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INTRODUCTION

The purpose of this guide is to provide design professionals, contractors, and building officials responsible for the MEP, Mechanical, Electrical, and Plumbing, with the information and guidance required to ensure that the seismic restraints required for a specific project are selected and/or designed, and installed in accordance with the code provisions. This guide will be written in several easily referenced sections that deal with specific portions of the code.

This guide is based on the National Building Code of Canada 2005 (NBCC 2005). The NBCC 2005 appears to be very different in the formulation of the design forces than the previous NBCC 1995 version. This document will be based entirely on the newer NBCC 2005 version.

1. National Building Code of Canada 2005; Canadian Commission on Building and Fire Codes and National Research Council of Canada, 1200 Montreal RD, Ottawa, ON K1A 9Z9 Chapter Division B – Part 4 Structural Design.

The selection and installation of the proper seismic restraints for MEP systems requires good coordination with the design professionals and contractors involved with the building project. A good spirit of cooperation and coordination is especially required for projects that have been designated as post-disaster buildings, such as hospitals, emergency response centers, police and fire stations. Coordination between the various design professionals and contractors will be a constant theme throughout this guide. This coordination is vital for the following reasons.

1. The seismic restraints that are installed for a system can and will interfere with those of another unless restraint locations are well coordinated.
2. The space required for the installed restraints can cause problems if non-structural walls need to be penetrated, or other MEP components are in the designed load path for the restraints.

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3. The building end of the seismic restraints must always be attached to structure that is adequate to carry the code mandated design seismic loads. It is the responsibility of the structural engineer of record to verify this.

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REQUIRED BASIC PROJECT INFORMATION

D2.9 – 2.1 Introduction:

As with any design job, there is certain basic information that is required before seismic restraints can be selected and placed. The building owner, architect, and structural engineer make the decisions that form the basis for the information required to select the seismic restraints for the pipe and duct systems in the building. This is information that should be included in the specification and bid package for the project. It also should appear on the first sheet of the structural drawings. For consistency, it is good practice to echo this information in the specification for each building system, and on the first sheet of the drawings for each system. In this fashion, this information is available to all of the contractors and suppliers that will have a need to know.

D2.9 – 2.2 Building Use – Nature of Occupancy [Sentence 4.1.2.1][1]:

How a building is to be used greatly affects the level of seismic restraint that is required for the MEP (Mechanical, Electrical, and Plumbing) components. In the NBCC 2005 the building use is defined through the Importance Category, which ranges in four stages from Low to Post-Disaster. Table 2-1 below summarizes the information found in Tables 4.1.2.1 of the NBCC 2005. The nature of the building use, or its Occupancy Category, is determined by the building owner and the architect of record.

[1] References in brackets [Sentence 4.1.2.1 and Table 4.1.2.1] apply to sections, tables, and/or equations in the National Building Code of Canada 2005.

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Table 2-1; Importance Category vs. Building Use and Occupancy [Table 4.1.2.1]

Importance Category	Building Use or Nature of Occupancy
Low	Buildings whose failure will present a low direct or indirect hazard to human life Ø Low human occupancy buildings where structural collapse is unlikely to cause injury or other serious consequences. Ø Minor storage buildings and structures.
Normal	Buildings not listed as Importance Category Low, High, or Post-Disaster.
High	Buildings which are likely to be used in Post-Disaster situations as shelters, which will include the following building types: Ø Elementary, middle, or secondary schools. Ø Community centers. Manufacturing and storage facilities which contain toxic, explosive, or hazardous materials in sufficient quantities to pose a hazard to the public is released, such as: Ø Petrochemical facilities. Ø Fuel storage facilities Ø Manufacturing and storage facilities for dangerous goods.
Post-Disaster	Buildings and structures which are designated as essential facilities which include but are not limited to: Ø Hospitals, emergency treatment facilities, and blood banks. Ø Emergency response facilities, fire, rescue, ambulance, and police stations, housing for emergency response equipment, and communications facilities including radio and television, unless exempted by the jurisdiction having authority). Ø Power generating stations and sub-stations. Ø Control centers for air land and marine transportation. Ø Water treatment, storage, and pumping facilities. Ø Sewage treatment facilities and buildings or structures required for national defense.

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D2.9 – 2.3 Site Class – Soil Type [Sentences 4.1.8.4.(2) and 4.1.8.1.(3)]:

The Site Class is related to the type of soil and rock strata that directly underlies the building site. The Site Class ranges from A to F progressing from the stiffest to the softest strata. Table 2-2 lists the various Site Classes and their corresponding strata.

Generally the structural engineer is responsible for determining the Site Class for a project. If the structural engineer's firm does not have a geotechnical engineer on staff, this job will be contracted to a geotechnical firm. The site profile is normally obtained by drilling several cores on the property. Unlike the U. S. building codes, there is no published default Site Class that may be that can be substituted for the actual Site Class that is determined from soils testing performed at the actual project location.

Table 2-2; Site Class vs. Soil Type [Table 4.1.8.4A]

Site Class	Soil Type
A	Hard Rock
B	Rock
C	Very Dense Soil & Soft Rock
D	Stiff Soil
E	Soft Soil
F	Liquefiable Soils, Quick Highly Sensitive Clays, Collapsible Weakly Cemented Soils, & etc. These require site-specific evaluation.

D2.9 – 2.4 Spectral Response Acceleration Value at 0.2 Second [Sentence 4.1.8.4.(1) and Table C-2]

The Spectral Response Acceleration Values at 0.2 Second, which are denoted as $S_{a(0.2)}$, have been determined for selected location in Canada and documented in the Canadian Journal of Civil Engineering, Volume 10, Number 4, pp 670-680, 1983. These values for selected location in Canada are presented in Table C-2 of the NBCC 2005, and are repeated for convenience below in Table 2-3

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Table 2-3; Spectral Response Acceleration Value at 0.2 Second for Selected Locations in Canada [Table C-2]

Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
British Columbia	------	Masset	0.53	Langley	1.10
100 Mile House	0.28	McBride	0.27	New Westminster	0.99
Abbotsford	0.92	Mcleod Lake	0.18	North Vancouver	0.88
Agassiz	0.67	Merrit	0.32	Richmond	1.10
Alberi	0.75	Mission City	0.93	Surrey (88 Ave & 156 St.)	1.10
Ashcroft	0.33	Montrose	0.27	Vancouver	0.94
Beatton River	0.12	Nakusp	0.27	Vancouver (Granville & 41 Ave)	0.88
Burns Lake	0.12	Nanaimo	1.00	Vernon	0.27
Cache Creek	0.33	Nelson	0.27	***Victoria Region***	------
Campbell River	0.62	Ocean Falls	0.38	Victoria (Gonzales Hts.)	1.20
Carmi	0.28	Osoyoos	0.28	Victoria (Mt. Tolmie)	1.20
Castlegar	0.27	Penticton	0.28	Victoria	1.20
Chetwynd	0.24	Port Alberni	0.75	Williams Lake	0.28
Chilliwack	0.73	Port Hardy	0.43	Youbou	1.00
Comox	0.66	Port McNeill	0.43	**Alberta**	------
Courtenay	0.65	Powell River	0.67	Athabasca	0.12
Cranbrook	0.27	Prince George	0.13	Banff	0.24
Crescent Valley	0.27	Prince Rupert	0.38	Barrhead	0.12
Crofton	1.10	Princeton	0.42	Beaverlodge	0.13
Dawson Creek	0.12	Qualicum Beach	0.82	Brooks	0.12
Dog Creek	0.32	Quesnel	0.27	Calgary	0.15
Duncan	1.10	Revelstoke	0.27	Campsie	0.12
Elko	0.27	Salmon Arm	0.27	Camrose	0.12
Fernie	0.27	Sandspit	0.56	Cardston	0.18
Fort Nelson	0.12	Sidney	1.20	Claresholm	0.15
Fort St. John	0.12	Smith River	0.52	Cold Lake	0.12
Glacier	0.27	Smithers	0.12	Coleman	0.24
Golden	0.26	Squamish	0.72	Coronation	0.12
Grand Forks	0.27	Stewart	0.30	Cowley	0.20
Hope	0.63	Taylor	0.12	Drumheller	0.12
Kamloops	0.28	Terrace	0.34	Edmonton	0.12
Kaslo	0.27	Tofino	1.20	Edson	0.15
Kelowna	0.28	Trail	0.27	Embarras Portage	0.12
Kimberley	0.27	Ucluelet	1.20	Fairview	0.12
Kitimat Plant	0.37	***Vancouver Region***	------	Fort MacLeod	0.16
Kitimat Townsite	0.37	Burnaby (Simon Fraser Univ.)	0.94	Fort McMurray	0.12
Lilooet	0.60	Cloverdale	1.00	Fort Saskatchewan	0.12
Lytton	0.60	Haney	0.97	Fort Vermilion	0.12
Mackenzie	0.23	Ladner	1.10	Grande Prairie	0.12

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Table 2-3 Continued; Spectral Response Acceleration Value at 0.2 Second for Selected Locations in Canada [Table C-2]

Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
Alberta	------	Humboldt Bay	0.12	Selkirk	0.12
Habay	0.12	Island Falls	0.12	Spit Lake	0.12
Hardisty	0.12	Kamsack	0.12	Steinbach	0.12
High River	0.15	Kindersley	0.12	Swan River	0.12
Hinton	0.24	Lloydminster	0.12	The Pas	0.12
Jasper	0.24	Maple Creek	0.12	Virden	0.12
Keg River	0.12	Meadow Lake	0.12	Winnipeg	0.12
Lac la Bishe	0.12	Melfort	0.12	**Ontario**	------
Lacombe	0.12	Melville	0.12	Ailsa Craig	0.16
Lethbridge	0.15	Moose Jaw	0.12	Ajax	0.22
Manning	0.12	Nipawin	0.12	Alexandria	0.68
Medicine Hat	0.12	North Battleford	0.12	Alliston	0.17
Peace River	0.12	Prince Albert	0.12	Almonte	0.58
Pincher Creek	0.19	Qu' Appelle	0.12	Armstrong	0.12
Ranfurly	0.12	Regina	0.12	Arnprior	0.64
Red Deer	0.12	Rosetown	0.12	Atikokan	0.12
Rocky Mountain House	0.15	Saskatoon	0.12	Aurora	0.19
Slave Lake	0.12	Scott	0.12	Bancroft	0.26
Stettler	0.12	Strasbourg	0.12	Barrie	0.16
Stony Plain	0.12	Swift Current	0.12	Beaverton	0.16
Suffield	0.12	Uranium City	0.12	Belleville	0.26
Taber	0.12	Weyburn	0.23	Belmont	0.20
Turner Valley	0.15	Yorktown	0.12	Big Trout Lake	0.12
Valleyview	0.12	**Manitoba**	------	CFB Borden	0.16
Vegreville	0.12	Beausejour	0.12	Bracebridge	0.18
Vermilion	0.12	Boussevain	0.12	Bradford	0.18
Wagner	0.12	Churchill	0.12	Brampton	0.26
Wainwright	0.12	Dauphin	0.12	Brantford	0.24
Wetaskiwin	0.12	Flin Flon	0.12	Brighton	0.25
Whitecourt	0.12	Gimli	0.12	Brockton	0.40
Wimborne	0.12	Island Lake	0.12	Burk's Falls	0.21
Saskatchewan	------	Lac du Bonnet	0.12	Burlington	0.36
Assiniboia	0.17	Lynn Lake	0.12	Cambridge	0.22
Battrum	0.12	Morden	0.12	Campbellford	0.23
Biggar	0.12	Neepawa	0.12	Cannington	0.17
Broadview	0.12	Pine Falls	0.12	Carleton Place	0.52
Dafoe	0.12	Portage la Prairie	0.12	Cavan	0.20
Dundurn	0.12	Rivers	0.12	Centralia	0.14
Estevan	0.15	Sandilands	0.12	Chapleau	0.12

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Table 2-3 Continued; Spectral Response Acceleration Value at 0.2 Second for Selected Locations in Canada [Table C-2]

Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
Ontario	------	Grimsby	0.40	Mattawa	0.51
Chatham	0.20	Guelph	0.21	Midland	0.15
Chesley	0.13	Guthrie	0.16	Milton	0.30
Clinton	0.13	Haileybury	0.29	Milverton	0.15
Coboconk	0.18	Haldimand (Caledonia)	0.34	Minden	0.19
Cobourg	0.24	Haldimand (Hagersville)	0.29	Mississauga	0.31
Cochrane	0.21	Haliburton	0.21	Mississauga (Port Credit)	0.32
Colborne	0.24	Halton Hills (Georgetown)	0.25	Mitchell	0.14
Collingwood	0.14	Hamilton	0.33	Moosonee	0.15
Cornwall	0.67	Hanover	0.13	Morrisburg	0.63
Corunna	0.14	Hastings	0.23	Mount Forest	0.15
Deep River	0.66	Hawkesbury	0.65	Nakina	0.12
Deseronto	0.27	Hearst	0.12	Nanticoke (Jarvis)	0.26
Dorchester	0.19	Honey Harbour	0.15	Nanticoke (Port Dover)	0.23
Dorion	0.12	Hornepayne	0.12	Napanee	0.28
Dresden	0.18	Huntsville	0.20	New Liskeard	0.29
Dryden	0.12	Ingersoll	0.19	Newcastle	0.22
Dunnville	0.35	Iroquois Falls	0.21	Newcastle (Bowmanville)	0.21
Durham	0.14	Jellicoe	0.12	Newmarket	0.19
Dutton	0.20	Kapuskasing	0.14	Niagara Falls	0.41
Earlton	0.26	Kemptville	0.60	North Bay	0.29
Edison	0.12	Kenora	0.12	Norwood	0.22
Elmvale	0.15	Killaloe	0.48	Oakville	0.35
Embro	0.18	Kincardine	0.12	Orangeville	0.18
Englehart	0.25	Kingston	0.30	Orillia	0.16
Espanola	0.12	Kinmount	0.19	Oshawa	0.21
Exeter	0.14	Kirkland Lake	0.24	Ottawa	0.66
Fenelon Falls	0.18	Kitchener	0.19	Owen Sound	0.13
Fergus	0.18	Lakefield	0.20	Pagwa River	0.12
Forest	0.14	Lansdowne House Leamington	0.20	Paris	0.22
Fort Erie	0.40	Lindsay	0.18	Parkhill	0.15
Fort Erie (Ridgeway)	0.39	Lion's Head	0.15	Parry Sound	0.16
Gananoque	0.31	London	0.18	Pelham (Fonthill)	0.40
Geraldton	0.12	Lucan	0.16	Pembroke	0.66
Glencoe	0.19	Maitland	0.41	Penetanguishene	0.15
Goderich	0.12	Markdale	0.14	Perth	0.39
Gore Bay	0.12	Markham	0.22	Petawawa	0.66
Graham	0.12	Martin	0.12	Peterborough	0.20
Gravehurst (Muskoka Airport)	0.17	Matheson	0.22	Petrolia	0.16

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Table 2-3 Continued; Spectral Response Acceleration Value at 0.2 Second for Selected Locations in Canada [Table C-2]

Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
Ontario	------	Temagami	0.30	Beauport	0.60
Pickering (Dunbarton)	0.23	Thamesford	0.18	Bedford	0.60
Picton	0.26	Thedford	0.14	Beloeil	0.67
Plattsville	0.18	Thunder Bay	0.12	Brome	0.42
Point Alexander	0.66	Tillsonburg	0.20	Brossard	0.68
Port Burwell	0.21	Timmins	0.17	Buckingham	0.68
Port Colborne	0.38	Timmins (Porcupine)	0.19	Campbell's Bay	0.67
Port Elgin	0.12	***Toronto (Metropolitan)***	------	Chambly	0.67
Port Hope	0.23	Etobicoke	0.26	Chicoutimi	0.62
Port Perry	0.19	North York	0.24	Chicoutimi (Bagotville)	0.63
Port Stanley	0.20	Scarborough	0.24	Chicoutimi (Kenogami)	0.62
Prescott	0.44	Toronto	0.26	Coaticook	0.41
Princeton	0.20	Trenton	0.25	Contrecoeur	0.66
Raith	0.12	Trout Creek	0.25	Cowansville	0.48
Rayside-Balfour (Chelmsford)	0.14	Uxbridge	0.19	Deux-Montagnes	0.68
Red Lake	0.12	Vaughan (Woodbridge)	0.24	Dolbeau	0.31
Renfrew	0.63	Vittoria	0.21	Drummondville	0.50
Richmond Hill	0.22	Walkerton	0.13	Farnham	0.59
Rockland	0.66	Wallaceburg	0.18	Fort-coulonge	0.67
Sault Ste. Marie	0.12	Waterloo	0.19	Gagon	0.12
Schreiber	0.12	Watford	0.16	Gaspé	0.22
Seaforth	0.14	Wawa	0.12	Gatineau	0.68
Simcoe	0.22	Welland	0.40	Gracefield	0.62
Sioux Lookout	0.12	West Lorne	0.20	Granby	0.48
Smith Falls	0.42	Whitby	0.21	Harrington-Harbour	0.12
Smithville	0.40	Whitby (Brooklin)	0.20	Harve-St-Pierre	0.33
Smooth Rock Falls	0.19	White River	0.12	Hemmingford	0.68
South River	0.23	Wiarton	0.12	Hull	0.68
Southhampton	0.12	Windsor	0.18	Iberville	0.66
St. Catharines	0.41	Wingham	0.13	Inukjuak	0.12
St. Mary's	0.16	Woodstock	0.19	Joliette	0.63
St. Thomas	0.20	Wyoming	0.15	Jonquiére	0.62
Stirling	0.25	**Québec**	------	Kuujjuaq	0.12
Stratford	0.16	Acton-Vale	0.45	Kuujjuarapik	0.12
Strathroy	0.17	Alma	0.59	La-Malbaie	2.30
Sturgeon Falls	0.23	Amos	0.17	La-Tuque	0.29
Sudbury	0.15	Asbestos	0.37	Lac-Mégantic	0.40
Sundridge	0.22	Aylmer	0.67	Lachute	0.64
Tavistock	0.17	Baie-Comeau	0.66	Lennoxville	0.38

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Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
Québec	------	Richmond	0.38	**New Brunswick**	------
Léry	0.70	Rimouski	0.63	Alma	0.27
Loretteville	0.63	Rivière-du-loup	1.10	Bathhurst	0.41
Louisevilee	0.63	Roberval	0.43	Campbellton	0.39
Magog	0.38	Rock-Island	0.42	Chatham	0.41
Malartic	0.21	Rosemère	0.68	Edmundston	0.41
Maniwaki	0.66	Rouyn	0.20	Fredericton	0.39
Masson	0.66	Salaberry-de-Valleyfield	0.69	Gagetown	0.34
Matane	0.68	Schefferville	0.12	Grand Falls	0.42
Mont-Joli	0.62	Senneterre	0.20	Moncton	0.30
Mont-Laurier	0.66	Sept-Îles	0.37	Oromocto	0.36
Montmagny	0.89	Shawinigan	0.58	Sackville	0.25
Montréal Region	------	Shawville	0.67	Saint John	0.34
Beaconsfield	0.69	Sherbrooke	0.37	Shippagan	0.34
Dorval	0.69	Sorel	0.65	St. Stephen	0.66
Laval	0.68	St-Félicien	0.31	Woodstock	0.41
Montréal	0.69	St-Georges-de-Cacouna	0.98	**Nova Scotia**	------
Montréal-Est	0.68	St-Hubert	0.68	Amherst	0.24
Montréal-Nord	0.69	St-hubert-de-Temiscouata	0.64	Antigonish	0.19
Outremont	0.69	St-Hyacinthe	0.59	Bridgewater	0.23
Pierrefonds	0.69	St-jean	0.69	Canso	0.24
St-Lambert	0.69	St-Jérôme	0.64	Debert	0.22
St-Laurent	0.69	St-Jovite	0.63	Digby	0.26
Ste-Anne-de-Bellevue	0.69	St-Nicolas	0.59	Greenwood (CFB)	0.25
Verdun	0.69	Ste-Agathe-des-Monts	0.59	***Halifax Region***	------
Nicolet (Gentilly)	0.64	Sutton	0.44	Dartmouth	0.23
Nitchequon	0.12	Tadoussac	0.84	Halifax	0.23
Noranda	0.20	Témiscaming	0.59	Kentville	0.24
Percé	0.20	Thetford Mines	0.35	Liverpool	0.24
Pincourt	0.69	Thurso	0.63	Lockeport	0.26
Plessisville	0.45	Trois-Rivières	0.64	Louisburg	0.22
Port-Cartier	0.46	Val-d'Or	0.22	Lunenburg	0.23
Povungnituk	0.22	Varennes	0.68	New Glasgow	0.18
Québec City Region	------	Verchères	0.67	North Sydney	0.19
Ancienne-Lorette	0.60	Victoriaville	0.43	Pictou	0.18
Levis	0.58	Ville-Marie	0.33	Port Hawkesbury	0.21
Québec	0.59	Waterloo	0.41	Springhill	0.24
Sillery	0.58	Windsor	0.36	Stewiacke	0.22
Ste-Foy	0.59	------------------------------	------	Sydney	0.20

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Table 2-3 Continued; Spectral Response Acceleration Value at 0.2 Second for Selected Locations in Canada [Table C-2]

Province & Location	$S_{a(0.2)}$	Province & Location	$S_{a(0.2)}$
Nova Scotia	------	Echo Bay / Port Radium	0.12
Tatamagouche	0.19	Fort Good Hope	0.15
Truro	0.21	Fort Providence	0.12
Wolfville	0.25	Fort Resolution	0.12
Yarmouth	0.23	Fort Simpson	0.12
Prince Edward Island	------	Fort Smith	0.12
Charlottetown	0.19	Hay River	0.12
Souris	0.15	Holman	0.12
Summerside	0.19	Inuvik	0.12
Tignish	0.22	Mould Bay	0.35
Newfoundland	------	Norman Wells	0.51
Argentia	0.18	Rae-Edzo	0.12
Bonavista	0.17	Tungsten	0.51
Buchans	0.15	Yellowknife	0.12
Cape Harrison	0.24	**Nunavut**	------
Cape Race	0.20	Alert	0.12
Channel-Port aux Basques	0.15	Arctic Bay	0.18
Corner Brook	0.14	Arviat / Eskimo Point	0.18
Gander	0.16	Baker Lake	0.12
Grand Bank	0.18	Cambridge Bay	0.12
Grand Falls	0.15	Chesterfield Inlet	0.16
Happy Valley-Goose Bay	0.15	Clyde River	0.50
Labrador City	0.12	Coppermine	0.12
St. Anthony	0.15	Coral Harbour	0.24
St. John's	0.18	Eureka	0.33
Stephenville	0.14	Iqaluit	0.13
Twin Falls	0.12	Isachsen	0.40
Wabana	0.12	Nottingham Island	0.24
Wabush	0.12	Rankin Inlet	0.12
Yukon	------	Resolute	0.35
Aishihik	0.26	Resolution Island	0.44
Dawson	0.54	-------------------------------	------
Destruction Bay	0.73	-------------------------------	------
Snag	0.61	-------------------------------	------
Teslin	0.19	-------------------------------	------
Watson Lake	0.45	-------------------------------	------
Whitehorse	0.22	-------------------------------	------
Northwest Territories	------	-------------------------------	------
Aklavik	0.18	-------------------------------	------

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D2.9 – 2.5 Importance Factor for Earthquake Loads [Sentence 4.1.8.5 and Table 4.1.8.5]:

The Importance Factor for Earthquake Loads (I_E) for the building is assigned based on the Importance Category of the building. It may be prudent to request both the assigned Importance Category and the Importance Factor for Earthquake Loads. The Importance Factor for Earthquake Loads may be specified more stringently than the Importance Category of the building would indicate in order to artificially provide increased protection for the building and its contents. The Importance Factor for Earthquake Loads is assigned as shown in Table 2-4

Table 2-4; Importance Factor for Earthquake Loads by Importance Category [Table 4.1.8.5]

Importance Category	Importance Factor for Earthquake Loads I_E
Low	0.8
Normal	1.0
High	1.3
Post-Disaster	1.5

D2.9 – 2.6 Summary:

The following parameters will be required by the design professionals having responsibility for MEP systems in a building, and should be determined by the structural engineer of record.

1. Importance Category: This defines the building use and specifies which buildings are required for emergency response or disaster recovery.
2. Spectral Response Acceleration Value at 0.2 Second: This is used to determine the actual Lateral Design Seismic Force.
3. Importance Factor for Earthquake Loads: This is a numerical value that translates the building usage into the Lateral Design Seismic Force used to design and/or select seismic

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restraints for non-structural components. This value used in conjunction with the Spectral Response Acceleration Value at 0.2 Second will determine whether seismic restraints are required for non-structural components or not.

These parameters should be repeated in the specification and drawing package for the particular system, mechanical, electrical, or plumbing, in question.

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DESIGN SESIMIC FORCES

D2.9 – 3.1 Introduction:

The code based horizontal seismic force requirements for MEP systems and components are either calculated by the seismic restraint manufacturer as a part of the selection and certification process, or may be determined by the design professional of record for the MEP systems under consideration.

This is an informational section. It will discuss the code based horizontal seismic force demand equations and the variables that go into them. This discussion will provide a deeper understanding for the designer responsible for selecting the seismic restraints for MEP systems and their components and the nature of the seismic forces and the factors that affect them.

D2.9 – 3.2 Lateral Design Seismic Force [Sentence 4.1.8.17.(1)][1]:

The seismic force is a mass, or weight, based force, and as such is applied to the MEP component at its center of gravity. Keep in mind that the earthquake ground motion moves the base of the building first. Then the motion of the building will accelerate the MEP component through its supports and/or seismic restraints. The lateral seismic force acting on an MEP component will be determined in accordance with the following set of equations from NBCC 2005.

$$V_P = 0.3 F_a S_{a(0.2)} I_E S_P W_P$$ **Equation 3-1**

Where:

V_P = the Lateral Design Seismic Force

F_a = the acceleration based site coefficient. Values for this coefficient are given in Table 3-1 based on the site class. Linear interpolation between these values is permitted.

[1] References in brackets [Sentence 4.1.8.17.(1)] apply to sections, tables, and/or equations in the National Building Code of Canada 2005.

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I_E = the Importance Factor for Earthquake Loads for the building. See Section D2.9 – 2.5 of this guide.

S_P = the horizontal force factor for the non-structural component and its anchorage to the building.

W_P = the weight of the non-structural component.

The value for S_P is computed in the following fashion.

$$S_P = \frac{C_P A_r A_x}{R_P}$$ **Equation 3-2**

Where:

C_P = the seismic coefficient for mechanical and electrical equipment. These values are given per component category in Table 3-2.

A_r = the response amplification factor used to account for the type of attachment of the mechanical or electrical component to the building listed by component category in Table 3-2.

A_x = the amplification factor at the elevation of the component attachment point in the building. It is used to account for the increasing flexibility of the building from grade level to roof level.

R_P = the element or component response modification factor listed by component category in Table 3-2.

A_x is computed as follows.

$$A_x = \left(1 + 2\frac{h_x}{h_n}\right)$$ **Equation 3-3**

Where:

h_x = the elevation of the attachment point to the structure of the non-structural component.

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h_n = the elevation of the roof line.

The values for S_P must remain within the following limits.

$$0.7 \le S_P \le 4.0 \qquad \text{Equation 3-4}$$

Table 3-1; Acceleration Based Site Coefficient, F_a [Table 4.1.8.4]

Site Class	Spectral Response Acceleration Value at 0.2 Second (Linear Interpolation Is Permitted)				
	$S_{a(0.2)} \le 0.25$	$S_{a(0.2)} = 0.50$	$S_{a(0.2)} = 0.75$	$S_{a(0.2)} = 1.00$	$S_{a(0.2)} \ge 1.25$
A	0.7	0.7	0.8	0.8	0.8
B	0.8	0.8	0.9	1.0	1.0
C	1.0	1.0	1.0	1.0	1.0
D	1.3	1.2	1.1	1.1	1.0
E	2.1	1.4	1.1	0.9	0.9
F	These values to be determined by site response analysis.				

D2.9 – 3.3 Basis of Design for NBCC 2005 [Sentences 4.1.3.1.(1a), 4.1.3.2.(4), 4.1.3.2.(6), 4.1.3.2.(7), and 4.1.3.2.(8) and Table 4.1.3.2]:

The design of seismic restraints in the NBCC 2005 is based on the Ultimate Limit State. This limit state is used for design when life safety is at issue to prevent building or system collapse. This design basis along with the prescribed loads for earthquake design will produce results which are consistent with LRFD design techniques. Therefore; LRFD allowable loads may be used for the design and selection of seismic restraints for MEP components.

D2.9 – 3.4 Summary:

This section has provided an insight into the way in which the seismic design forces for MEP systems and components are to be computed. It is generally not necessary for a designer to

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actually run the computations for the seismic design forces. These forces are normally computed by the manufacturer of the seismic restraint devices as part of the selection and certification process to ensure that the proper components are selected per the code and the specification.

Table 3-2; Seismic Coefficient, Response Amplification Factor, and Response Modification Factor NBCC 2005 [Table 4.1.8.17]

Category	Non-Structural Component	C_P	A_r	R_P
7	Suspended light fixtures with independent vertical support	1.00	1.00	2.50
11	Machinery, fixtures, equipment, ducts, and tanks (including contents):	-----	------	------
	That are rigidly connected.	1.00	1.00	1.25
	That are flexible or flexibly connected.	1.00	2.50	2.50
12	Machinery, fixtures, equipment, ducts, and tanks (including contents) containing toxic or explosive materials, materials having a flash point below 38°C or firefighting fluids:	-----	------	------
	That are rigidly connected.	1.50	1.00	1.25
	That are flexible or flexibly connected.	1.50	2.50	2.50
13	Flat bottom tanks (including contents) that are attached directly to the floor at or below grade within a building.	0.70	1.00	2.50
14	Flat bottom tanks (including contents) that are attached directly to the floor at or below grade within a building that contain toxic or explosive materials, materials that have a flash point below 38°C or firefighting materials.	1.00	1.00	2.50
15	Pipes, ducts, cable trays (including contents)	1.00	1.00	3.00
16	Pipes, ducts, cable trays (including contents) containing toxic or explosive materials.	1.50	1.00	3.00
17	Electrical cable trays, bus ducts, conduits.	1.00	2.50	5.00
18	Rigid components with ductile material and Connections.	1.00	1.00	2.50
19	Rigid components with non-ductile material or Connections.	1.00	1.00	1.00
20	Flexible components with ductile material and Connections.	1.00	2.50	2.50
21	Flexible components with non-ductile material or Connections.	1.00	2.50	1.00

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GENERAL EXEMPTIONS AND REQUIREMENTS

D2.9 – 4.1 Introduction:

The National Building Code of Canada has limited exemptions for MEP components written in to it. The SMACNA Seismic Restraint Manual – Guidelines for Mechanical Systems, 2nd Edition with Addendum No. 1, 1998; is not directly referenced in the NBCC. Therefore, it is safe to assume that any exemptions in the SMACNA manual that have been previously taken are no longer allowed.

There are, however, some general exemptions for MEP components which will be covered in this section. Along with the exemptions, this section will the requirements for flexible/flexibly connected (isolated) components, direction of seismic design force application, structural connections, deflections, transfer of seismic forces to the building structure, and hanger rods for MEP components.

D2.9 – 4.2 General Acceleration Based Exemption for MEP Components [Sentences 4.1.8.1, and 4.1.8.17.(2)][1]

Sentence 4.1.8.1 is a general exemption for building, and also applies to those buildings that have been assigned to the Importance Category classified as Post Disaster. The deflections and loads due to earthquake motion as specified in Sentence 4.1.8.17, do not apply to MEP Components when $S_{a(0.2)} \leq 0.12$. Under this condition seismic restraints will not be required for MEP components.

The next general exemption is found in Sentence 4.1.8.17.(2) and applies to buildings that have been assigned to Importance Categories Low, Normal, and High. Section 2.9 – 3.0 of this guide

[1] References in brackets [Sentence 4.1.8.17.(2)] apply to sections, tables, and/or equations in the National Building Code of Canada 2005.

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covered the seismic design forces specified by the NBCC. The basic acceleration term multiplying the weight (mass) of the MEP component is $I_E F_a S_{a(0.2)}$. This term includes the importance of the building, the effects of the ground upon which the project is being built, and the expected horizontal acceleration produced by the design earthquake for the project location. This general exemption for MEP components is based on the value of this term. If $I_E F_a S_{a(0.2)} < 0.35$, then MEP components that fall into categories 7 through 21 in Table 3-2 of this guide do not require seismic restraint for buildings assigned to Importance Categories Low, Normal, and High.

D2.9 – 4.3 "Chandelier" Exemption [Sentence 4.1.8.17.(13)]

This exemption does not read exactly as the companion exemption in the International Building Code (IBC); see Kinetic's Guide to Understanding IBC Seismic for MEP, Section D2.1 – 4.5. So, for clarity it will be directly quoted below.

> Isolated suspended equipment and components, such as pendant lights, may be designed as a pendulum system provided that adequate chains or cables capable of supporting 2.0 times the weight of the suspended component are provided and the deflection requirements of Sentence 4.1.8.17.(11) are satisfied.

D2.9 – 4.4 Isolated vs. Rigidly Connected Components [Sentence 4.1.8.17.(4)]:

The NBCC basically says that MEP components that can be defined by Categories 11 and 12 in Table 3-2 of this Guide are to be treated as flexible/flexibly connected (isolated) components. If, however, the fundamental period of the component and its connections to the building structure can be shown to be less than or equal to 0.06 second, it mat be treated as though it were a rigid or rigidly connected component.

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D2.9 – 4.5 Design Horizontal Seismic Load Application [Sentence 4.1.8.17.(7)]:

The design horizontal seismic loads are to be applied in the direction the results in the most critical loading for the MEP component and its attachment to the structure. This will ensure that the most conservative design and selection of seismic restraints for the MEP component has been made.

D2.9 – 4.6 Connection of MEP Components to the Building Structure [Sentence 4.1.8.17.(8)]:

Connections for the MEP components to the building structure must be designed to resist gravity loads, meet the requirements of Sentence 4.1.8.1 of the NBCC, and also satisfy the following additional requirements.

1. Friction due to gravity loads may not be used to resist seismic forces.
2. The $\boldsymbol{R_P}$ value for non-ductile fasteners such as adhesives, powder shot pins, and other power actuated fasteners must be taken as 1.0.
3. Shallow embedment anchors, shallow expansion, chemical, epoxy, or cast-in-place, are those whose embedment depth to nominal diameter ratio is less than 8:1. For these types of anchors the value for $\boldsymbol{R_P}$ shall be taken as 1.5.
4. Drop in anchors and power actuated fasteners, such as powder shot pins, are not to be used in tensile applications.

D2.9 – 4.7 Lateral Deflections of MEP Components [Sentence 4.1.8.17.(10)]:

The lateral deflections based on design horizontal seismic force specified the Sentence 4.1.8.17.(1), see Section D2.9 – 3.0 of this guide, need to be multiplied by a factor of $\boldsymbol{R_P / I_E}$ to yield more realistic values for the anticipated deflections. The values of $\boldsymbol{R_P}$ and $\boldsymbol{I_E}$ are used to

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artificially inflate the loads to ensure the selection of seismic restraints and attachments that will meet the Post-Disaster criteria.

D2.9 – 4.8 Transfer of Seismic Restraint Forces [Sentence 4.1.8.17.(11)]:

This provision is intended to engender co-operation between the MEP design professionals and the structural engineering professionals. It is basically saying that the MEP components and their attachments to the building structure must be designed in such away that they do not transfer any loads to the structure that were not anticipated by the structural engineer. This means that the MEP design professionals must inform the structural engineer of the anticipated dead loads and seismic restraint forces at the restraint attachment points as soon as the MEP component selections have been finalized. Conversely, the structural engineer needs to make him or her self available to the MEP design professionals to work out issues surrounding the seismic loads and the attachment points for the seismic restraints used for the MEP components.

D2.9 – 4.9 Seismic Restraints for Suspended MEP Components & Hanger Rods [Sentence 4.1.8.17.(12)]:

The seismic restraints for suspended MEP equipment, pipes, ducts, electrical cable trays, bus ducts, and so on, must meet the force and displacement conditions of Sentence 4.1.8.17, and be designed in such away that they do not place the hanger rods in bending.

D2.9 – 4.13 Summary:

The exemptions and requirements outlined in this section are intended to assist the MEP design professionals and contractors in planning their project contribution efficiently. Also, they help define the limits of responsibility for each MEP design profession and trade.

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