



BUILDING SYSTEMS DESK REFERENCE

The Property Professional's Guide
to Building Systems Maintenance

Ray Congdon, CEM, OPMP, LEED-AP, FMA



Table of Contents

| | |
|-------------------------------|-----|
| About BOMA International..... | 3 |
| Acknowledgements..... | 4 |
| Introduction..... | 5 |
| Electrical..... | 6 |
| Elevator..... | 21 |
| Energy Conservation..... | 29 |
| HVAC..... | 36 |
| Life Safety..... | 128 |
| Maintenance..... | 150 |
| Plumbing..... | 167 |
| Glossary..... | 186 |

About BOMA International

Founded in 1907, the Building Owners and Managers Association (BOMA) International is an international federation of more than 100 local associations and affiliated organizations. The 16,500-plus members of BOMA International own or manage more than 9 billion square feet of commercial properties in North America and abroad. BOMA's mission is to enhance the human, intellectual and physical assets of the commercial real estate industry through advocacy, education, research, standards and information. On the Web at www.boma.org.

BOMA International has developed this publication as a service to the office building industry and to the public. Use of this publication is voluntary and should be undertaken after an independent review of the applicable facts and circumstances of the particular projects. Although BOMA International has made all reasonable efforts to present comprehensive and accurate information, NO GUARANTEES OR WARRANTIES, INCLUDING EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS ARE MADE WITH RESPECT TO THIS PUBLICATION BY BOMA INTERNATIONAL, ITS OFFICERS, DIRECTORS, EMPLOYEES, OR AGENTS, WHO ALSO ASSUME NO LEGAL RESPONSIBILITY FOR THE ACCURACY OF THE PRESENTATIONS, COMMENTS, OR OTHER INFORMATION IN THIS PUBLICATION. IN ADDITION, NO LIABILITY IS ASSUMED AND ALL LIABILITY IS EXPRESSLY DISCLAIMED FOR NEGLIGENCE OR DAMAGES OF ANY KIND, ANY DECISIONS, CONTRACTS, COMMITMENTS, OBLIGATIONS OR ANY OTHER ACTIONS UNDERTAKEN OR MADE ON THE BASIS OF THE INFORMATION CONTAINED IN THIS PUBLICATION. These documents have important legal and financial consequences, and independent consultation with an attorney and financial advisor are encouraged with respect to execution or modification.

No part of this publication may be reproduced, recorded or copied in any manner or by any means, in whole or in part, without the prior permission of BOMA International, 1101 15th St., NW, Suite 800, Washington, DC, 20005, 202-408-2662 or from other individuals or organizations owning copyright interests in other parts of the publication as identified.

Acknowledgements

About the Author

Ray Congdon, CEM, OPMP, LEED-AP, FMA, is currently the director of engineering for CBRE on the Hewlett Packard account. Ray provides engineering leadership and direction for their North America portfolio consisting of 22-million square feet across the U.S. and Canada. Ray's career spans over 26 years in property and facility management in a diverse offering of buildings including commercial, healthcare, retail, manufacturing and critical environment. Ray has been recognized for his efforts in developing and leading instruction for property professionals and is a certified instructor in construction and land development. He regularly presents on building operations for BOMA, BOMI and Building Operator Certification.

The author would like to thank the following companies and individuals who supported the development of this publication by providing graphics and images.

Alfa Laval
 Baltimore Aircoil Company
 CBRE - Arthur Harper
 Cleaver-Brooks
 Industrial Training
 University, Inc. - Joel Cook
 Iwaki America
 Mr. Shims - David Davies
 NEEA BetterBricks
 National Fire Protection
 Association
 Spirax Sarco
 Trane
 Travis Smith
 TSI Incorporated,
 Shoreview, MN, USA
 Watts Regulator Company

Ray Congdon, Sr.: who introduced me to building operations during my high school years and maintained a cool head during that experience!

Cindy, Josh and Megan Congdon: who endured my obsessive hobby of capturing images of buildings and building systems on every vacation.

Jeff Kasowski, Wright Runstad & Company: thank you for seeing my potential and investing in me; I am forever indebted.

Carol Thomas: thank you for teaching me the true meaning of "empathy" and other critical life lessons. You are a very special person, and I am blessed to have known you.

Earl Wayman, GVA: one of my biggest supporters, a fellow educator and a fine friend.

Rod Kauffman and Susan Cole, BOMA/Seattle-King County: thank you for supporting BOMA BEST and building operating engineer development. You provided the springboard for this book!

Cynthia Putnam and Stan Price: Building Operator Certification (BOC).

Lorie Damon, Kristin Bowling, Emily Naden and Lisa Prats and the other fine people at BOMA International.

Design

Pittny Creative

BOMA International Officers

Chair & CEO
 Joseph W. Markling
CBRE
Los Angeles, CA

Chair Elect
 Richard W. Greninger, CPM
Carr Properties
Washington, DC

Vice Chair
 John G. Oliver, CPM
Wells Real Estate Funds
Atlanta, GA

Secretary-Treasurer
 Rebecca B. Hanner, CPM, RPA
Cassidy Turley
Raleigh, NC

President & COO
 Henry H. Chamberlain, APR,
 FASAE, CAE
BOMA International
Washington, DC

Published by

Building Owners and Managers
 Association (BOMA) International
 1101 15th Street, NW, Suite 800
 Washington, DC 20005
 202.408.2662
 www.boma.org

Introduction

In property and facility management the level of success is commonly attributable to an understanding of building systems by property professionals. This knowledge is required to manage operating expenses, support capital planning, ensuring tenant satisfaction, optimizing operations and supporting energy conservation and sustainability efforts. It is common for property and facility managers to rely on operating engineers and contractors to assist in the decision-making process when it comes to building systems.

At the 2010 BOMA International Conference, “Meet the Speaker” mini-sessions were featured. The intent of these mini-sessions was to provide an opportunity for attendees to meet with speakers of selected sessions to engage in more in-depth topic discussions. Ray Congdon, who had led a session on building ventilation systems earlier that day, was one of the featured speakers.

Ray’s mini-session was scheduled for 20 minutes however, the interest in learning about building systems was so high that the session was extended to just over 90 minutes. During his session, an attendee asked Ray if he was aware of a reference book that described, in layman’s terms, how various building systems worked and interacted with other systems. That question prompted the discussions that have taken place over the past two years that led to the development of this publication.

The purpose of the Building Systems Desk Reference is to provide an entry-level introduction to the equipment associated with various building systems including: HVAC, electrical, plumbing, elevator and fire and life safety. In addition, sections on preventive maintenance and energy conservation have also been included. The Building Systems Desk Reference places a heavy emphasis on graphics and includes more than 600 images to illustrate the more than 500 terms associated with these systems.