1. General Information

1.1 Section Contents

.1 Systems and devices for protection against earthquake shock effects from static-supported technical equipment and elastically supported, i.e. vibration-proof, including all mechanical devices and mechanical equipment, fume hoods and laboratory fume cupboards, control / regulating systems for mechanical and electrical building installations, incinerators, kitchen equipment, electric light fixtures, transformers, motor control centers, uninterruptible power supplies, diesel generators, emergency power systems and fire protection systems.

1.2 Related sections

.1 Section 21 05 01 - Mechanical - General requirements

1.3 References

.1 Unless otherwise indicated, complete all work in accordance with the current edition of the "*Code de Construction du Québec*"

.2 In addition, design and perform the work in accordance with any other code or other standard having jurisdiction, according to the edition in force, including but not limited to: QUALITY ASSURANCE

.1 American Iron and Steel Institute (AISI).

.1 AISI, Specification for the Design of Cold-Formed Steel Structural Members.

.2 [American National Standards Institute (ANSI)/National Fire Protection Association (NFPA). TRANSPORTATION, STORAGE ET HANDLING.

.1 ANSI/NFPA 13, Installation of Sprinkler Systems.]

.3 American Society of Civil Engineers (ASCE).

.1 ASCE 96, Structural Applications of Steel Cables for Buildings.

.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

.1 ASHRAE, A Practical Guide to Seismic Restraint.

.3 American Society for Testing Materials (ASTM).

.1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-

Dipped, Zinc-Coated, Welded and Seamless.

.2 ASSTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A475, Standard Specification for Zinc-Coated Steel Wire Strand.

.4 ASTM A603, Standard Specification for Zinc-Coated Steel Structural Wire Rope.

.5 ASTM A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

.6 ASTM E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.

.4 Canadian Standards Association (CSA)/CSA International

.1 CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).

.1 ANSI/SMACNA 001, Seismic Restraint Manual: Guidelines for Mechanical Systems.

1.4 Characteristics of earthquake-proof systems and devices

.1 Earthquake-proof systems to be fully integrated and compatible with the following:

.1 Acoustic and anti-vibration devices prescribed;

.2 Building design features and electrical and mechanical installations.

.2 Each specialized contractor is responsible for the seismic measures related to their discipline.

.3 During an earthquake, the earthquake protection devices must be able to withstand, without damage, the maximum relative movement of the structure provided during the construction of the building and must prevent the mechanical and electrical systems from moving, overturning and causing injury to the occupants during the earthquake.

.4 Design of seismic protection devices and systems developed by an engineer specialized in the field of earthquake engineering and recognized in the province of Quebec.

1.5 Documents/samples to be submitted

.1 Submit all required documents and samples in accordance with Section 21 05 01 - Mechanical - General Requirements.

.2 Submit the following documents:

.1 Detailed version of the calculation criteria;

.2 Execution drawings, of the same quality and format as the drawings that are part of the contract documents, the lists of materials and equipment, schematic representations and detailed specifications for all elements of each of the planned seismic protection devices and systems;

.3 Calculation documents, worksheets and charts, including the calculation of the stresses attributable to seismic forces, according to the *Code de construction du Québec*;

.4 Separate workshop drawings for each seismic protection device or system and for each of their components;

.5 Document specifying the location of each device or system;

.6 Lists of the different types of seismic protection devices or systems and their related elements;

.7 Document showing or indicating details of anchor and fastening devices, anchoring loads and methods of attachment to structural elements;

.8 Document specifying the installation instructions and methods.

.3 Submit the documents signed and sealed by a qualified engineer recognized by the Province of Quebec, certifying that the products, materials and equipment meet the requirements regarding physical characteristics and performance criteria.

.4 Submit installation instructions provided by the manufacturer.

1.6 Documents/elements to be submitted upon completion

.1 Submit all required documents and materials upon completion of the required work and attach them to the "Operation and Maintenance Manual" in accordance with Section 21 05 01 - Mechanical - General Requirements.

.2 Include the instructions for the control of seismic protection devices and systems with the maintenance sheets.

1.7 Waste management and disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 21 05 01 - Mechanical - General Requirements.

1.8 Anti-earthquake parameters

.1 The seismic measures must be selected to meet the requirements of the latest edition of the *Code de Construction du Québec* and SMACNA.

Vp = V . I . Sp . Wp

Where Sp = Cp . Ar . Ax

Vp = V . I . Cp . Ar . Ax . Wp

Where Ax = 1+ (hx/hn)

Vp = V . I . Cp . Ar . (1 + (hx/hn)) . Wp

Where V = The speed ratio of the zone (m/s) (annexe C of the NBC).

I = The earthquake-proof priority coefficient should be 1.5 for civil protection buildings, 1.3 for schools and 1.0 for other buildings.

Cp = seismic coefficient for components of mechanical and electrical equipment (see table 4.1.9.1.E. of the National Building Code)

Ar = Amplification response factor must be 1.0 for components that are both rigid and rigidly connected and for non-brittle pipes and ducts, = 1.5 for components located on the ground that are flexible or flexibly connected except for non-brittle pipes and ducts, = 3.0 for all other cases,

Hx = The height of the level being calculated in relation to the base (ground).

Hn = The height of the highest level of the main part of the structure.

Wp = The weight of a part of the work

Vp = The lateral force acting on a part of the work

If Vp = 0.15 Wp or less, the level of required protection is SHL-C.

Vp = 0.16 Wp to 0.30 Wp, the level of required protection is SHL-B.

Vp = 0.31 Wp to 0.48 Wp, the level of required protection is SHL-A.

Vp = 0.49 Wp or more, the level of required protection is SHL-AA.

.2 The aforementioned levels of required protection refer to the SMACNA 1338 standard, "Seismic Restraint Guidelines for Mechanical Systems"

1.9 Determining the level of protection

.1 For piping, electrical conduits and ventilation ducts, install earthquake-resistant anchors and stabilizers in accordance with the requirements of the "Seismic Restraint Manual" as published by the SMACNA.

.2 The level of protection for the building is SHL- "X" where "X" is defined according to SMACNA 1338 and determined and calculated for each project.

2. Products

2.1 Source of supply

.1 Earthquake-proof protection systems and devices provided by only one manufacturer with experience in the field.

2.2 General information

.1 Earthquake-proof protection systems and devices must prevent permanent movement, in addition to damage caused by horizontal, vertical and overturning movements.

.2 Earthquake-proof protection systems and devices must be compatible with the electromechanical design. They must not interfere with the normal operation of the electromechanical systems.

.3 The earthquake-proof systems and devices must be operational in flexibility and continuity, in all directions to mitigate the effects of shock.

.4 The attachments and anchor points must be able to withstand the same maximum loads as the earthquake-proof systems and devices.

.5 Attachment of earthquake-proof systems and devices to reinforced concrete frames:

.1 Expandable type anchors with a high degree of mechanical strength;

.2 No anchors to be installed with a nail gun;

.6 No device, related support or bonding pad must yield before the frame or structure yields.

.7 Seismic devices consisting of cast iron, threaded tubes or other frangible materials are not acceptable.

.8 Earthquake-proof devices must not interfere with the operation of the fire protection devices or compromise their integrity.

.9 Stabilize all accessories, such as diffusers and light fixtures, installed in suspended ceilings.

2.3 Steel angle

.1 Angle made from a cold-formed, AISI-compliant plate, having a minimum tensile strength of Fu = 410 MPa (59 ksi) and an elastic yield stress of Fy = 300 MPa (43 ksi).

2.4 C-channel

.1 C-channel built in accordance with the ASTM A1011/A1011M GR 33 and CSA G40.20/G40.21 standards.

2.5 Structural piping

.1 Structural piping built according to the ASTM A53/A53M standard, type E or S, grade B.

2.6 Cable

.1 Cable built in accordance with the standard ASTM A603 or ASTM A475 standard with a seven wire minimum and covered with a layer of class A.

.2 Fitting parts in accordance with the requirements of the ASCE 96 standards and capable of supporting 110% of the ultimate stress of the cable.

2.7 Bolts

.1 Bolts built in accordance with the ASTM A307 standard, rank A, hex.

2.8 Seismic protection for static support devices.

.1 Attach the devices to the hangers that must be attached to the frame.

.2 Install devices to prevent the oscillation of devices along the horizontal plane, tilting of devices along the vertical plane and sliding or buckling of the devices along the axial plane.

.3 Use buckle resistant hanger rods.

2.9 Seismic protection for elastic support devices.

.1 Attach the devices to the suspension hangers, which must be secured to the frame with rigid rods along all three (3) axes.

.2 The devices must be operational in flexibility and continuity. To this end, they must include elastomeric elements, or by other means to reduce the effects of shock.

.3 The earthquake protection devices must not interfere with the action of the soundproofing and anti-vibration elements. During normal operation, the clearance between the material and the earthquake protection devices must be 6 mm to 12 mm.

.4 If seismic-type insulators are to be used, they must then be designed and installed to withstand the minimum accelerating forces.

.5 The devices must never be compressed to the point of losing their effectiveness.

.6 Earthquake-proof protection systems and devices must prevent the complete unloading of anti-vibration devices and systems.

.7 When standard insulators are used, earthquake-proof devices will be incorporated in the vibration damping devices to prevent overturning.

3. Execution

3.1 General information

.1 Anchor points and fastening devices:

.1 Check anchor bolts, dowel diameters, depth of penetrations in concrete and length of welds in accordance with the drawings submitted for approval.

.2 Bolt all equipment that is not insulated against vibration transmission to frame or structure.

.3 Oblong openings for adjusting bolts are prohibited.

.4 For seismic purposes, small diameter pipes may be attached to the larger diameter pipes that will retain them. The opposite practice is prohibited.

.5 Anchor points in concrete slabs should be away from edges in accordance with the ASTM E-488 standard and the anchor manufacturer's recommendations.

.6 Anchors in concrete slabs must be driven at least eight times the diameter of the slabs.

.7 Install restraining straps on all C-Clamps, used to support the piping, to hold them at their anchor point during an earthquake. Straps manufactured by the same manufacturer as the clamps.

.2 Restraining cables:

.1 Connect the restraining cables to the suspended units so that their axial bearing passes through the center of gravity of the devices to protect.

.2 Tighten the cable fasteners according to the manufacturer's recommendations.

.3 Use grommets, lugs, and other hardware that is appropriate for alignment of seismic devices and to prevent cables from bending at the anchor points.

.4 In the case of suspended ceilings, place the 90º angle restraining cables in relation to each other along the plane and attach them to the building framing at a 45º angle.

.5 Adjust the cable tension so that they do not appear loose, but do not interfere with the normal operation of the anti-vibration devices.

.6 Tighten the cables to reduce slack to 40 mm by pressing with thumb. Under normal operation, the cables must not support the weight of the retained material.

.3 Tighten the bolts to the "C" channel with the following torques:

.1 DN ½: 68 Nm (50 ft-lb);

.2 DN ¾: 169 Nm (125 ft-lb);

.4 Install earthquake-proof protection systems and devices at least 25 mm from other equipment or utility lines.

.5 Miscellaneous equipment not isolated against vibrations:

.1 Bolt the hardware to the mounting base and then to the frame using through bolts.

.6 Coordinate the connection operations with other trades.

.7 Vertical tanks:

.1 Anchor the tanks to the mounting base and then to the frame using through bolts.

.2 Install strip steel retaining collars above the center of gravity.

.8 Horizontal tanks:

.1 Provide at least two retaining straps with anchor bolts attached to the frame.

.9 Brace the equipment independently from the ventilation ducts and pipes.

.10 Never use two bracing types in the same direction.

.11 Do not stabilize the devices or equipment when the length of the suspension rods is less than 300 mm.

.12 Do not install earthquake-proof protection systems and devices at an angle greater than 60º or an angle less than 45º measured from the horizontal.

.13 Install the transversal earthquake-proof protection systems and devices perpendicular to the direction of the conduit or piping with a maximum angle variation of 2.5º.

.14 Install the longitudinal earthquake-proof protection systems and devices parallel to the direction of the conduit or piping with a maximum angle variation of 2.5º.

.15 Install at least two transverse earthquake-proof protection systems and devices and one longitudinal earthquake-proof protection system and device for each section of straight conduit or pipe.

.16 Install transverse and longitudinal earthquake-proof protection systems and devices at a maximum distance of 100 mm from a vertical support, which must be reinforced as needed.

3.2 Manufacturer's instructions

.1 Comply with manufacturer's written requirements, recommendations, and specifications, including any available technical bulletins, instructions for handling, storing, and installing products, and data sheet instructions.

3.3 Entry of utility pipes into the building

.1 Provide means to ensure the flexibility of the pipes to prevent breakage of the latter in the case of earthquakes.

3.4 On-site quality control

.1 Once the installation work is complete, earthquake-proof protection systems and devices must be inspected and certified by an engineer specialized in this field and recognized in the province of Quebec.

.2 Submit a written report to the Engineer with the certificate of compliance.

.3 If necessary, the Contractor must make corrections and adjustments required based on the written report submitted by the specialized Engineer.

3.5 Documents required for commissioning

.1 Once the certification is complete and the report is accepted, provide the Engineer

with a complete copy of the project file reviewed and annotated to show the post-completion conditions.

3.6 Installation for piping other than fire protection

.1 Perform the installation and design of earthquake-proof systems in accordance with the "ASHRAE, A Practical Guide to Seismic Restraint" and the ANSI/SMACNA 001 standard.

.2 Earthquake-proof devices and systems must meet the requirements for pipe anchoring and guidance.

.3 Stabilize the piping to DN 3 and more.

.4 Stabilize fuel, medical gas and compressed air lines to DN 1 and above.

.5 Install mechanical restraints for piping to the following minimum frequency:

.1 For transverse stabilization:

.1 DN 8 or less: 12.2 m.

.2 DN 10 and more: 6.1 m.

.3 Reduce these distances by half for gas, non-ductile or screwed piping.

.2 For longitudinal stabilization:

.1 DN 5 or less: 24.4 m.

.2 DN 6 and DN 8: 12.2 m.

.3 DN 10 and more: 6.1 m.

.4 Reduce these distances by half for gas, non-ductile or screwed piping.

.6 For plastic piping, a standard support bracket must be provided according to the manufacturer's recommendations or midway between the joints.

.7 The transverse earthquake-proof protection system and device of a section of piping, may act as a longitudinal earthquake-proof protection system and device for a pipe section of the same dimensions that is connected perpendicularly to the first, if the braces are less than 600 mm of an elbow or T coupling.

.8 Install seismic partition assemblies where the piping runs through a seismic partition of the building. Stabilize this assembly transversely, vertically and longitudinally within 1.83 m on each side of the partition.

.9 Stabilize a 90º change of direction on each side of the cast iron and glass piping.

.10 Do not stabilize suspended piping with supports located less than 300 mm from the structure.

3.7 Installation for ventilation ducts

.1 Perform the installation and design of earthquake-proof systems in accordance with the "ASHRAE, A Practical Guide to Seismic Restraint" and the ANSI/SMACNA 001 standard.

.2 Stabilize rectangular and oblong ventilation ducts with a surface area of 0.55 m² and above, and circular ducts with a diameter of 700 mm and above.

.3 A transverse earthquake-proof protection system and device for one duct section, may also serve as a longitudinal support for another perpendicular duct section of the same or lesser dimensions, if the support is installed within 600 mm from the intersection.

.4 A wall (including gypsum wall) can be used as an earthquake-proof protection system and device if the duct is securely fastened to its perimeter on the wall.

.5 Install mechanical restraints to the following minimum frequency:

.1 For vertical stabilization:

.1 Vertical stabilization is provided by regular brackets.

.2 For transverse stabilization: 9.1 m.

.3 For longitudinal stabilization: 18.3 m.

.6 Do not stabilize suspended ducts with brackets located less than 300 mm from the structure. Brackets must be attached to the ducts with at least two n° 10 metal screws and installed within 50 mm from the top of the duct.

3.8 Rigid rods and anchor points

.1 Connect the restraining rods to the suspended material so that their axial bearing passes through the center of gravity of the material to protect.

.2 Use the appropriate diameter rods that meet the seismic media manufacturer's requirements.

.3 The vertical, lateral and longitudinal rods must be installed according to the bracket manufacturer's recommendations.

END OF SECTION