Acknowledgments

This Seismic Restraint Standards Manual was developed with input and advice from members of a special seismic restraint task force comprised of electrical contractors and professional engineers, whose members are listed below. The Association extends its thanks and appreciation to task force members for their dedication to this project.

We would also like to acknowledge the manual’s primary author and reviewers for their efforts to develop a seismic restraint manual that will benefit both contractors and design professionals and other members of the industry.

STANDARDS MANUAL TASK FORCE

Deborah Cahill
President, ECABC
Burnaby

George Ingham
United Power Ltd.
North Vancouver

Ron Fettback
Western Pacific Enterprises GP
Coquitlam

Chris Wolfe
Vibra-Sonic Control & Materials Handling Ltd.
Burnaby

Mike Williams, P.Eng.
Bridge Electric Corp.
Richmond

Stan Hussey, President
Harbourview Electric Ltd.
Burnaby

DEVELOPMENT AND REVIEW

Primary Consulting Engineer & Author
Cam Robinson, P.Eng.
Levelton Consultants Ltd.
Richmond

Reviewing Consulting Engineers
Sacre-Davey Engineering Inc.
Bryan Lee
North Vancouver

Dragan Todorovic, P.Eng.
Chercovar Massie & Associates Ltd.
Vancouver

©ECA, 2015
All Rights Reserved

ELECTRICAL CONTRACTORS ASSOCIATION
201 - 3989 Henning Drive, Burnaby, B.C. V5C 6P8
Printed in British Columbia
NOTICE TO USERS OF THIS MANUAL

Acceptance

Users of this manual accept any assumption of risk. This manual is prepared for use within the limitations of applications that are explained in this document. It is our intent that the overseeing design professionals review this document for suggested seismic restraint guidelines in designing and building electrical systems. However, the Electrical Contractors Association of B.C. (ECABC) does not regulate or enforce the use of these guidelines and accepts no responsibility and assumes no liability for any use or misuse of the contents in this manual.

Amendments

The Association may, from time to time, issue formal interpretations or interim amendments to the manual; these may represent significant changes between published editions. This manual does not endorse specific products; however, it does include a list of acceptable products based on their use and acceptance in today’s marketplace. The list of acceptable products will be expanded in future editions as suggested products are submitted for review and acceptance by the Association.

Formal Interpretation

Questions regarding guidelines, interpretation, or other information in this manual should be submitted to the Association in written form, especially when the question represents a point of disagreement. All inquiries will be reviewed by the Association and, as necessary, revisions will be made in the form of future amendments and additions. The Association is the final authority with respect to interpretation of guidelines in this manual.

Application

The standards contained in this manual were developed using widely accepted industry standards and seismic engineering principles, and in consultation with and based on information obtained from, manufacturers, users, testing laboratories and others with specialized experience. Standards in this manual are subject to revision as further experience and investigation may warrant. Construction techniques, methods, and products that comply with these standards will not necessarily be acceptable if, when examined and tested, they are found to have other features that impair anticipated results of the standards.
The Electrical Contractors Association of B.C., and other contributors to this manual, assume no responsibility and accept no liability for the application of the principles or techniques contained herein.

Authorities considering adoption of any standards contained herein should always review all applicable federal, provincial, and municipal regulations for specific installations.

Preprint Permission

Partial, systematic, or large-scale reproduction for sale or profit or inclusion in another document is prohibited without prior written permission from the copyright owners. However, contractors, as well as government and private sector specifying authorities are welcome to reproduce those pages that are relevant to the bidding process for new construction and renovation work within the province of British Columbia, provided that the material copied is not altered in substance and that the reproducer assumes all liability for the specific application, including errors in reproduction. Please refrain from copying and distributing large portions of this manual, or the manual in its entirety.

The ECABC Logo

The Electrical Contractors Association of B.C. logo is registered as a membership identification mark. The Association determines acceptable use of the logo and expressly forbids its use to represent anything other than membership in the Association. Membership in ECABC and the use of the Association’s logo in no way constitute or reflect Association approval of any product, method, or component; nor that the product, method or component is in compliance with standards published or recognized by ECABC.
We welcome your input into the content of this manual. Please forward suggestions for revisions or additions to the address below. Please use extra pages if required.

NOTE: Final decision to insert the recommendations will rest with ECABC.

NAME: ___________________________ TELEPHONE: ________________
COMPANY: ________________________ FAX: ____________________
ADDRESS: _________________________ E-MAIL: ________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

Electrical Contractors Association of B.C.
201 - 3989 Henning Drive
Burnaby, B.C. V5C 6P8
ORDER FORM

______________ copies of the *Seismic Restraint Standards Manual*

Name:

Company:

Address:

City: Postal Code: Telephone:

E-mail:

Please contact ECA for fee schedule:

Electrical Contractors Association of B.C.
201 – 3989 Henning Drive
Burnaby, B.C. V5C 6P8
FOREWORD

History of the Guidelines

In the last twenty years there have been a number of significant earthquakes in the Pacific Northwest America Region, including some areas of British Columbia. Experience has shown that much of the damage that occurs during earthquakes happens to non-structural components.

Building codes have long recognized the necessity for the seismic restraint of non-structural components in buildings. In more recent editions of the National Building Code the requirements have become more rationalized and much more specific for various types of equipment. In British Columbia the Sheet Metal Airconditioning Contractors National Association (SMACNA) guidelines, based on guidelines established in the state of California, have been used for the restraint of mechanical ductwork and pipework. However, there has been no document specifically for electrical equipment.

To remedy this situation, ECABC decided to undertake the production of a seismic restraint manual specific for electrical equipment. Work on the project began in the spring of 1996. The development process included a survey of industry members that included electrical contractors, consulting engineers and building authorities.

In response to the 2012 revision to the British Columbia Building Code, ECABC decided to conduct a complete review of the seismic manual to address the code changes. At the same time, significant changes were occurring in the post-install concrete anchor industry to address cracked concrete. The Third Edition of the ECABC Seismic Restraint Manual addresses these changes.

Purpose of the Guidelines

During the past, architectural and engineering designs for protection against earthquake damage were confined primarily to the structural systems of buildings. It was discovered, however, that even if a building did not collapse, the destruction of non-structural elements such as emergency generators and transformers and pipe systems could cause great damage to the building and even loss of life. Damage to the electrical systems can render a building uninhabitable for weeks or months. As a result, seismic concerns now include restraints for electrical conduits, cable tray and equipment.

The purpose of this manual is to provide a comprehensive and yet flexible set of guidelines that accommodate all parts of the province of British Columbia. The goal is to enable designers and contractors to determine the correct restraints for electrical equipment, so that the equipment is more likely to maintain its integrity and remain attached to the building structure during an earthquake.
The challenge of developing guidelines able to cover the vast expanse of the province of British Columbia was overcome by the establishment of seven seismic zones. There are no areas in B.C. that are exempt from seismic activity; however, each is differently affected by seismic activity and the soil conditions (Site Class) on which the building stands. Zone I will not require seismic restraint of electrical equipment unless the building is required to be fully functional for post-disaster use. Zones II through IV may or may not require seismic restraint depending on soil conditions and building importance.

**Roles of the Construction Professional**

Please note this manual is not designed to supercede the responsibility of design professionals for appropriate seismic restraint. Electrical contractors can use these guidelines to determine appropriate restraints for the majority of electrical equipment that they will install. However, throughout this manual are exceptions where the services of a registered professional engineer familiar with the seismic restraint of non-structural components should be engaged. The intention is that as design professionals create construction documents, they will refer to these guidelines in the documents. Further information will be needed in the case of specifications for restraint of equipment that is covered by these guidelines.

**What Is Not In This Manual**

This manual does not address the ordinary support for electrical equipment that is required for gravity loads. The restraints illustrated in this document are those needed to provide the extra support for seismic loads.

As well, this manual does not include the specific requirements for isolated equipment (i.e. equipment that is on springs). Please see the equipment section for more information.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Title Page</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgments</td>
<td>i</td>
</tr>
<tr>
<td>Notice to Users</td>
<td>ii</td>
</tr>
<tr>
<td>Foreword</td>
<td>iv</td>
</tr>
<tr>
<td>Suggestions for Supplements</td>
<td></td>
</tr>
<tr>
<td>Order Form</td>
<td></td>
</tr>
<tr>
<td>Section 1</td>
<td>Introduction</td>
</tr>
<tr>
<td>Section 2</td>
<td>Instructions for using the Guidelines</td>
</tr>
<tr>
<td>Section 3</td>
<td>General Requirements</td>
</tr>
<tr>
<td></td>
<td>I. Electrical Conduit</td>
</tr>
<tr>
<td></td>
<td>II. Cable trays</td>
</tr>
<tr>
<td></td>
<td>III. Electrical equipment</td>
</tr>
<tr>
<td></td>
<td>IV. Panel boxes</td>
</tr>
<tr>
<td></td>
<td>V. Light fixtures and radiant heat panels</td>
</tr>
<tr>
<td>Section 4</td>
<td>Drawings of Typical Bracing Requirements</td>
</tr>
<tr>
<td></td>
<td>Typical conduit bracing - Layout</td>
</tr>
<tr>
<td></td>
<td>Typical cable tray bracing - Layout</td>
</tr>
<tr>
<td></td>
<td>Typical cable tray bracing - Transverse</td>
</tr>
<tr>
<td></td>
<td>Typical conduit bracing - Longitudinal</td>
</tr>
<tr>
<td></td>
<td>Transverse bracing for cable tray</td>
</tr>
<tr>
<td></td>
<td>Longitudinal bracing for cable tray</td>
</tr>
<tr>
<td></td>
<td>Floor mounted equipment</td>
</tr>
<tr>
<td></td>
<td>Tall floor mounted equipment</td>
</tr>
<tr>
<td></td>
<td>Wall mounted equipment/Control panel</td>
</tr>
<tr>
<td></td>
<td>Ceiling mounted equipment</td>
</tr>
<tr>
<td></td>
<td>Building integrated power station mounting details</td>
</tr>
<tr>
<td></td>
<td>Pendant light fixture</td>
</tr>
<tr>
<td></td>
<td>Fluorescent light fixture</td>
</tr>
<tr>
<td>Section 5</td>
<td>Drawings of Typical Connections to Various Materials</td>
</tr>
<tr>
<td></td>
<td>Typical connections to concrete</td>
</tr>
<tr>
<td></td>
<td>Typical aircraft cable connections #1</td>
</tr>
<tr>
<td></td>
<td>Typical aircraft cable connections #2</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous connections in concrete #1</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous connections in #2</td>
</tr>
<tr>
<td></td>
<td>Typical connections to steel</td>
</tr>
<tr>
<td></td>
<td>Typical connections to open web steel joists #1</td>
</tr>
<tr>
<td></td>
<td>Typical connections to open web steel joists #2</td>
</tr>
<tr>
<td></td>
<td>Typical connections to wood joist</td>
</tr>
<tr>
<td></td>
<td>Typical connections to wood I - joist</td>
</tr>
<tr>
<td>Section 6</td>
<td>Seismic Zones for British Columbia</td>
</tr>
<tr>
<td>Section 7</td>
<td>Schedules of</td>
</tr>
<tr>
<td></td>
<td>Zone I-schedule of bracing requirements for conduit 1.0</td>
</tr>
<tr>
<td></td>
<td>Zone I-schedule of bracing requirements for conduit 1.3</td>
</tr>
<tr>
<td></td>
<td>Zone I-schedule of bracing requirements for conduit 1.5</td>
</tr>
<tr>
<td></td>
<td>Zone II-schedule of bracing requirements for conduit 1.0</td>
</tr>
<tr>
<td></td>
<td>Zone II-schedule of bracing requirements for conduit 1.3</td>
</tr>
<tr>
<td></td>
<td>Zone II-schedule of bracing requirements for conduit 1.5</td>
</tr>
<tr>
<td></td>
<td>Zone III-schedule of bracing requirements for conduit 1.0</td>
</tr>
<tr>
<td></td>
<td>Zone III-schedule of bracing requirements for conduit 1.3</td>
</tr>
</tbody>
</table>
Zone III-schedule of bracing requirements for conduit 1.5    Figure 7.1.9
Zone IV-schedule of bracing requirements for conduit 1.0    Figure 7.1.10
Zone IV-schedule of bracing requirements for conduit 1.3    Figure 1.1.11
Zone IV-schedule of bracing requirements for conduit 1.5    Figure 1.1.12
Zone V-schedule of bracing requirements for conduit 1.0    Figure 7.1.13
Zone V-schedule of bracing requirements for conduit 1.3    Figure 7.1.14
Zone V-schedule of bracing requirements for conduit 1.5    Figure 7.1.15
Zone VI-schedule of bracing requirements for conduit 1.0    Figure 7.1.16
Zone VI-schedule of bracing requirements for conduit 1.3    Figure 7.1.17
Zone VI-schedule of bracing requirements for conduit 1.5    Figure 7.1.18
Zone VII-schedule of bracing requirements for conduit 1.0    Figure 7.1.19
Zone VII-schedule of bracing requirements for conduit 1.3    Figure 7.1.20
Zone VII-schedule of bracing requirements for conduit 1.5    Figure 7.1.21
Zone I-schedule of bracing requirements for cable trays    Figure 7.2.1
Zone II-schedule of bracing requirements for cable trays    Figure 7.2.2
Zone III-schedule of bracing requirements for cable trays    Figure 7.2.3
Zone IV-schedule of bracing requirements for cable trays    Figure 7.2.4
Zone V-schedule of bracing requirements for cable trays    Figure 7.2.5
Zone VI-schedule of bracing requirements for cable trays    Figure 7.2.6
Zone VII-schedule of bracing requirements for cable trays    Figure 7.2.7

Section 8
Schedule of bracing members    Figure 8.1
Schedule of end connectors    Figure 8.2
Schedule of steel and wood end fasteners    Figure 8.3
Simpson Strong-tie strong-bolt wedge anchors for cracked concrete    Figure 8.4.1
Simpson Strong-tie titen HD screw anchors for cracked concrete    Figure 8.4.2
Future Use    Figure 8.4.3
Future Use    Figure 8.4.4
Future Use    Figure 8.4.5
Hilti carbon steel KB-TZ wedge anchors for cracked concrete    Figure 8.4.6
Hilti stainless steel KB-RTZ wedge anchors for cracked concrete    Figure 8.4.7
Hilti HDA carbon steel & R-316 stainless steel undercut anchors    Figure 8.4.8
Hilti HAD carbon steel & R-316 stainless steel undercut anchors w/sleeve    Figure 8.4.9
Hilti HSL-3 heavy duty sleeve anchor for cracked concrete    Figure 8.4.10

Section 9
Appendices
Appendix A: Overview of Aspects and Assumptions Underlying this Manual
Appendix B: Maximum Factored Capacities of Braces
Appendix C: Maximum Factored Capacities of End Connectors
Appendix D: Maximum Factored Capacities of End Fasteners
Appendix E: Simpson Strong-Tie Bulletin with Design Example