacy of support systems for ceilings, particularly heavy plaster ceilings, and follow up with on-site inspection.

.8 Structurally design and detail required guardrails.

.9 Advise the prime consultant, if applicable, of expected movements of the structure, including those due to deflection, shrinkage, settlement, and volume changes in the soil. Provide adequate allowances in all affected elements, including partitions and mechanical systems.

.10 If the expected movements of a grade-supported floor slab cannot justifiably be accommodated or tolerated, use a structural slab. A crawl space is generally not necessary and should be provided only in cases where there are specific known benefits that justify the extra cost. Structural slabs constructed over a degradable void-form shall not be used where a significant amount of buried piping will be provided below the floor. The piping shall be protected within trenching or other means to isolate the piping from soil. If there is a significant amount of piping, a crawl space should be considered.

.11 Specify concrete floor flatness that is consistent with the flooring material to be applied and the architect's aesthetic requirements. Because of the higher placing and finishing cost involved, specify unconventionally stringent flatness and levelness only for areas where there is a justifiable benefit.

3.5 Drawings

.1 Indicate the following design parameters on drawings, for review, construction and future reference:

.1 Geotechnical design parameters.

.2 Structural design parameters, as follows:

.1 Design loads
.2 Provisions for future additions
.3 Material properties

.3 Criteria for design to be carried out by contractors.

.4 Existing grade, finished grade, main floor and foundation elevations.

.5 Any special construction procedures assumed in design.

End of Structural Section

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4.1 References

.1 Meet or exceed the following guidelines and standards:

.1 Canadian Standards Association (CSA) Standards

.2 ASHRAE Handbooks

.3 ASHRAE Standards

.4 SMACNA Standards

.5 *Industrial Ventilation: A Manual of Recommended Practice,* American Conference of Governmental Industrial Hygienists.

.6 *Management Strategy for the Phasing Out of CFC's and Halons, at Alberta Infrastructure Facilities.*

.7 *Fumehood Code of Practice*, Alberta Government.

.8 *EMCS Guideline for Logical Point Mnemonics,* Alberta Infrastructure.

4.2 General

4.2.1 Drawings

.1 Prepare project drawings with schematic diagrams indicating the following:

.1 Mechanical systems, major equipment, components, and EMCS control points.

.2 Equipment, components, piping and ductwork, arranged to accurately reflect the physical (on-site) configuration including equipment connections, valves and dampers.

.3 Devices that measure air and water flow, temperature, and pressure.

.2 Identify EMCS control points according to the Alberta Infrastructure *EMCS Guideline for Logical Point Mnemonics*.

.3 Position flow measuring devices according to the manufacturer's recommended locations and dimension the required straight length entering and leaving each device.

4.2.2 Specifications

.1 Use the Alberta Infrastructure Master Specification as a basis for developing project specifications.

4.2.3 Accessibility

.1 Provide sufficient access space for servicing, maintaining and removal of equipment and components or portions thereof (i.e. tube bundles, filter media, large motors).

.2 Indicate access space on drawings.

.3 For equipment not mounted on a roof curve, provide minimum 1.0 m clearance between underside of equipment and roof surface underneath.

4.3 Design Criteria

.1 Design mechanical systems according to the criteria set out in Tables 4.3.1.a, 4.3.1.b and 4.3.1.c following under this article.

.2 Special buildings or building areas may require different conditions than those outlined in Table 4.3.1. Document these conditions and make allowances in system design.

TABLE 4.3.1a, Design Criteria - Office and Institutional Occupancies

Building Systems	Indoor Design Condition	Outdoor Ambient Temperature	Outside Air	Safety Factor
Heating	22°C	Jan. 1% as per Alberta Bldg. Code	Infiltration allowance: 1.0 AC/h for perimeter zone 4.5 m deep.	10%
Overall Ventilation Rate	4.5 AC/h minimum		Minimum 10.0 L/s per person	10%
Air Conditioning[1]	22°C	July 2.5% as per Alberta Bldg. Code	N/A	10%
Humidification	15%	-30°C & below	N/A	0%
	30%	-10°C & above		
Evap. Cooling	60% max humidity	N/A	100 %	0%

[1] *Do not allow 10% safety factor when sizing central cooling plant equipment.*

TABLE 4.3.1b, Design Criteria - Warehouse and Industrial Occupancies

Building Systems	Indoor Design Condition	Outdoor Ambient Temperature	Outside Air	Safety Factor
Heating	20°C, except 22°C in office areas	Jan. 1% as per Alberta Bldg. Code	N/A	10%
Overall Ventilation Rate	4.5 AC/h minimum in office areas		Minimum 10.0 L/s per person in office areas	10%
			Minimum 0.25 L/s per m^2 in warehouse areas	

TABLE 4.3.1c, Design Criteria - Enclosed Parking Structures

Building Systems	Indoor Design Condition	Outdoor Ambient Temperature	Outside Air	Safety Factor
Heating	10°C	Jan. 1% as per Alberta Bldg. Code	100% make-up to replace exhaust	0%

4.4 Heating

4.4.1 General

.1 In large mechanical rooms containing natural gas burning equipment, provide ventilation to control the room temperature within the temperature ratings of equipment (e.g. electrical panels).

4.4.2 Hydronic Systems

.1 Provide a minimum of 2 boilers, each sized at 50% of total heating design capacity.

.2 Provide a minimum of 2 primary circulation pumps, each sized for parallel pump operation at 50% of maximum design capacity.

.3 Size heating elements for:

  .1 exterior wall envelope heat loss,

  .2 infiltration allowance as per Table 4.3.1a, and

  .3 where applicable:

    .1 roof heat loss, and

    .2 reheat of minimum supply air quantity.

.4 Provide a temperature controlled piping loop for air handling system coils, separate from loop supplying radiation, radiant panels and terminal reheat coils.

.5 Where terminal coils are installed to reheat increased air flow required for intermittent exhaust purposes, and heating water supply temperature varies, select coils for the lowest supply water temperature anticipated.

.6 Heat domestic hot water with heaters or boilers independent of the building heating system.

.7 Provide minimum 50% glycol solution for heating coils in air handling units.

.8 Do not circulate glycol solution through boilers.

4.5 Cooling

4.5.1 General

.1 Design cooling system based on criteria set out in Table 4.5.1 following under this article.

Table 4.5.1 Cooling System Guidelines

Cooling Load	Cooling Medium	Heat Rejection Equipment	Compressor Type	Additional Information
280 kW (80 ton) or less	Refrigerant (Direct Expansion)	Air cooled condenser	Scroll or reciprocating hermetically sealed	105 kW (30 ton) maximum cooling capacity per air handling unit
280 to 705 kW (80 to 200 ton)	Chilled water	Air cooled condenser or air cooled chiller Evaporative cooling tower. Free cooling heat exchanger is optional	Rotary screw Rotary screw	
Greater than 705 kW (200 ton)	Chilled water	Evaporative cooling tower with free cooling heat exchanger	Rotary screw, centrigufal or absorption where cost effective	Refer to 4.5.2 for multiple chiller cooling plants.

.2 Consider use of variable flow pumping to conserve energy use.

.3 Provide chillers that allow the supply water temperature to be reset electronically.

.4 Do not provide mechanical refrigeration to mechanical equipment rooms.

4.5.2 Multiple Chiller Cooling Plants

.1 Provide two chillers as a minimum with variable flow pumping on the chilled and condenser water circuits for:

  .1 central cooling plants with a total load more than 1050 kW output that serve more than one building,

  .2 buildings that require a chiller larger than 1750 kW output, and

  .3 buildings that serve a special function as determined by Alberta Infrastructure

.2 Size chillers by taking into account the magnitude and duration of lighter loads relative to the peak cooling demand to ensure optimum chiller operation.

4.6 Air Handling Systems

4.6.1 Central

.1 Design air systems, except 100% outside air make-up type and residential furnaces, with an economizer cycle and a return fan.

.2 Provide air plenums with hinged, sealed access doors and lighting for inspection of each chamber.

.3 Size return air dampers in mixing sections at 70% of the area of the exhaust air dampers, to allow adequate control of mixed air.

.4 Use factory manufactured air blenders, pre-engineered and with proven performance, to mix outside and return air to prevent air stratification and provide uniform flow across coil face.

.5 Wetted media type evaporative cooling and humidification shall be a once-through type. Arrange the media and water spray headers in sections to achieve accurate capacity control. Headers to include solenoid valves and adjustable flow control. Drain pan shall be of stainless steel construction. The media shall be dry prior to shut down of air system.

.6 On predominantly cooling-only systems, provide preheat coil with sufficient capacity to supply air at 5°C above room temperature, to maintain continual design ventilation.

.7 When multiple air systems are used, duct return air to each air handling system separately. Do not use common return air plenums.

.8 Do not use mechanical rooms as air plenums.

.9 Provide air filters with a minimum efficiency of 30% (MERV 8) based on ASHRAE 52.1 – Dust Sport.

4.6.2 Zoning

.1 Make allowances for electronic equipment in air conditioned offices by determining the amount of heat emitted by the equipment installed, or allow 7.0 W/m^2 when heat load cannot be determined.

.2 Limit interior zones, and exterior zones on the same exposure, to maximum 600 L/s, unless a specific function requires more.

.3 Provide separate zones for corner spaces if cooling requirements are significantly different from adjacent zones.

.4 Match heating and cooling zones.

4.6.3 Distribution

.1 Ensure that proper air distribution is achieved through correct diffuser application, selection, and location in ceiling grid.

.2 Take into account variable air volumes and tenant requirements so that proper air circulation is achieved under all conditions.

.3 For unique ceilings, confirm air flow patterns with special studies, or by testing a mock-up.

4.6.4 Variable Air Volume (VAV)

.1 Use variable frequency drives on fan motors to vary supply and return air volumes.

.2 Design perimeter zones with:

  .1 VAV box positioners operation to maintain minimum outside air requirements,

  .2 Heating elements sized as outlined in clause 4.4.2.3.

.3 Design interior zones with VAV boxes that close fully when unoccupied. Do not provide reheat coils in these boxes unless process air must be tempered.

.4 In zones with roof heat loss, provide radiation elements and temperature sensor to maintain minimum 18°C within ceiling space.

.5 For zones that require process air, e.g. for fume hoods, provide a VAV system with reheat coils. VAV box positioner to be activated to go to maximum air supply position when process air is required, returning to normal VAV operation otherwise.

.6 Sequence heating elements and VAV boxes on the same temperature sensor, except for radiation elements within ceiling space.

4.6.5 Rooftop Units

.1 Provide make-up air units with remote control panels that can be interlocked in a supervisory or control capacity to the EMCS system, where applicable.

.2 At outdoor air temperatures below 0°C , provide controls to limit the lowest supply air temperature to 5°C above room temperature. Both outdoor air and supply air temperatures set points shall be adjustable.

.3 Provide large turn down (i.e. 15 to 1) natural gas valves for heating sections. If large turn down is not available provide two-stage.

4.7 Controls

4.7.1 General Requirements

.1 Use BACnet or LonWorks compliant distributed digital control (DDC) energy management control systems (EMCS) to:

- control heating, ventilating and air conditioning systems.
- execute control strategies to minimize energy consumption.
- monitor and record mechanical systems' performance.
- provide dial out of alarm signals.

.2 Approve commercially available field proven systems that will be installed, engineered and commissioned by trained and qualified personnel, employed by companies that can provide an acceptable level of after service.

.3 Provide systems with user friendly interface and control language that allows user reprogramming of the control sequences. Provide program and graphics editing software including all required manuals.

.4 Create dynamic graphics in the central control unit (CCU) for all mechanical systems. Provide a graphics of each floor showing smoke control zones. Include all EMCS controlled space temperatures and smoke dampers.

.5 Use terminal equipment controllers (TEC's) in new construction or in retrofits where majority of terminal equipment will be upgraded.

.6 TEC's should not be used for control of major equipment, i.e. boilers, air handling units, etc.

.7 Provide for offsite support access by including a modem or serial device server for telephone or internet connectivity.

4.7.2 EMCS Design Objectives

.1 Develop a plan early in the project to define the requirements for:

- contract documentation,
- vendor acceptance,
- product approval,
- system field inspection,
- customized control software, and
- commissioning the EMCS.

4.7.3 EMCS Operating Objectives

.1 Use custom control sequences and application programs to conserve energy by:

- controlling primary energy consuming equipment.
- deciding optimum start and stop times for equipment and systems that do not operate 24 hours a day.
- resetting air and heating water supply temperatures using feed back from occupied space demand.
- resetting humidity from outside air temperature.
- using air systems to preheat, precool or purge to achieve the objective space temperature at the start of occupancy.
- controlling car plugs.

.2 Use custom control sequences and application programs to provide stable control by resetting heating water supply temperature using feedback from occupied space demand and outside air temperature.

4.7.4 Field Devices

.1 Specify electrically powered actuators to drive all valves, dampers and other control devices, except that central equipment actuators may be pneumatically powered in extensions or renovations to existing facilities where pneumatic power of adequate capacity is available.

.2 Ensure control valves are selected with flow characteristics to match the application. Size so as to maintain reasonably linear control characteristics.

.3 Consider the use of 1/3 and 2/3 sized control valves for coils with large load variations.

.4 Match the damper type, face area, power of actuator, and method of rod and damper linkage to give a linear volume control characteristic.

4.7.5 Contract Documents

.1 Provide detailed requirements for:

- O&M Manuals.
- Operator training.
- Central and Portable Control Stations.
- Remote and Terminal Control Units including control language.
- Field Devices, Conduit and Wiring.
- Identification of Points, Devices and Wiring.
- System Start-up and Testing including point verification and calibration.

.2 Provide schematics for each mechanical system showing specified control points.

.3 Provide point sheets listing all points to be installed. Group points on a per system basis. Refer to Alberta Infrastructure EMCS Guideline for Logical Point Mnemonics when selecting point names.

.4 Provide detailed control sequences identifying the use or purpose of every specified control point

.5 Use the Alberta Infrastructure Basic Master Specification sections as a basis for documents. NOTE: Master Specification Sections are continuously evolving. Refer to AI&T Resource Centre web site for current version or contact Technical Services Branch, Manager EMCS, to obtain latest DRAFT version.

4.7.6 Start-up, Testing and Point Verification

.1 Ensure the controls contractor verifies every physical point and submits check sheets showing all calibration values as well as actuator spans for pneumatic actuators.

.2 Ensure contractor submits trend data showing that all control loops have been tuned.

.3 Witness all start-up tests and perform point verifications as outlined under 15956.

4.8 Roof Drainage Systems

.1 Provide a minimum of two roof drains per contained near-flat roof area, except a single drain may be provided for near-flat roof areas not greater than 6 m^2, e.g. entrance canopies, elevator penthouses.

.2 Use internal drainage systems with open flow drains and minimum 100 mm diameter pipes. Do not use controlled flow drains.

.3 Direct flow that is discharged at grade so that it does not flow onto pedestrian or vehicle traffic areas, where it could freeze and become a safety hazard, or onto areas where it could cause erosion damage.

.4 Terminate roof drain exterior discharge outlet with an elbow at least 1.0 m above grade. Provide a thermostatically controlled immersion heater from the discharge back into the building to prevent freeze-up during the winter.

4.9 Miscellaneous

.1 Provide back flow prevention that conforms to either *The National Plumbing Code of Canada* or the requirements of the municipality, whichever is more stringent.

.2 Obtain approval for water treatment consulting services from Alberta Infrastructure when special water systems are required.

.3 Where an emergency power system is installed, ensure the following equipment is connected to it:

- .1 Heating pumps.
- .2 Boilers complete with controls.
- .3 Associated EMCS systems.

.4 Consult with Alberta Infrastructure for building envelope penetrations by hot pipes such as emergency generator exhaust pipes and incinerator chimneys.

.5 Refer to Acoustics Section for acoustic requirements related to mechanical systems and components.

.6 Refer to Landscape Development Section for exterior and interior hose bibb requirements related to landscaping.

.7 Where a sprinkler system is to be installed, as a minimum, show the following information on tender drawings.

.1 Location and type of sprinkler heads.
.2 Routing of main lines.
.3 Location of sprinkler tree.
.4 Location of fire pumps.
.5 Fire protection system schematic.

4.10 Commissioning

.1 Determine the commissioning requirements for each project based on complexity, size, cost, location, occupancy, new or unique client requirements, and consistent with the risks associated with system performance. Prepare and review commissioning plan with Alberta Infrastructure.

.2 Verify the installation and test the performance of each component and system, individually and collectively, to ensure the facility is complete, and functioning efficiently according to the design objectives and approved client requirements.

.3 Provide suitable documentation of verification and performance tests.

.4 Train building operators to operate and maintain systems, through formal seminars and demonstrations of equipment and systems.

.5 Ensure appropriate operation and maintenance manuals are provided for use by the building operators. For each system, include design criteria, system information, operation procedures, maintenance requirements and shop drawings.

End of Mechanical Section

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5.1 References

.1 Meet or exceed guidelines and standards of the following organizations:

.1 Canadian Standards Association

.2 Illuminating Engineering Society of North America

.3 Institute of Electrical and Electronics Engineers

.4 Insulated Cable Engineers Association

.2 Meet requirements of the APEGGA guideline entitled, *Responsibilities For Engineering Services For Building Projects V1.0 – April 2001.*

5.2 Service and Power Distribution

5.2.1 Service Sizing

.1 For multi-building sites with a service voltage over 750 V or sized 600 A and over, coordinate electrical services with Alberta Infrastructure.

.2 Size main services and service transformers according to connected load or estimated load, whichever is greater.

.3 Calculate connected load using demand factors as dictated by the type of load plus an allowance for future load growth. Discuss future load allowances with Alberta Infrastructure.

.4 Calculate estimated loads based on basic power loads plus additional loads anticipated for heavy power usage areas.

.5 Calculate basic power load due to lighting, general power, convenience loads and basic mechanical equipment, as follows:

.1 Buildings Over 1000 m^2 With Air Conditioning: 50 VA/m^2 x total building area.

.2 Buildings Under 1000 m^2 With Air Conditioning: 60 VA/m^2 x total building area.

.3 Buildings Without Air Conditioning: 40 VA/m^2 x total building area.

.6 Heavy power usage areas include kitchens, workshops, laboratories and areas with large numbers of electrical equipment connections or receptacles. For these areas, calculate additional loads as follows:

.1 Each Heavy Usage Area: 100 VA/m^2, or,

.2 Connected load at 100% demand, plus

.3 Other loads such as snow melting, block heater outlets, welders and electric heating. Calculate additional connected load at 100% demand with a seasonal and work flow diversity factor applied.

5.2.2 Single Line Drawings

.1 Provide electrical single line diagrams, as part of the Contract Documents, indicating the following:

.1 Configuration, type, voltage and amperage ratings of switchgear, transformers, panelboards and motor control centres (MCCs).

.2 Type, size and amperage ratings of services and feeders.

.3 Type, frame size and trip rating of overcurrent protective devices.

.4 Available fault current at switchgear, panelboards, transformer secondaries and overcurrent devices.

.5 Connected load at switchgear, panelboards and MCCs.

.6 Anticipated demand load at switchgear, panelboards and MCCs.

.7 Service and distribution grounding.

.2 Provide copies of single line diagrams from Record Drawings, recording actual construction, as follows:

.1 Incorporate into Operating and Maintenance Manuals.

.2 Frame and hang in each major electrical equipment room, with equipment in the room highlighted.

5.2.3 Protection and Control

.1 Ensure priority tripping and coordination of overcurrent and ground fault devices on feeders. Provide final consolidated trip curves for additions, services sized 600 A and over, and multi-building sites.

.2 Ensure adequate fault duty ratings of all switchgear, panels, MCCs and overcurrent devices. Provide calculation results when requested by Alberta Infrastructure.

.3 Provide all services and feeders sized 600 A and over with ground fault protection. Where ground fault protection is provided on services and feeders, ensure protection is also provided for downstream feeders and loads that are susceptible to nuisance ground faults.

.4 Establish load monitoring and shedding procedures and evaluate the feasibility of peak demand control through the use of load shedding or emergency generation equipment. Review the parameters of these procedures with Alberta Infrastructure.

.5 Do not provide undervoltage protection on main breakers. Provide single phase motor protection using differential overloads or phase loss shutdown by the EMCS system.

.6 Provide high voltage relaying using relay accuracy class CTs with test block and solid state relays with trip indication for each function. Provide a DC battery source for all high voltage control and tripping power.

5.2.4 Switchgear, Panelboards and MCCs

.1 Switching and Overcurrent Devices - Use moulded case circuit breakers with thermal, magnetic trip for all circuit protective devices except as follows:

   .1 Use industrial duty, draw out type air circuit breakers for all services and feeders 800 Amps and over.

   .2 Use moulded case breakers with solid state trip units for all services over 400 Amps and under 800 Amps.

   .3 Use metal enclosed switchgear with air magnetic, vacuum or SF 6 circuit breakers for all high voltage equipment.

   .4 Obtain the approval of Alberta Infrastructure for the use of fused equipment. (Consideration will only be given where fault duties of equipment require a limitation of the available fault current.)

.2 Bussing: do not use aluminum bussing. Use solid copper for switchgear sized 600 A and over.

.3 Metering: provide panel mounted digital owner's metering for all services and feeders 600 A and over, as follows:

   .1 Meter to display true RMS values for phase voltage (line to line and line to neutral), phase currents, kVA, kVAR, kW, PF, Hz, MWhr, kWd and kVAd.

   .2 Meter to be field programmable via front key pad and RS232 or RS422 port.

   .3 Meter to have two programmable dry contacts.

   .4 Size instrument transformers such that the initial design full load is approximately 60% of rating.

   .5 Provide PT and CT test blocks for each meter.

   .6 Meter to have RS232 or RS422 data output port.

.4 Accessories: provide lifting equipment for all industrial type air circuit breakers, high voltage switches and stacked high voltage starters.

.5 Working Clearances: provide all switchgear and MCCs with minimum 1.5 m frontal clearance, in addition to space required for drawout equipment in full disconnect position, and all free standing switchgear with minimum 1.0 m back and side clearance

.6 Housekeeping Pads: provide all floor mounted equipment with a housekeeping pad except for roll-out style switchgear.

.7 Location: do not locate main service and distribution equipment in mechanical, storage or janitor rooms.

5.2.5 Transformers

.1 Location:

- .1 Main Building Transformers: locate outside with pads and screens where required.
- .2 Indoor Transformers Over 45 kVA: allow for removal by wheel mounted equipment.
- .3 Do not locate distribution transformers in ceiling spaces.
- .4 Coordinate transformer heat removal with Mechanical.

.2 Size:

- .1 Such that average demand loading is at least 60% of rating.
- .2 To limit fault current available on the secondary side.
- .3 Maximum 1000 kVA.

.3 Secondary voltage (listed in order of preference):

- .1 347/600 V, three phase, four wire.
- .2 120/208 V, three phase, four wire.
- .3 115/230 V, single phase, three wire.
- .4 Obtain approval of Alberta Infrastructure for other voltages and connections.

.4 Acoustical Considerations:

- .1 Ensure adequate acoustic ratings, treatment, location and mounting of transformers. Refer to Acoustics Section for specific requirements.

5.2.6 Feeders

.1 Size feeders for a maximum 2% voltage drop from main distribution to branch circuit panelboard under full load conditions.

.2 Use copper conductors for feeders. Panel, MCC and distribution board feeders larger than No. 6 may be aluminum alloy.

.3 Provide a full capacity neutral and a ground conductor with all feeders.

5.2.7 Power Factor

.1 Correct power factor to at least 95% where normal loading yields a power factor of less than 90%.

.2 Provide correction capacitors for:

  .1 Motors 25 kW and larger.

  .2 Groups of motors smaller than 25 kW where total motor load is over 250 kW.

.3 Locate capacitors close to the motor or group of motors, preferably downstream of starters.

.4 Review use of automatic correction equipment with Alberta Infrastructure.

5.2.8 Motor Protection and Control

.1 Do not use fuses for individual motor overcurrent protection.

.2 Provide single phase protection for all three phase motors either by relaying, differential overloads or EMCS shutdown.

.3 Provide time delay on speed change for 2 speed starters.

.4 Provide space on backpan for EMCS current sensors.

.5 Variable Frequency Drives to be of pulse width modulation type. Provide VFD’s with input filtration to limit harmonic current content to meet requirements of IEEE Standard 519 where the point of common coupling is considered to be the drive terminals. Provide output reactor to limit rise time to suit motor type and lead length.

5.3 Lighting

5.3.1 General

.1 Design to maximize the energy efficiency of lighting systems. Design in accordance with the Model National Energy Code of Canada for Buildings 1997.

.2 Only use the task-ambient approach where work surface and task orientations are predetermined and as agreed to by Alberta Infrastructure.

.3 It is not necessary to design for worst case work surface and task orientations in general office space.

.4 Design to minimize direct and reflected glare and maximize contrast.

5.3.2 Recommended Levels (Lighting)

.1 Lighting Level Selection Criteria: Use the following criteria to select minimum average maintained values within spaces:

- .1 Visual Task: medium contrast or small size.
- .2 Occupants Ages: 40 to 55 years.
- .3 Task Duration: prolonged periods.
- .4 Reflectances: room surfaces and task backgrounds - 30 to 70%

.2 Maintained Values: Use the following criteria for calculation of maintained values:

.1	Luminare Dirt Depreciation:	0.80
.2	Lamp Lumen Depreciation:	0.85

5.3.3 Uniformity

.1 All areas in a space need not be to minimum average maintained values if functions permit. Lighting levels may be non-uniform. For example, circulation areas in an office may be of a lower level than recommended for the work surface.

5.3.4 Minimum Maintained Horizontal Illumination

.1 The following are required minimum lighting levels:

.1 Storage, Circulation and Corridors: minimum 300 lx at floor level.

.2 General Use Office Space: minimum at the work surface as follows:

.1 For system designs supported by point by point computer calculations and where partitioning, furniture and interior finish reflectance are known:

Indirect or semi indirect systems:	500 lux
Direct systems incorporating low brightness luminaires, reflectors or diffusers:	550 lux

.2 For all other systems: 700 lux

5.3.5 Interior Landscape Lighting

.1 Provide interior landscape planting areas with supplemental lighting as follows:

.1 Horizontal Illumination: 1600 lx minimum, 4300 lx average.

.2 Horizontal to Vertical Ratio: maximum 5:1.

.3 Controls:

.1 Time clock set to 14 h "ON" period.
.2 Photo cell to turn on when ambient level below 4000 lx.

.4 Values measured on ground plane.

5.3.6 Exterior Lighting

.1 Use incandescent floodlights with motion sensor complete with daylight, "ON" time and sensitivity adjustments for exterior lighting of man doors and exits which are of infrequent use.

.2 Use cutoff luminaires for all parking, roadway and area lighting.

5.3.7 Sources

.1 Only use lamps which are readily available from local distributor's stock. Do not use U shaped lamps.

.2 Maximize the use of energy efficient lamps. For general fluorescent lighting use 32 watt, T8, tri-phosphor lamps. Use HID for parking, roadway and area lighting.

.3 Minimize the use of incandescent sources. Use only where minimal burning hours are expected or where architectural considerations dictate.

.4 Do not use HID sources in courtrooms or office space.

.5 For exit signs use LED signs where LED's illuminate the entire face or stencil cutout.

5.3.8 Diffusers

.1 Use framed diffusers in fluorescent luminaires wider than 350 mm.

.2 Use polycarbonate diffusers for exterior luminaires.

.3 High efficiency, low brightness diffusers are preferred in areas containing electronic work stations.

5.3.9 Ballasts

.1 Use energy efficient ballasts. Use electronic ballasts for fluorescent luminaires. Electronic ballasts to have Total Harmonic Distortion of less than 12% and a Power factor of better than 0.95. (refer to Master Specifications).

.2 Review use of electronic ballasts for luminaires in courtrooms with Alberta Infrastructure.

.3 For acoustical and electromagnetic interference considerations, refer to Acoustical Section.

5.3.10 Control

.1 Do not use breaker switching.

.2 Use low voltage switching for all 347 V branch circuits. Do not locate relays in ceiling space.

.3 Provide switching for conference rooms, board rooms, groups of common offices and large areas common to a single user.

.4 Provide time clock or programmed switching for large general use areas.

.5 Provide photocell and time clock control for exterior and perimeter interior luminaires.

.6 Provide motion sensor control for night lighting, exterior man doors and low use areas where economics are favourable.

5.4 Branch Wiring

5.4.1 General

.1 Use copper conductors.

.2 Obtain approval of Alberta Infrastructure for the use of non-metallic sheathed cables. Consideration will only be given for buildings of combustible construction.

.3 Use AC-90 cable only in short lengths for final connections to luminaires and similar equipment.

.4 Provide separate circuits for coffee makers, refrigerators and microwave ovens.

5.4.2 Block Heater Outlets

.1 For more than 10 and up to 30 parking stalls:

- .1 Provide thermostatic controlled contactors designed to shut off all power to outlets when outside temperature is above -10°C.
- .2 Provide timer to cycle energized outlets on and off at a maximum 20 minute period.

.2 More than 30 parking stalls:

- .1 Provide thermostatic controlled contactors designed to shut off all power to outlets when outside temperature is above -10°C.
- .2 Split the load into two groups. Alternately cycle each group on and off with a maximum 20 minute period.

.3 Use the building's EMCS system to control parking lot loads where possible. Coordinate with Mechanical Section.

5.4.3 Provisions for Mechanical

.1 Provide heat tracing for piping or connect immersion heater in accordance with Section 3 - Mechanical.

.2 Provide UPS for head end of EMCS systems in consultation with Alberta Infrastructure.

5.5 Life Safety and Security Systems

5.5.1 General

.1 Provide back-up power for all life safety and security systems.

.2 Provide battery back-up for all systems with volatile electronic memory.

.3 Review the use of UPS systems with Alberta Infrastructure.

5.5.2 Fire Alarms

.1 Use horns for audible signals unless site conditions dictate otherwise.

.2 Design systems to CAN/ULC-S524-M91, *Standard for the Installation of Fire Alarm Systems*, and test and verify systems to CAN/ULC S537 M86, *Standard for the Verification of Fire Alarm Systems*.

.3 Coordinate duct detectors with mechanical to ensure air velocities are compatible with detectors.

5.5.3 Emergency Power

.1 Design emergency power, where required, to CSA C282, *Emergency Electrical Power Supply for Buildings*, and the IEEE Orange Book, *Recommended Practice for Emergency and Standby Power*.

.2 Provide emergency power to mechanical loads as outlined in Section 3 Mechanical.

.3 Provide a minimum of one receptacle in electrical and mechanical rooms connected to emergency power where a generator is installed.

5.5.4 Emergency Lighting

.1 Provide battery powered emergency lighting units with minimum 1 hour capacity in all electrical and generator rooms.

5.6 Electronic Offices

5.6.1 General

.1 For projects containing electronic office space or electronic equipment such as computers, microprocessors and electronic communications equipment, review the requirements for supplemental electrical protection of electronic equipment with Alberta Infrastructure.

.2 Determine the extent and severity of electrical service disturbances including voltage sags, surges, short term and long term transients and outages. Consult with the Utility in order to determine the likely incidence of these disturbances.

.3 Identify electronic equipment and systems likely to be affected by disturbances and the extent of protection necessary for normal operation.

.4 Provide electrical protection and line power conditioning for affected equipment as follows:

.1 Surge protectors: electronic or varistor surge arrestors for equipment affected by transients.

.2 Isolation Transformers: electrostatically shielded transformers for equipment affected by transients and noise.

.3 Regulated Power Supplies: for equipment and systems affected by transients, noise, voltage sags and surges.

.4 Electronic Filters: for equipment affected by power line noise.

.5 Uninterruptible Power Supplies: for equipment requiring continuity of service.

5.6.2 Computer Grade Circuits

.1 Provide computer grade circuits consisting of breakers, raceways, wire, outlets and receptacles designed to provide power to electronic equipment.

.2 Supply only electronic equipment with these circuits. Do not use these circuits to supply convenience receptacles or mechanical equipment.

.3 Generally supply only two computer work stations per circuit. Review the options for circuiting with Alberta Infrastructure.

.4 Do not use common neutrals. Provide a separate, isolated ground for each circuit.

.5 Provide receptacles coloured orange and labeled "computer only".

.6 For installations with more than 12 computer grade circuits provide a separate panel fed via an isolating transformer with an electrostatic shield.

5.6.3 Grounding Computer Grade Circuits

.1 Provide a separate ground wire from each computer grade circuit to the branch circuit panelboard.

.2 Provide an isolated ground buss in each branch circuit panelboard supplying electronic loads.

.3 Ground the branch panelboard ground buss to the equipment ground within the panel unless fed directly from a transformer where the ground shall be to the transformer neutral ground point.

.4 Size all grounding conductors to carry the fault current necessary to trip the overcurrent devices protecting the loads, panelboards and feeders associated with the grounding system.

5.6.4 Voice and Data Wiring

.1 Refer to the *Standard for Voice and Data Wiring*, in the Alberta Infrastructure "Consultants Guide".

.2 Review the requirements for a wire management system for communication cables with Alberta Infrastructure.

5.7 Miscellaneous

5.7.1 Lightning Protection

.1 Provide lightning arrestors on all services supplied from an overhead line.

.2 Review the requirements for and installation techniques of structure lightning protection with Alberta Infrastructure.

.3 As a guideline, provide lightning protection for the following:

  .1 Structures in urban areas which are taller than adjacent structures within a 500 m radius.

  .2 Structures in rural areas which are taller than adjacent structures or trees within a 100 m radius.

.4 Do not provide protection for adequately grounded metal buildings.

5.7.2 Envelope Penetrations

.1 Ensure adequate treatment for all envelope penetrations such as generator exhaust piping, lightning down conductors and points and service masts. Refer to Building Envelope Section for specific requirements.

5.7.3 Commissioning

.1 For commissioning requirements, refer to Section 3 - Mechanical.

End of Electrical Section

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6.1 References

.1 Meet or exceed the guidelines and standards of the following, as applicable:

.1 ASHRAE: 1999 *Applications Handbook*, Chapter 49: Sound and Vibration Control

.2 CMHC: *New Housing and Airport Noise*.

.3 CISC: *Handbook of Steel Construction* - Appendix G, Guide for Floor Vibrations.

6.2 General

.1 The intent of these requirements is to ensure that the acoustic environment of the building is compatible with the general needs and comfort of the building occupants, and the surrounding residential areas.

6.3 Definitions

.1 The following are definitions of common parameters used to describe the acoustic characteristics of building environments, materials and assemblies:

.1 Sound Transmission Class (STC): a single number rating of the sound transmission loss properties of a wall, floor, window or door. A good reference for wall and floor STC ratings is the Alberta Building Code.

.2 Ceiling Attenuation Class (CAC): this is a single number rating of the sound transmission properties of a suspended ceiling system between two rooms having a common plenum.

.3 Noise Reduction Coefficient (NRC): a single number rating of the sound absorptive properties of a material ranging from 0.01 (negligible absorption) to approximately 1.00 (very high absorption). Manufacturers of ceiling boards, wall panels and various sound absorptive finishes will usually list the NRC rating in their product information.

.4 Articulation Class (AC): a ceiling performance rating specifically used for open-plan offices. Articulation Class is a single number rating describing a ceiling boards' ability to attenuate speech sounds between workstations.

.5 Noise Criteria (NC): a somewhat dated method of rating HVAC system noise. NC is still often used as a design criterion because many manufacturers of mechanical equipment continue to use it.

.6 Room Criterion (RC): a more recent rating for HVAC system noise. RC is the preferred rating for setting design goals and for qualifying field installations.

6.4 Acoustically Critical Spaces

.1 Consult with Alberta Infrastructure on rooms where speech privacy, sound isolation, background noise or reverberation control is critical. In most cases, more than one of these acoustic conditions will need to be considered for interview and therapy rooms, teleconference rooms, courtrooms, auditoria and lecture halls.

.2 Secure interview rooms in court facilities require specific soundproofing requirements, as outlined in Alberta Infrastructure document, *Acoustical and Security Requirements for Secure Interview Rooms in Court Facilities*.

.3 Consult with Alberta Infrastructure on unusual situations, where adjacent occupancies may not be acoustically compatible and special construction is required.

.4 Consult with Alberta Infrastructure on large open-plan office projects. There are numerous acoustical requirements associated with this type of space layout.

6.5 Architectural

6.5.1 General

.1 Develop the floor plan so that noise sensitive spaces are not next to high noise areas (e.g. conference rooms adjacent to mechanical rooms). Consider both the horizontal and vertical layouts.

6.5.2 Floor Construction

.1 Evaluate the need for a floating concrete floor to isolate very loud equipment (e.g. chillers; large open-ended fan units) in mechanical areas. A floating floor is rarely necessary except when rooms with low noise criteria (e.g. auditoria and studios) are located directly below such mechanical areas. It is recommended that an acoustic consultant make a preliminary estimate of the mechanical noise and, if required, develop the details for this type of floor.

.2 Evaluate the construction of floors for impact noise. Footstep noise and other impact sounds can be a source of annoyance, particularly through lightweight and uncarpeted floors. Design for impact sound isolation is especially important where areas of high impact (e.g. corridors, exercise rooms, child play areas) are located above or directly adjacent to occupied rooms. Consult with Alberta Infrastructure on floor details for reducing impact sound.

6.5.3 Interior Partitions

.1 Design interior partitions for sound isolation as follows:

Space Description	STC Rating (minimum)
Moderate Privacy Requirements - General Office Space, Small Meeting Rooms	40
Confidential Privacy Requirements - Executive Offices - Large Conference Rooms, Training Rooms	45
Acoustically Critical Spaces (see Section 5.4) -Therapy Rooms, Courtrooms - Studios, Auditoria, Lecture Halls	50+ (varies)

.2 Partitions with STC 45 rating should generally be full height or incorporate a gypsum board plenum barrier.

.3 Use full-height wall construction or drywall ceilings in rooms that require STC 50 or greater.

.4 Prepare large scale details that show continuous, airtight seals at building component junctions such as:

.1 Partition to perimeter heater cabinet,
.2 Partition to suspended ceiling,
.3 Partition to window mullion at exterior walls.

.5 Provide a complete, airtight sound seal around piping, duct and conduit that penetrate partitions and floors. Sealants must comply with fire separation and waterproofing requirements, as applicable.

.6 Provide a solid airtight barrier behind perimeter heater cabinets to prevent sound transfer at common partitions.

.7 Do not use operable partitions between areas that require a high degree of speech privacy. Where operable partitions are deemed necessary for general noise isolation, specify a partition that has a minimum STC 50 rating. Detail such partitions according to ASTM E557, *Standard Recommended Practice for Architectural Application and Installation of Operable Partitions.*

.8 Use massive wall construction (e.g. concrete block, poured concrete, multi-layer drywall) to separate occupied spaces from duct shafts and mechanical rooms.

6.5.4 Interior Finishes

.1 Specify ceiling boards that have a minimum CAC rating of 35 for closed office areas or other rooms that require speech privacy. Generally, these boards will be mineral-fibre type.

.2 Provide a sound absorptive ceiling finish in all general office space, corridors, cafeterias, lobbies and large public areas. Ceiling boards or other ceiling finishes should have a minimum NRC of 0.60.

.3 Consider additional sound absorbing wall finishes for recreation facilities and other rooms where a high degree of noise is expected.

.4 Provide carpet to all occupied floor areas above offices and other noise sensitive areas to minimize impact noise of footsteps.

6.5.5 Open-Plan Offices

.1 Consider the following where optimum open-plan conditions are desirable (e.g. Call Centres).

.2 Specify ceiling boards that have a minimum AC rating of 170 where most systems furniture is approximately 1.5 metres high.

.3 Specify ceiling boards that have a minimum AC rating of 200 where most systems furniture is approximately 1.8 metres. This is required where maximum privacy between workstations is desirable.

.4 Specify foil backing for all glass-fibre ceiling boards.

.5 For a mix of open-plan areas and enclosed offices, different ceiling boards may be required for each type of space. However, manufacturers offer boards with identical finishes for both applications.

.6 Consider maintenance requirements in the selection of ceiling boards and other sound absorptive finishes. Avoid cloth-faced glass fibre ceiling boards, soft spray-applied materials and other finishes that are difficult to clean.

.7 Avoid flat light lenses. Parabolic or deep "egg-crate" diffusers are preferable.

.8 Specify electronic sound masking.

6.6 Mechanical

6.6.1 Background Noise

.1 Design mechanical systems to provide background noise levels, as follows:

Space Description	Room Criterion (RC)
Radio/Recording Studio, Auditorium	20 maximum
Audio/Visual Room, Courtroom, Teleconference Room	25 maximum
Large Conference Room, Observation/Therapy Room, Classroom, Lecture Hall	25 – 30
Enclosed Office, Meeting Room	30 – 35
Open-Plan Areas, Library, Cafeteria, Reception/Waiting Areas	35 – 40
Computer Room, Kitchen	45 maximum
Light Maintenance Shop	50 maximum

In most office settings, a neutral, unobtrusive background noise helps to increase speech privacy. Therefore, over-silencing is undesirable.

.2 Consult with Alberta Infrastructure on spaces that require a noise level of RC 25 or less.

6.6.2 Ducts, Terminal Devices, Heat Components and Silencers

.1 Whenever possible, design the system layout so that any medium velocity ducts and terminal boxes are above service space such as corridors.

.2 Do not locate exhaust fans directly above meeting rooms and conference rooms serving such spaces. Locate these fans in the ceiling plenum above a less critical area (e.g. Waiting/Reception or Corridor) and provide acoustically-lined duct on the fan intake.

.3 Avoid placing rooftop equipment over noise-sensitive areas. Provide details describing acoustic treatment, duct configuration and roof penetration seals for any rooftop installations.

.4 Design main air distribution systems to minimize the use of acoustic duct lining, whenever possible.

.5 Select acoustic silencers with the lowest static pressure loss, when a selection of two or more silencers exist.

.6 Use flexible connections between fans, plenums and all related ductwork.

.7 Provide smooth air flow conditions near fan units to minimize air turbulence. Large, rectangular ductwork with medium and high air velocities can create low frequency duct rumble. Spiral-wound, round duct is preferred for air velocities over 9 m/s or where excessive turbulence is anticipated.

.8 Use non-continuous perimeter heat cabinets that allow acoustic barriers to be installed behind the cabinet at all window mullion locations. Provide easy access at these locations.

.9 Select terminal boxes on basis of both induct and radiated noise level. Manufacturer's VAV box noise data often assumes the equipment is located above a mineral fibre suspended ceiling and that there is use of acoustically-lined duct. Ensure that the design includes the effect of these elements.

.10 Select diffusers/air outlets so that the combined noise from all diffusers in a room meets the design criterion. Noise from a single diffuser will typically need to be specified 6 - 10 dB lower than RC(N) goal when several diffusers are in the same room.

.11 Locate balancing damper at least 2 m away from diffuser.

.12 Provide at least 600 mm of straight duct at diffuser inlet.

.13 Do not use Z shape return air transfer ducts (sound traps) for offices with enclosed plenum spaces. A simple rectangular opening in the plenum barrier, located above the office door, will generally be adequate. Where it is necessary to return air directly between critical areas (i.e. two offices) use a 1.5 m long straight rectangular duct with acoustic duct liner.

6.6.3 Plumbing Noise

.1 Use a resilient sleeve around supply pipes with oversize clamps fastened to structure, in areas where water flow noise may be a disturbance. Sleeves comprised of 12 mm thick closed-cell elastomeric pipe insulation or proprietary resilient pipe fasteners are acceptable. Do not use hard plastic sleeves.

.2 Ensure that pipes penetrating through drywall partitions are not rigidly connected. Provide a sleeve at the wall opening, leaving an air space around the pipe, and seal with a resilient caulking.

.3 Where double plumbing walls are used (e.g. washrooms), attach supply piping only to the fixture side of the wall structure.

.4 Consider the use of pressure reducing valves (PRV's) in the system to minimize plumbing noise for noise sensitive areas. Size PRV's to limit the pressure at fixtures to 375 kPa.

.5 Install water hammer arrester adjacent to any quick-acting solenoid valves.

6.6.4 Vibration Isolation

.1 Use the current *ASHRAE Applications Handbook*, as a guide for selecting vibration isolation of mechanical equipment.

.2 Provide vibration isolators for all vibrating pipes and ducts in mechanical chases and walls common to noise sensitive areas.

.3 Use flexible connectors on pumps that require vibration isolation from piping. Twin sphere neoprene rubber flex connectors are preferred.

.4 Use flexible connections between fans, plenums and all related ductwork.

.5 For rooftop equipment, vibration problems can usually be avoided if the static deflection of each spring isolator is at least 15 times the structural deflection of the roof due to the equipment loading. Typically, this requires springs with a static deflection of 50 to 100 mm.

6.6.5 Community Noise

.1 Determine the community noise impact of large outdoor mechanical equipment, e.g. cooling towers, chillers, and large fan units with louvres to outside. Occupants of residences within 1000 metres of such equipment can be annoyed by mechanical noise, particularly at night.

.2 Silence or strategically locate outdoor mechanical equipment and intake/exhaust openings to meet local municipal noise by-law requirements. In the absence of a noise by-law, design systems to a maximum level of 50 dBA for neutral sounding equipment and 45 dBA if the equipment has a tonal noise (e.g. axial fans). These levels are determined at the residential property line nearest to the equipment.

6.7 Electrical

6.7.1 Ballasts

.1 Electronic ballasts can cause severe interference with infrared sound systems. Consult with Alberta Infrastructure when electronic ballasts are being considered for spaces with infrared assistive listening systems, e.g. courtrooms.

6.7.2 Transformers

.1 Avoid locating transformers within ceiling spaces above noise sensitive spaces.

.2 Provide vibration isolators for transformers located near occupied spaces. Use the following table as a guide for selecting vibration isolators:

	Near Non-Critical Areas		Near Critical Areas	
Size (kVA)	**Isolator Type**	**Static Deflection**	**Isolator Type**	**Static Deflection**
Under 50	neoprene pad	3 mm	neoprene isolator	10 mm
50 – 250	neoprene isolator	10 mm	spring isolator or hanger	19 mm
Over 250	spring isolator or hanger	19 mm	spring isolator or hanger	25 mm

.3 Provide flexible conduit to make the connection to the transformer.

6.8 Structural

.1 Specify minimum 130 mm thick concrete for mechanical room floors, to minimize structural vibration problems.

.2 Allow for a minimum of 100 mm thick concrete housekeeping pad for major mechanical equipment. Refer to mechanical consultant for further requirements.

.3 Design structural steel supporting floors to prevent transient footstep induced vibration from exceeding the annoyance threshold. Refer to *CISC Handbook for Steel Construction* - Appendix G, Guide for Floor Vibration.

.4 Ensure that rooftop mechanical equipment is located on a stiff portion of a lightweight roof to avoid resonance problems. If the dead load of the equipment causes the roof structure to deflect more than 6 mm, then additional roof stiffening is recommended.

6.9 Exterior Acoustic Insulation

.1 Design adequate exterior acoustic insulation for all occupied buildings built within an Airport Vicinity Protection Area established by an APVA regulation. Use Part 11 of the most recent Alberta Building Code and the CMHC guideline *New Housing and Airport Noise* to develop exterior construction details.

End of Acoustical Section

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7.0 Introduction

.1 Barrier-free accessibility in existing buildings is important to Alberta Infrastructure. All requirements of the latest edition of the Alberta Building Code (ABC) must be considered in addition to the barrier-free issues mentioned herein to ensure that modifications maintain the safety and usability of buildings.

.2 Use Article 7.2 to determine the level of accessibility required in the existing building and then use the remainder of this section judiciously to establish a means of providing this accessibility.

.3 This Section identifies items to be considered when addressing the issue of barrier-free accessibility for existing buildings for persons with physical, sensory and developmental disabilities. These items are broken down so as to be readily accessible for small projects or combined as required to suit large projects.

.4 Requirements are described in conformance with the "critical path method" which provides the order in which requirements should follow in sequence. If the sequence is not followed, portions of the building may be upgraded to barrier-free status but may not be accessible. For example, a washroom may have been upgraded, including all washroom items including door opening size, but if there is not the required space adjacent to the door to accommodate operation of the door by persons with disabilities the washroom is not barrier-free accessible.

.5 A guide, "*Design Aid for Barrier-Free Accessibility in Existing Buildings*" is available to provide tips to the Designer to help avoid some problems that may arise when addressing Barrier-Free Accessibility in existing buildings.

7.1 References

.1 *Alberta Building Code*, latest edition

.2 *Barrier-free Design Guide*, prepared by the Barrier-free Design Advisory Committee of the Safety Codes Council and with the assistance of Alberta Municipal Affairs.

.3 *CAN/CSA-B651-95, Barrier-Free Design*, Canadian Standards Association.

.4 *Design Aid for Barrier-Free Accessibility in Existing Buildings* prepared by Alberta Infrastructure to assist the Designer in avoiding some problems that may arise when addressing Barrier-Free Accessibility in existing buildings.

7.2 Level of Barrier-Free Accessibility

.1 The first step in developing a barrier-free accessibility upgrading project is to set the level of accessibility based on general objectives and funding available. Select a level for each of the three variables below:

Number of Floors

- Main Floor only
- Main Floor plus other floor(s)
- All Floors

Extent of Upgrade

- Public Areas Only
- Throughout

Standard of Upgrade

- To meet the Alberta Building Code (ABC)
- To meet the ABC plus CSA Standard B651

.2 Thus the minimum level of upgrade, based on this classification system, is Main Floor/Public Areas Only/Alberta Building Code and the maximum level is All Floors/Throughout/ABC plus CSA-B651.

.3 Notwithstanding the foregoing, the level of barrier-free accessibility or portions thereof, shall be determined by Alberta Infrastructure on an individual project basis.

7.3 Design Requirements

7.3.1 Use of Reference Documents

.1 Refer to Section 3.8 of the Alberta Building Code (ABC), which provides the minimum requirements for Barrier-Free Design, to the fullest extent possible in conjunction with the remainder of the ABC. In some cases major work may be required and in other cases minimal work may be required to provide the minimum acceptable level of barrier-free access depending on the scope of work for the individual project.

.2 Refer to the “Barrier-Free Design Guide” for graphic and written examples to illustrate code requirements and elements of good Barrier-Free Design.

.3 Refer to the CSA Standard B-651 for design assistance. Wherever possible, incorporate the requirements of this standard into the design, within the scope of work of the individual project. Some of the requirements of this standard are beyond the requirements of the Alberta Building Code.

.4 Where the ABC and CSA Standard B-651 address the same issues, when practical, the more stringent recommendations should govern.

7.3.2 Level of Accessibility

.1 Consult with Alberta's Infrastructure to determine level of accessibility required for the project in accordance with Article 7.2.

7.3.3 Code Analysis

.1 Perform a comprehensive building code analysis of the particular building including building occupancy, occupant load, fire resistance rating requirements, corridor and stair widths, exit requirements, and required number of water closets and lavatories based on occupant load. Note that occupant load is based upon area available for people, not number of persons using the building. Optimally all concerns should be addressed.

7.3.4 Design Development

.1 Ensure all the following issues are addressed in order, unless directed otherwise by Alberta Infrastructure.

  .1 Site Accessibility

    .1 Consider barrier-free parking, complete with curbcuts/ramps, exterior lighting, and signage.

  .2 Building Access

    .1 Building Entrance Accessibility: consider method of accessing the building entrance from the street, parking areas and walkways.

    .2 Building Entrance: consider thresholds, powered door operators, location of controls, guard rails and required number of barrier-free entrances.

  .3 Accessibility of Path of Travel within Main Level

    .1 Access to Facilities: consider width of corridors and exits, differing elevations of floor levels, flooring requirements, door width and door location requirements, door hardware requirements.

.4 Personal Facilities

.1 Hygienic Facilities: determine if existing washrooms can be modified or if it is more feasible to introduce new separate washrooms to meet barrier-free requirements. Then consider required sizes of facilities, building plumbing fixture requirements, washroom accessories and mounting heights.

.2 Personal Use Facilities: consider requirements for drinking fountain/coolers and public phones.

.5 Accessibility to Other Levels

.1 Stairwells: consider stair width, landing sizes, stair surfaces and nosings, handrails and guardrails, and lighting.

.2 Chair Lifts: determine if chair lifts can be used to provide access to other levels while ensuring the required exit width is not minimized when chair lift is in operation.

.3 Platform Lifts: consider the travel distance limits and location. Generally platform lifts are only acceptable for use within one floor level.

.4 Enclosed Platform Lifts: consider use restrictions, travel distance limits, requirements for shaft and machine room, and location.

.5 Elevators: consider size, travel distances and speed, suitability of various types, location, accessibility and design of controls.

.6 Accessibility of Path of Travel Within Other Levels

.1 Consider the requirements of Paragraph 4.3 and 4.4 for each accessible floor to provide at least the same level of barrier-free accessibility provided on the first barrier-free level with the possible exception of public phones.

.7 Emergency Services: Emergency Lighting, Exit Signs, Fire Alarm

.8 Signage within the Barrier-Free Path of Travel

.1 Minimum Requirements: provide signage for barrier-free services and facilities provided.

.9 Building Security

.1 User Actuated Systems: consider mounting heights of actuation devices and requirements for audible and visual signals to indicate when door lock is released.

.2 Remote Actuated Systems: consider mounting heights of call devices and requirements for audible and visual signals to indicate when door lock is released.

End of Barrier-Free Accessibility in Existing Buildings Section

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8.1 References

.1 *Geometric Design Standards for Canadian Roads and Streets*, by the Roads and Transportation Association of Canada.

.2 Alberta Environmental Protection:

- *Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Facilities*
- *Stormwater Management Guidelines*
- *Risk Management Guidelines for Petroleum Storage Tank Sites*

.3 Alberta Fire Code, by the Alberta Fire Prevention Council.

.4 Uniform Traffic Control Devices for Canada, by the Council on Uniform Traffic Control Devices for Canada.

.5 Local municipal standards, guidelines and by-laws.

.6 Flood Risk Management Guidelines, by Alberta Infrastructure.

.7 Propane Installation Code: CAN/CGA-B149.2.

.8 Canadian Standards Association (CSA).

8.2 Site Selection

.1 Prior to acquiring a property:

.1 Confirm site is suitable for proposed development as per the attached Table A in Appendix B. For a copy of the "Flood Risk Management Guidelines" contact Alberta Infrastructure.

.2 Complete or review existing Environmental Site Assessments (ESAs) to determine environmental liability of site.

.3 Consult with authority having jurisdiction to determine if there are any archeological restrictions for this site.

.4 Determine if direct or indirect access to a highway is required and if adequate road access is available to the site.

.5 Determine if a Traffic Impact Assessment (TIA) is required and if public transportation is available and adequate.

.6 Proposed development must be in compliance with planning/zoning requirements. Confirm need for storm water management on site.

.7 Confirm that site topography is suitable for the project.

.8 Confirm availability of offsite services such as power, water, sanitary, storm and natural gas.

.9 Fill out the Transportation & Site Requirements Checklist in Appendix C.

8.3 Site Survey Plan and Site Plan

.1 Conduct site survey and prepare a site survey plan if required.

.2 From the information on the site survey plan, include the following items on the site plan in the contract documents:

.1 Legal description and address of the property, property lines and their legal dimensions, and legal pins.

.2 Adjacent trees, sidewalks, roadways, utilities, easements and how the new development will tie to them.

.3 Work of the contract and work by other forces and contracts.

.4 Main floor elevations and geodetic datum and the equated elevation.

.5 All utilities, including power and telephone.

8.4 Site Access

.1 Design the location of site access in consideration to driveways and intersections adjacent to and opposite the site.

8.5 Site Signs

.1 Determine the locations of signs with due consideration to vehicular sight lines.

8.6 Site Grading

.1 Grade site to a minimum of 2% to drain surface water away from buildings.

.2 Address potential ponding and icing problems associated with downspouts. Provide splash pads under downspouts.

8.7 Roads, Walks and Parking

.1 Design driveways and off-site walks to meet local municipal standards.

.2 Maintain minimum grade of 1% for concrete and asphalt surfaces.

.3 Maintain minimum grade of 2% for graveled surfaces.

.4 Provide roadways with a 2% crown or crossfall. Provide sidewalk with 2% crossfall.

.5 Provide barrier-free access walkways, entrances and parking spaces, along with appropriate surfaces that do not restrict the mobility of physically disabled people.

.6 Lay out parking lots and locate parking fixtures to facilitate snow clearing and removal and to avoid damage from snow moving equipment.

.7 In order to address a potential safety concern, efforts should be made to separate main vehicular traffic from the main pedestrian traffic.

.8 Design for snow dumping areas to reduce snow removal requirements.

.9 Do not obstruct parking lot user access to electrical plug-ins.

.10 Provide a pavement structure cross-section for parking and roadways.

.11 For roads and parking lots where heavy trucks are anticipated, design pavement structure based on traffic projections and the California Bearing Ratio.

.12 Provide protective concrete sealers on concrete walks located in prominent areas where de-icing agents will be used.

.13 Provide a concrete pad for garbage bin and locate bin for ease of access and safety.

8.8 Utilities

.1 Provide dimensions of utilities to property lines or use a grid coordinate system.

.2 Where utilities are to be connected to municipal systems, confirm with municipalities and utility companies the adequacies of their systems to service the site.

.3 Where utilities are to be connected to existing on-site systems, advise the user department and confirm that the existing on-site systems can accommodate the additional loads.

.4 Early in the design, confirm with municipalities about any restrictions on stormwater discharge to their stormwater drainage system.

.5 Contact the local municipality to confirm the municipal water pressure, and fire flow capacity. Determine whether on-site boosting is required for a fire sprinkler system.

.6 On large sites, locate utilities in utility corridors, keeping in mind any potential for future development.

8.9 Tanks for Petroleum Products

.1 Comply with requirements of the *Alberta Fire Code*, published by the Alberta Fire Prevention Council.

.2 Verify the need for fuel tanks in consultation with Alberta Infrastructure and Transportation and Transportation (Site Services). Consider using day tanks for emergency generators.

.3 Where need for tanks is confirmed, provide above ground tanks.

.4 Clean up contaminated sites according to *Risk Management Guidelines for Petroleum Storage Tank Sites*.

End of Site Services Section

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9.1 References

.1 Alberta Agriculture, Food and Rural Development Documents:

.1 Alberta Yards and Gardens: What to Grow;

.2 Backyard Pest Management;

.3 Pruning in Alberta.

.2 Alberta Infrastructure Documents:

.1 Manual for Maintenance of Grounds.

.3 Local municipality landscape requirements.

9.2 Exterior Landscape Development

.1 Include municipal boulevards in the landscape design and construction.

.2 Retain as many trees on site as feasible; protect trees and their roots by hoarding. Maintain existing grades to the drip lines of trees, or provide tree wells to compensate for change in grades. Remove existing trees from site that are considered hazardous to property and public safety.

.3 Grade topsoil to drain surface water away from buildings and walkways. Provide positive drainage within tree pits having a tree grate covering.

.4 Design with consideration to maintenance requirements of selected plant and grass varieties, availability of water for maintenance, and soil conditions for plant and grass growth.

.5 In grass areas, provide enough distance between trees and other features to accommodate cost effective mowing equipment. Avoid sharp angles and tight spaces that would make lawn maintenance difficult and unsafe.

.6 Space all plants at no less than 60% of mature spread.

.7 Keep tops of berms free of trees, shrubs and plant beds.

.8 Design slopes, including grassed berms, at less than 3:1 and free from hazardous maintenance requirements.

.9 Design all planters to have minimum planting width of 1.5 m, with minimum 300 mm depth of gravel for drainage and minimum 600 mm depth of soil mix. Provide weeping holes at planter bases.

.10 Consider the use of plant varieties that are indigenous to the locality.

.11 Subject to budget considerations, sod areas adjacent to the building, areas of high pedestrian traffic and difficult seed establishment areas. Use appropriate grass seed mixtures on other areas.

.12 Provide adequate maintenance in contract for all plants and grass areas until established.

9.3 Planting Near Buildings and Utilities

.1 Provide mulches for dry areas under building overhangs. Do not design these areas for plants.

.2 Locate shrubs at least 750 mm from foundations and edges of sidewalks.

.3 Select small trees or high shrubs with a mature height of 3 m, for areas within 15 m of any overhead utility.

.4 Do not locate trees within the immediate vicinity of underground utility lines.

.5 Do not obscure exterior lighting and building signs with plants.

9.4 Irrigation Systems

.1 Where geotechnical information indicates the presence of highly plastic clay, avoid locating irrigation outlets close to buildings. Changes in moisture content in this type of clay results in volume changes and movement that can damage floors and foundations.

.2 Provide exterior hose bibbs on buildings at every 50 m along building walls.

.3 In municipalities where sewage treatment charges are based on water consumption, provide separate meter if cost efficient.

.4 Where practical, contain all irrigation systems and equipment within the property lines of the project.

.5 Provide pipe sleeves for irrigation systems under roadways and sidewalks. Ensure complete coverage of landscape areas. Design irrigation systems to allow for emptying water from distribution pipes.

.6 Incorporate rain sensors in irrigation systems to prevent overwatering.

.7 Specify low water use systems where appropriate.

.8 Consult with user department before considering irrigation systems for landscape areas other than those adjacent to facilities.

9.5 Interior Landscape Development

.1 Provide gravel for drainage in all planting areas and planters.

.2 In atria, ensure access for maintenance requirements.

.3 Provide adequate lighting conditions to meet growing requirements of selected interior plants.

.4 Provide interior hose bibbs every 15 m along building walls in atria.

.5 Use high quality artificial plants in buildings where maintenance of live tropical plants is difficult or poor lighting conditions exist.

9.6 Environmental and Conservation Considerations

.1 Design to minimize maintenance requirements. Consider irrigation, mowing, trimming, pruning, fertilizing, pesticide application and general clean-up requirements.

.2 Use mulches to reduce maintenance and watering requirements for trees and shrubs.

.3 Minimize the requirement for irrigation through selection and placement of plant material.

.4 Minimize mowed grass areas. Use low maintenance ground cover plantings, including low maintenance grass mixes, where appropriate.

.5 Use plant material to reduce heating and cooling requirements for buildings.

.6 Use plant material to control snow drifting.

End of Landscape Development Section

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10.1 Site Considerations

.1 Prior to purchasing a property, hire an experienced environmental consultant to complete a Phase I Environmental Site Assessment (ESA), to determine if any site contamination is present. Consult with Alberta Infrastructure – Site Services Branch.

.2 If the property contains buildings refer to building considerations below.

10.2 Building Considerations

.1 For existing facilities a hazardous materials audit should occur whenever a building will be renovated or demolished, and when suspect materials are in poor condition. The area of the audit should reflect the project scope. The audit can be conducted by an experienced environmental consultant or by Alberta Infrastructure technical staff.

.2 A hazardous materials audit should include identification, recommendations, and a removal/disposal cost estimate for the following:

- .1 Asbestos containing building materials.
- .2 Chlorofluorocarbons (CFC's) in mechanical equipment used for cooling.
- .3 Chemicals such as water treatment solutions, glycol, cleaning solutions and laboratory chemicals.
- .4 Lead sheeting used in roofing, x-ray rooms and for acoustical privacy.
- .5 Lead used in batteries and paint.
- .6 Mercury used in switches, thermostats and thermometers.
- .7 Polychlorinated Biphenyl's (PCB's) containing oil, used in light fixture ballasts and electrical transformers.
- .8 Radioactive components such as those found in smoke detectors.
- .9 Mould growing on building materials.

.3 All identified hazardous materials that will be disturbed in a renovation/demolition are usually completely removed. Hazardous materials removal/disposal is usually the first component of work in a renovation/demolition. Contact Building Environmental Unit in Building Sciences Section technical staff if in doubt.

.4 For a list of typical asbestos containing materials refer to Alberta Infrastructure - Technical Bulletin No. 20A (latest edition) available from Alberta Infrastructure - Technical Services Branch.

.5 When there is a concern about whether an existing building material is asbestos or mould containing, it should be considered as potentially harmful, and safe work procedures should be used, unless testing confirms the material to be non-asbestos or non-mould containing. Consult with Alberta Infrastructure technical staff for proper safe work procedures and testing laboratories.

.6 When selecting materials for a new building or an existing building renovation, asbestos containing materials should be avoided. Typical asbestos products manufactured today are considered non-friable materials (i.e. board and pipe products only). Also, mould resistant products are becoming more readily available.

.7 When selecting materials for a new building or an existing building renovation, avoid the potential for harmful chemical off-gassing wherever possible. Examples include materials or products such as carpeting, glues, paints, particleboard furniture, etc., that may contain formaldehyde or volatile organic compounds. These materials or products should be off-gassed off site, prior to installing them in the building.

.8 Construction dust control and clean-up procedures should be implemented to assure building occupants are not overexposed to dust. Controls would include dust barriers, negative air pressure within the construction area, and sealing mechanical ventilation ductwork. Clean-up procedures would include HEPA vacuuming, wet wiping techniques and ductwork cleaning.

End of Environmental Section

AC/h (also ACH)........*air changes per hour*

ADA...........................*Americans with Disabilities Act*

APEGGA....................*Association of Professional Engineers, Geologists and Geophysicists of Alberta*

ARCA..........................*Alberta Roofing Contractors Association*

ASHRAE.....................*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.*

ASTM..........................*American Society for Testing and Materials*

CAC...........................*ceiling attenuation class*

CCU ....*central control unit*

CFC............................*chlorinated fluorocarbon*

CISC...........................*Canadian Institute of Steel Construction*

CMHC........................*Canada Mortgage and Housing Corporation*

CSA ....*Canadian Standards Association*

CSC ....*Construction Specifications Canada*

CSTC..........................*ceiling sound transmission class*

DDC...........................*distributed digital control*

EMCS.........................*energy management control system*

HID ....*high intensity discharge*

HVAC.........................*heating, ventilating & airconditioning*

IEEE...........................*Illumination, Electrical and Electronic Engineers*

IES..............................*see IESNA*

IESNA.........................*Illuminating Engineering Society of North America*

LAN ....*local area network*

LED............................*light emitting diode*

MBM ....*modified bituminous membrane*

MCC...........................*motor control centre*

NC ....*noise criteria*

NRC...........................noise reduction coefficient (also National Research Council)

PERSIST.....................Pressure Equalized Rain Screen Insulated Structure Technique

RC ....room criterion (acoustics)

RCU...........................remote control unit

RSI..............................thermal resistance in SI units

SI ....Système Internationale (metric system)

SMACNA....................Sheet Metal & Air Conditioning Contractors National Association

STC.............................sound transmission class

TCU...........................terminal control unit

ULC............................Underwriters Laboratories of Canada

UPS ....uninterruptible power supply

UV ....ultraviolet

VAV ....variable air volume

TABLE A – FACILITY CLASSIFICATION AND PREFERRED DESIGN FLOOD ELEVATION LEVELS FOR ALBERTA INFRASTRUCTURE OWNED AND FUNDED NEW FACILITIES ς

		CLASS	IMPORTANCE OF AVOIDING MAJOR DAMAGE DURING A FLOOD EMERGENCY	DESIGN FLOOD LEVEL	EXAMPLES OF FACILITIES	COMMENTS
Decreasing consequence assuming adequate warning	Lifeline facilities	1	Critical to the ability to save and avoid loss of human life.	1:1000	Legislative buildings Communication centres	 Including computing centres
		2	Critical to the ability to rescue and treat the injured and to prevent secondary hazards.	1:1000	Hospitals and medical facilities Extended care facilities	Including ancillary facilities such as power plants, service and maintenance facilities
		3	Critical urban linkages important to the maintenance of public order and welfare.	1:500	Courthouses Provincial Buildings	Serve as government centres for communication in event of emergency
		4	Critical to the ongoing housing of substantial populations.	1:500	Schools Post-secondary educational facilities Seniors Residences High-rise buildings Correctional facilities Rehabilitation treatment centres	Schools and post-secondary educational facilities may be required to serve as emergency relief centres.
		5	Critical to the orderly return to long term social and economic welfare.	1:500	Airports	Critical for access for supplies and support.
	Other facilities	6	Important to the ability to avoid endangering human life and environment.	1:1000	Hazardous waste disposal and treatment facilities High risk research facilities	
		7	Important to retention of documented historical data and artifacts.	1:1000	Museums, archives, cultural centres	
		8	Important to provide threshold level of protection.	1:100	Offices Retail facilities Warehouse Service & maintenance Parking Other	Other than those associated with facilities in the higher Design Flood Level categories See comments under Site Selection for short-term use facilities.

ς Water and Wastewater Facilities are not included in Table A. Contact Alberta Environment for guidelines, related to the location of these facilities, entitled “Standards and Guidelines for Municipal Waterworks , Wastewater and Storm Drainage Systems” published in Dec. 1997 by Alberta Environmental Protection.

Appendix 'C'

Transportation & Site Requirement Checklist for Projects Funded by Alberta Infrastructure

Project:	
Location/Facility:	

Jurisdiction/RHA: ______________________

Contact: ______________________

Tel: ______________________

Items to consider in the site selection/development process:	**Yes**	**No**	**Problem Resolved**	**Comments on any problems, project implications and plan to resolve.**
Is direct or indirect access to a highway required?	☐	☐	☐	
Is adequate road access available?	☐	☐	☐	
Is a Traffic Impact Assessment (T.I.A.) required?	☐	☐	☐	
Is Public Transportation available & adequate?	☐	☐	☐	
Compliance with planning / zoning requirements?	☐	☐	☐	
Phase 1 Environmental Site Assessment completed?	☐	☐	☐	
Are further environmental assessments warranted?	☐	☐	☐	
Is the site topography suitable for the project?	☐	☐	☐	
Is the site outside the appropriate floodplain? (as per Appendix 'B')	☐	☐	☐	
Does the site have stormwater management requirements?	☐	☐	☐	
Are offsite services such as power / water / sanitary / storm / gas available?	☐	☐	☐	
Have geotechnical / foundation concerns been considered?	☐	☐	☐	

Other Concerns:

____

Branch: ______________________

Project Manager: ______________________

Date: ______________________