

# Essentials of Data Center Projects

1st Edition

Currently in preview, click buy full version

# **Essentials of Data Center Projects**

**1st Edition**



We welcome all comments about this publication. If you have any questions about BICSI and its services, please contact our office at 800.242.7405 (USA/Canada toll free); +1 813.979.1991; fax +1 813.971.4311; e-mail [bicsi@bicsi.org](mailto:bicsi@bicsi.org); website [www.bicsi.org](http://www.bicsi.org).

BICSI®, Tampa, FL 33637

© 2019 BICSI®

All rights reserved.

First edition published 2019

First printing May 2019

Printed in the United States of America

ISBN (print) 978-1-928886-80-8

ISBN (Electronic) 978-1-928886-81-5

All brand names, trademarks, and registered trademarks are the property of their respective holders.

No part of BICSI's *Essentials of Data Center Projects*, 1<sup>st</sup> edition, may be copied, reproduced, or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without prior agreement and written permission from BICSI.

The contents of BICSI's *Essentials of Data Center Projects*, 1<sup>st</sup> edition, are subject to revision without notice due to continued progress in information and communications technology (ICT) systems methodology, design, and manufacturing.

THIS PUBLICATION IS SOLD AS IS, WITHOUT WARRANTY OF ANY KIND, RESPECTING THE CONTENTS OF THIS PUBLICATION, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES FOR THE PUBLICATION'S QUALITY, PERFORMANCE, MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE. BICSI SHALL NOT BE LIABLE TO THE PURCHASER OR ANY OTHER ENTITY WITH RESPECT TO ANY LIABILITY, LOSS, OR DAMAGE CAUSED DIRECTLY OR INDIRECTLY BY THIS PUBLICATION.

BICSI World Headquarters  
8610 Hidden River Parkway  
Tampa, FL 33637-9000 USA  
Tel.: +1 813.979.1991 or  
Tel.: 800.242.7405 (USA & Canada toll-free)  
Fax: +1 813.971.4311  
E-mail: [bicsi@bicsi.org](mailto:bicsi@bicsi.org)  
Website: [www.bicsi.org](http://www.bicsi.org)



This publication is not a single source document but a compendium of many sources of ICT industry-related terminology.

The information contained in this publication includes, but is not limited to, national and international codes, de jure and de facto standards, and industry-accepted best practices terminology.

BICSI recommended best practices are industry-established best practices and not specifically developed by BICSI. When necessary, BICSI will select and recommend widely used and acceptable methods for the performance of a particular task or process based on numerous factors, including, but not limited to, widespread field acceptance, manufacturer's recommended methods, and safety.

## WARNING

It is the responsibility of the user of BICSI's *Essentials of Data Center Projects*, 1<sup>st</sup> edition, to determine the use of the applicable safety and health practices (e.g., in the United States, Occupational Safety and Health Administration [OSHA], *National Electrical Code*<sup>®</sup> [NEC<sup>®</sup>], *National Electrical Safety Code*<sup>®</sup> [NEESC<sup>®</sup>]) associated with information and communications technology (ICT) installation and design practices. BICSI shall not be liable to the purchaser or any other entity with respect to any liability, loss, or damage caused directly or indirectly by application or use of this publication. No project is so important nor any completion deadline so critical to justify nonconformance to ICT industry standards. This publication does not address safety issues associated with its use. It is the ICT industry professional's responsibility to use established and appropriate safety and health practices and to determine the applicability of all regulatory issues.

# About BICSI ... Advancing Information and Communications Technology

---

## BICSI Vision Statement

BICSI® is the worldwide preeminent source of information, education, and knowledge assessment for the constantly evolving information and communications technology (ICT) industry.

## BICSI Mission Statement

BICSI's mission is to:

- Lead the ICT industry with excellence in publications, education, and knowledge assessment.
- Advance our members' ability to deliver the highest quality products and services.
- Provide our members with opportunities for continual improvement and enhanced professional stature.

## BICSI 2018-19 Board of Directors

**President:** Jeffrey Beavers, RCDD, OSP, CFHP

**President-Elect:** Todd W. Taylor, RCDD, NCS, OSP

**Secretary:** Carol Everett Oliver, RCDD, ESS

**Treasurer:** Robert "Bob" Erickson, RCDD, NTS, OSP, WD, RTPM

**Global Region Director:** Rick Cordia, RCDD, RTPM, DCDC, CT, PE

**Canadian Region Director:** Fernando Neto, RCDD

**U.S. North-Central Region Director:** Chris Scharrer, RCDD, NTS, OSP, CTS-D

**U.S. Northeast Region Director:** Matthew Odell, RCDD

**U.S. South-Central Region Director:** Mark Reynolds, RCDD

**U. S. Southeast Region Director:** Lee Renfroe, RCDD, ESS, TECH

**U.S. Western Region Director:** Pat McMurray, RCDD, NTS, OSP, DCDC, PMP

**BICSI Executive Director & Chief Executive Officer:** John D. Clark Jr., CAE

## Technical Publications

Become a member and you will receive substantial discounts on BICSI's highly acclaimed manuals and standards—long considered the definitive reference source of the industry. BICSI's manuals serve as valuable references and study tools for BICSI courses and exams. BICSI manuals and special ICT publications are based on global best practices that follow and, in many cases, exceed the requirements of recognized international codes, standards, and regulations.

Our most popular publications include the *Telecommunications Distribution Methods Manual (TDMM)*, *Outside Plant Design Reference Manual (OSPDRM)*, *Information Technology Systems Installation Methods Manual (ITSIMM)*, *Telecommunications Project Management Manual (TPMM)*, and many other ICT specialty publications.

Standards include ANSI/BICSI 001, *Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*; ANSI/BICSI 002, *Data Center Design and Implementation Best Practices*; ANSI/BICSI 003, *Building Information Modeling (BIM) Practices for Information Technology Systems*; ANSI/BICSI 004, *Information Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities*; ANSI/BICSI 005, *Electronic Safety and Security (ESS) System Design and Implementation Best Practices*; ANSI/BICSI 006, *Distributed Antenna System (DAS) Design and Implementation Best Practices*; ANSI/BICSI 007, *Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises*; ANSI/BICSI 008, *Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices*; BICSI 009, *Data Center Operations and Maintenance Best Practices*; ANSI/BICSI N1, *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*; ANSI/BICSI N2, *Practices for the Installation of Telecommunications and ICT Cabling Extended to Support Remote Power Applications*; BICSI G1, *ICT Outside Plant Construction and Installation: General Practices*; and BICSI G2.2, *ICT Outside Plant Construction and Installation: Aerial Cable Installation*.

For a complete list of member benefits, visit [www.bicsi.org](http://www.bicsi.org).

### Join BICSI Today!

BICSI membership is open to individuals and corporations serving the ICT and building industries. Join BICSI and combine your expertise with your colleagues in the network of ICT professionals. Complete BICSI information is available upon request. For a membership application or other information, contact:

Membership  
8610 Hidden River Parkway  
Tampa, FL 33637-1000 USA  
Tel.: 800.242.7405 (USA/Canada toll-free)  
Tel.: +1 813.979.1991  
Fax: +1 813.971.4311  
E-mail: [bicsi@bicsi.org](mailto:bicsi@bicsi.org)  
Website: [www.bicsi.org](http://www.bicsi.org)

## Acknowledgments

---

BICSI's Technical Information and Methods (TI&M) Committee serves to coordinate the information within all of BICSI's technical publications. BICSI officers, membership, and Technical Publications and Design staff wish to thank the TI&M Committee and its many volunteer contributors who helped in the development of the first edition of BICSI's *Essentials of Data Center Projects (EDCP)*.

A data center can be described as a room with several servers, but the reality is that a data center is a complex facility, with interdependencies on multiple disciplines, systems, and equipment. As the complexity of a data center continues to increase, so does the project that enables its construction.

The following dedicated TI&M Subject Matter Experts (SMEs) provided the key expertise required for the development of this publication's technical content:

**TI&M Chair:**

**Michael Collins**, RCDD, RTPM; *AT&T*

**TI&M Vice-Chair:**

**Robert B. Merling, Jr.**, RCDD,  
OSP; *Parsons Transportation Group*

**EDCP 1<sup>st</sup> Edition SMETL:**

**Phil Janeway**, RCDD; *JDH Contracting*

**EDCP 1<sup>st</sup> Edition Contributors:**

**Richard S. Anderson**, RCDD, CDT, CDCT,  
CIBET; *Rosendin Electric Inc.*

**Jonathan Jew**, *J&M Consultants*

**Sue LeMay**, RCDD; *ComNet Communications*

**John Romanski**, OSP, WD, ESS, RTPM,  
DCDC; *Precision Contracting Services, Inc.*

**Jeff Silveira**, RITP, CAE, *BICSI Director of Standards*

The following BICSI Professional Development staff members produced this publication at BICSI World Headquarters, Tampa, FL:

**Vice President of Professional Development:**

Gail Moore-Swaby

**Director of Publications:**

Clarke Hammersley

**Director of Standards:**

Jeff Silveira

**Technical Editors:**

Allen Dean  
Jeff Giarrizzo  
Clarke Hammersley  
Jeff Silveira

**Design and Production:**

John Litzel, Senior Publications Designer

## BICSI Policy for Numeric Representation of Units of Measurement

---

BICSI technical manuals primarily follow the modern metric system, known as the International System of Units (SI). The SI is intended as a basis for worldwide standardization of measurement units. With the exception of conduit and plywood measurements, units of measurement in this publication are expressed in general and approximate SI terms, followed by an equivalent imperial (U.S. customary) unit of measurement in parentheses (exceptions are listed below):

In general, approximate (soft) conversions are used in this publication and are denoted with the approximate symbol ( $\approx$ ) in front of the metric number. Approximate conversions are considered reasonable and practicable; they are not precise equivalents, but are considered as “industry friendly.” Example:  $\approx 15$  m (50 ft), not the hard conversion of  $\approx 15$  m (49.2 ft).

In some instances, equivalents (hard conversions) may be used when it is a:

- Manufacturer requirement for a product (e.g., conduit, plywood sizes).
- Standard or code requirement.
- Safety factor.
- In general, approximate SI units of measurement are converted to an imperial unit of measurement and placed in parentheses. Exception: When the reference material from which the value is pulled is provided in imperial units only, the imperial unit is the benchmark.
- For metric conversion guidelines, refer to IEEE/ASTM SI 10, American National Standard for Metric Practice.
- Trade size is approximated for both metric and nonmetric purposes. Example:  $\approx 100$  metric designator (4 trade size).
- In some instances (e.g., optical fiber media specifications), the physical dimensions and operating wavelengths are designated.

## Comments? More Information?

---

We welcome your comments about BICSI's *Essentials of Data Center Projects*, 1<sup>st</sup> edition. To do so, simply complete the Reader's Comment Form on the last page of this Preface, attach your comments to the form, and return it to BICSI. Our goal is to make BICSI publications the most important design and reference tools in your office.

You can also contact us directly by calling, faxing, or e-mailing us at:

**BICSI World Headquarters**

8610 Hidden River Parkway

Tampa, FL 33637-1000 USA

Tel.: 800.242.7405 (USA/Canada toll-free)

Tel.: +1 813.979.1991

Fax: +1 813.971.4311

E-mail: [bicsi@bicsi.org](mailto:bicsi@bicsi.org)

## Reader's Comment Form

---

### ***Essentials of Data Center Projects, 1<sup>st</sup> Edition***

You may use this form to communicate your comments about this publication, its organization, or the subject matter. Your comments will be sent to BICSI's Technical Information and Methods (TI&M) Committee for review and action, if any is deemed appropriate. Please attach a separate page containing your comments.

Please complete the following information:

|                 |                |                 |         |
|-----------------|----------------|-----------------|---------|
| last name       | first name     | middle initial  | date    |
| company name    |                |                 |         |
| mailing address |                |                 |         |
| city            | state/province | zip/postal code | country |
| daytime phone   | fax            | e-mail          |         |

Thank you for your comments.

**Send to:** Attn: BICSI's *Essentials of Data Center Projects*, 1<sup>st</sup> Edition  
User Response  
BICSI  
8610 Hidden River Parkway  
Tampa, FL 33637-1000 USA

**or fax to:** +1 813.971.4311

**or scan and e-mail to:** [chammersley@bicsi.org](mailto:chammersley@bicsi.org)

### **Office Use Only**

Response from TI&M Committee:

Class A     Class B     Class C

---

TI&M Committee chair signature

date

---

TI&M Manual SMETL signature

date

## Table of Contents

---

### **Chapter 1: Data Center Concepts**

|   |      |
|---|------|
| Conceptualization of the Data Center. . . . .                 | 1-1  |
| Alternative Data Center Conceptual Design Solutions . . . . . | 1-14 |

### **Chapter 2: Project Planning**

|  |      |
|--|------|
| Project Planning . . . . .                                 | 2-1  |
| Request for Proposals . . . . .                            | 2-3  |
| Design Planning . . . . .                                  | 2-13 |
| Operations and Business Continuity Design Factors. . . . . | 2-26 |
| Other Planning Needs . . . . .                             | 2-59 |

### **Chapter 3: Project Implementation**

|   |      |
|---|------|
| Pre-Construction. . . . .                         | 3-1  |
| Project Installation and Implementation . . . . . | 3-12 |
| Commissioning . . . . .                           | 3-22 |
| Project Closeout . . . . .                        | 3-35 |

### **Chapter 4: Project Management Essentials**

|  |      |
|--|------|
| Project Management: An Overview . . . . .      | 4-1  |
| Project Management Tools . . . . .             | 4-8  |
| Stakeholder Relations and Management . . . . . | 4-33 |

### **Chapter 5: Project Documentation**

|  |      |
|--|------|
| Project Documentation . . . . .          | 5-1  |
| Types of Project Documentation . . . . . | 5-12 |

### **Glossary**

### **Acronyms and Abbreviations**

### **Data Center Resources**

## Figures

---

### Chapter 1: Data Center Concepts

|            |   |      |
|------------|---|------|
| Figure 1.1 | Simplified planning process for a data center . . . . .                       | 1-2  |
| Figure 1.2 | Relationship of factors in data center services availability class. . . . .   | 1-5  |
| Figure 1.3 | Reliability framework across all service layers. . . . .                      | 1-15 |
| Figure 1.4 | Example of a multi-data center Class 3 . . . . .                              | 1-16 |
| Figure 1.5 | Example of a multi-data center Class 3 with three Class 2 facilities. . . . . | 1-17 |
| Figure 1.6 | Multi-data center Class 4 example with four Class 2 facilities . . . . .      | 1-18 |
| Figure 1.7 | Outsourcing model matrix . . . . .  | 1-20 |
| Figure 1.8 | Outsourcing decision tree. . . . .  | 1-23 |

### Chapter 2: Project Planning

|            |   |      |
|------------|---|------|
| Figure 2.1 | Traditional design process . . . . .        | 2-13 |
| Figure 2.2 | Data center design process . . . . .        | 2-14 |
| Figure 2.3 | Typical core risk management team . . . . . | 2-27 |
| Figure 2.4 | Security balance . . . . .                  | 2-34 |
| Figure 2.5 | Vulnerability model . . . . .               | 2-37 |
| Figure 2.6 | Elements of a security program . . . . .    | 2-42 |
| Figure 2.7 | Layering. . . . .                           | 2-43 |
| Figure 2.8 | Client/supplier model. . . . .              | 2-60 |

### Chapter 3: Project Implementation

|            |                                  |      |
|------------|----------------------------------|------|
| Figure 3.1 | Change control process . . . . . | 3-10 |
|------------|----------------------------------|------|

### Chapter 4: Project Management Essentials

|             |   |      |
|-------------|---|------|
| Figure 4.1  | Project management project responsibilities. . . . .                        | 4-1  |
| Figure 4.2  | Simple organizational breakdown structure . . . . .                         | 4-8  |
| Figure 4.3  | PERT or network logic diagram using the precedence diagram method . . . . . | 4-13 |
| Figure 4.4  | Work breakdown structure network diagram task . . . . .                     | 4-14 |
| Figure 4.5  | Network diagram . . . . .   | 4-14 |
| Figure 4.6  | Milestone chart. . . . .  | 4-15 |
| Figure 4.7  | Gantt chart . . . . .   | 4-16 |
| Figure 4.8  | Calendar of schedule. . . . .   | 4-17 |
| Figure 4.9  | Project earned value management chart . . . . .                             | 4-32 |
| Figure 4.10 | Communications perceptions . . . . .  | 4-36 |
| Figure 4.11 | Example of a stakeholder management plan . . . . .                          | 4-38 |

### Chapter 5: Project Documentation

|            |   |     |
|------------|---|-----|
| Figure 5.1 | U.S. National Computer-Aided Design Standard® layer name format . . . . . | 5-9 |
|------------|---|-----|

## Tables

---

### Chapter 1: Data Center Concepts

|           |   |     |
|-----------|---|-----|
| Table 1.1 | Relationship between availability percentage and allowable downtime . . .                       | 1-4 |
| Table 1.2 | Identifying operational requirements: Time available for planned maintenance shutdown . . . . . | 1-6 |
| Table 1.3 | Identifying operational availability rating: Maximum annual downtime (availability %) . . . . . | 1-7 |
| Table 1.4 | Classifying the impact of downtime on the mission . . . . .                                     | 1-8 |
| Table 1.5 | Determining data center services Availability Class . . . . .                                   | 1-9 |

### Chapter 4: Project Management Essentials

|            |  |      |
|------------|--|------|
| Table 4.1  | Example of a work breakdown structure . . . . .                          | 4-11 |
| Table 4.2  | Work breakdown structure in a text outline format . . . . .              | 4-12 |
| Table 4.3  | Example of a work breakdown structure with work packages . . . . .       | 4-21 |
| Table 4.4  | Project work breakdown structure with schedule and labor hours . . . . . | 4-22 |
| Table 4.5  | Planned value table . . . . .  | 4-23 |
| Table 4.6  | Earned value tracking . . . . .  | 4-25 |
| Table 4.7  | Week two update . . . . .  | 4-26 |
| Table 4.8  | Week two earned value . . . . .  | 4-26 |
| Table 4.9  | Week two actual cost. . . . .  | 4-27 |
| Table 4.10 | Formulas . . . . .   | 4-27 |
| Table 4.11 | Week two status . . . . .  | 4-29 |
| Table 4.12 | Week four status. . . . .  | 4-30 |
| Table 4.13 | Week six status . . . . .  | 4-31 |
| Table 4.14 | Project communications. . . . .  | 4-35 |



## **Chapter 1**

# **Data Center Concepts**

Chapter 1 introduces the BICSI Class methodology for creating the preliminary concept of a data center for most applications. Use of multiple data centers and a data center outsourcing model are also provided as considerations for addressing potential owner or client needs.



## **Chapter 2**

# **Project Planning**

Chapter 2 describes the planning phase of a data center build, which includes the activities from the request for proposal (RFP) through the design phase.



## **Chapter 3**

# **Project Implementation**

Chapter 3 supplies information related to data center project implementation, beginning with the bidding process, moving through construction and commissioning, and leading to project closeout.



## **Chapter 4 Project Management Essentials**

Chapter 4 provides a summary of project management concepts and elements that are part of a data center project. Content includes project management fundamentals, project management tools, and stakeholder relations.



## **Chapter 5**

# **Project Documentation**

Chapter 5 provides an overview of the applicable elements of project documentation. It includes descriptions of construction documents (e.g., drawings, specifications) and other documentation, such as logs, submittals, and forms that are used during the execution of a project.



## **Glossary**

This Glossary provides concise and up-to-date terminology pertaining to data center projects. It includes specific definitions, terminology, and acronyms used in the execution of these projects.