Multnomah County

Facilities Specification Standards

2024 Updates

Last updated 8/16/2024

MULTNOMAH COUNTY OREGON
Facilities and Property Management Division

TABLE OF CONTENTS

I. INTRODUCTION

Multnomah County Oregon (hereafter referred to as the County) establishes these standards to provide direction in the preparation of construction specifications for the County. This document identifies those standards that the County considers essential to preparing specifications and related documentation in a consistent and acceptable manner. These standards describe specification requirements for bid packages, format, content, editing, and quality.

General Objectives
The County issues these standards to:

1. Promote the successful use and control of project specifications and related documentation for Multnomah County owned buildings.
2. Establish minimum requirements for consistent format, professional appearance, and data interchangeability among specification files and other building documents.
3. Create accurate, accessible and current building and project documentation.
4. Expedite project delivery and reduce development cost.

Cross-References
Additional administrative requirements and related information may be found in:

1. *Multnomah County Revit Standards 2.1* (PDF)
2. *Multnomah County Facilities Communications Requirements* (Google/PDF) *(Revised June 2022)*
3. *Multnomah County Signage Standards (Revised 2016) (Google/PDF)*
4. *Multnomah County Space Assignment Design and Use FAC-4 (Revised December 2017)*
5. *Multnomah County High Performance Green Building Procedure FAC-9 (Revised March 2023)*
6. *Multnomah County Facilities Asset Strategic Plan (issued May 2015)*
7. *Healthy Purchasing Initiative (Resolution No 2012-150)*
8. *Toxic Reduction Strategy (Resolution No 06-073)*
9. *LEED Gold & High Performance Green Building Policy (Resolution No. 08-004)*
10. *PUR-8 Sustainable Purchasing and Social Equity (Issued 2010)*
11. *National Electrical Installation Standards*
12. *2010 ADA Standards for Accessible Design, Department of Justice*
13. *2019 Oregon Structural Specialty Code, Chapter 11 Accessibility Amendment*
14. *Workplace Modernization Initiative: Furniture Standards* (Google/PDF) *(Revised April 2022)*
15. *Multnomah County DIRTT standards: (DIRTT Standards / PDF)*
16. *Multnomah County Library Wayfinding and Sign Standards: (PDF)*
17. *Multnomah County FPM Flooring Use Matrix (FPM Flooring Use Matrix_2024 / PDF)*

A/E Service Provider Responsibility
The County requires that all specifications submitted from the A/E Service Provider comply with these standards. An A/E Service Provider is defined as an organization contracted to provide professional services requiring planning and/or design work, and may include architects, engineers, consultants, drafting services, furniture installers, interior designers, space planners, or design-build contractors (who have professional liability insurance and the capability to produce digital documents).

For any deviation from these standards, submit a written request with specific explanations to the County Project Manager (hereafter referred to as the Project Manager). The Project Manager is the person designated to represent the County on issues for a specific project. The County will review the request and respond with a written authorization of acceptance or explanation of denial.

Comments or Questions
The County welcomes your recommendations to improve our documents and documentation process. Address comments or questions about the interpretation or use of these standards to:

Martin Feavel, Capital Improvements Project Manager email: martin.feavel@multco.us

MULTNOMAH COUNTY OREGON
Facilities and Property Management Division
401 N. Dixon St.
Portland, OR 97227

All revised sections of the 2024 Facilities Specification Standards are highlighted in Yellow.

II. BID PACKAGES

Provide specification sections and information, which the County will assemble together with their documents and issue as Bid Packages to solicit work on public projects. For samples of County-provided documents and templates, refer to *Appendix A*. For coordination with drawing documents, refer to the *Multnomah County Revit Standards* (Google/PDF).

FORMAL BIDS (Greater or Equal to $150,000)

Bidding Pages for Construction

The County prepares separate Bidding Pages to provide information unique to each project. At contract signature, the Bidding Pages are attached to the Project Manual and Addenda to form the "Specification and Contract Agreement". Bidding Pages for Construction may include:

1. Invitation to Bid.
2. Table of Contents.
3. Instructions to Bidders.
4. Workforce Training & Hiring Program.
5. Bid Forms.
6. Bid Bond (form).
7. State of Oregon First Tier Subcontractor Disclosure Requirements.
8. Monthly Subcontractor Payment and Utilization Report (Form D).

Project Manual for Construction

The County assembles material from the County and A/E Service Provider into a Project Manual, organized as follows:

1. Title/Certification Page: A/E Service Providers (and their associated professional consultants) stamp and sign the Title/Certification page in accordance with state laws, professional practices, and their contract obligations. Refer to *Exhibit A2: Sample Title/Certification Page*.
2. Table of Contents: The County prepares a Table of Contents to list all specification division numbers and names, whether used or not. Where not used, the County will indicate "NOT USED" after the division number and name. The Table will also list specification section numbers and names used for each division and their page number.
3. Conditions of the Contract: The County prepares specification sections and exhibits for the Conditions of the Contract, which may include the following:
   a. Contract Agreement,
   b. General Conditions,
   c. Supplementary Conditions (where applicable), and
   d. Prevailing Wage Rates (where BOLI and/or Davis Bacon rates are applicable).
4. Technical Sections: A/E Service Providers have sole responsibility to prepare all technical specification sections (Division 1-49-). Edit standard specifications templates where provided by the County. Elsewhere use the standard MASTERSPEC® template or A/E Service Provider standard specifications to develop project-specific specification sections. Consider Basis of Design information found in *Appendix B, C, D and E.* Follow general principles found in the *CSI Manual of Practice*.

Addenda

The County may issue addenda during the bid process. Addenda form part of the Contract Documents and may modify previous Addenda, Bidding Pages, Project Manual and Drawings. The County lists items of addition, deletion, change, or clarification for those sections it is responsible. The County refers to and attaches the A/E Service Provider stamped list of items for those sections it is responsible for. Where a Pre-Bid Conference is mandatory, the County will issue the Attendance List in an addendum.

INFORMAL BIDS (Less than $150,000)

Project Manual

Where the County indicates the project does not require a Formal Bid, the County assembles material from the County and A/E Service Provider into a Project Manual organized as follows:

1. Invitation to Bid: The County prepares the solicitation forms.
2. Title/Certification Page: A/E Service Providers (and their associated professional consultants) stamp and sign the Title/Certification page in accordance with state laws, professional practices, and their contract obligations. Refer to *Exhibit A2: Sample Title/Certification Page*.
3. Table of Contents: The A/E Service Provider prepares a Table of Contents to list all specification division numbers and names, whether used or not. Where not used, the A/E Service Provider will indicate “NOT USED” after the division number and name. The Table will also list specification section numbers and names used for each division and their page number.
4. Instructions to Bidders: The County describes requirements for bidders and the bidding process.
5. Bid Forms: The County modifies standard bid forms for specific project requirements.
6. Conditions of the Contract: The County prepares specification sections and exhibits for the Conditions of the Contract, which may include the following:
   a. Contract Agreement (Public Improvement Contract), and
   b. Prevailing Wage Rates (if BOLI and/or Davis Bacon rates are applicable).
7. General Requirements: The County modifies standard specification templates to provide a single Exhibit A (in lieu of Division 1 sections). Where specific paragraphs are not used, the County will indicate “NOT USED” in the Table of Contents.
8. Technical Sections: A/E Service Providers have sole responsibility to prepare all sections of Division 1-49. Edit standard specifications templates where provided by the County. Elsewhere use the standard MASTERSPEC® template or A/E Service Provider standard specifications to develop project-specific specification sections elsewhere. Consider Basis of Design information found in *Appendix B, C, D and E*. Follow general principles found in the *CSI Manual of Practice*.

III. FORMAT

Prepare specification templates and project specifications using the Construction Specifications Institute (CSI) 49-division format. For further instructions, refer to the *CSI Manual of Practice*.

Specification Template Format

The County may request an A/E Service Provider to prepare or modify a County standard specification template using MASTERSPEC®. When this occurs, the A/E Service Provider shall obtain a license to use MASTERSPEC®, a product of the American Institute of Architects, published by Arcom. The A/E Service Provider shall export each relevant MASTERSPEC® section into a separate Microsoft Word ® document and edit the Microsoft Word ® file to suit County requirements. The A/E Service Provider shall edit the specification template in accordance with the format instructions described below.

Technical Section Format

For specification templates and project specifications, use the standard CSI three-part format and adhere to the following:

1. Center the section number and name in upper case (separated by a dash) on the first page of each specification section.

2. Do not carry a sentence over to the next page. Finish the sentence on the current page, or start it at the top of the following page. Select pagination for "Widows and Orphans."
3. Center "END OF SECTION" on the last page of each specification section, two lines below the bottom text of the section.

Technical Page Format

Refer to *Exhibit A3: Sample Paragraph* for examples of the following requirements:

1. Text Font Style: Arial
2. Text Color: Automatic (including header and footer)
3. Text Size: 11 point (except 10 point for header and footer)
4. Margins: 1" top, 1" bottom, 1" left, 1" right, 1" header, .5" Footer
5. Paragraph Spacing: Set to 0
6. Page Header:
   Multnomah County Oregon <Consultant Name>
   <Building Code – Building Name> <Document File Path Name>
   <Project Number – Project Name> <Consultant Project Number>
7. Page Footer:
   <Publication Date> <Section Number - Name> Page # of #
   <% Complete – Set Name>

Abbreviations, Acronyms and Terms

Adhere to the guidelines, standards, and examples found in the *CSI Manual of Practice*. Use terms defined by the County in the General Conditions and other County publications. Conform to the following:

1. Use "Architect" when referring Architect, Engineer, or A/E Services Provider;
2. Use "Owner" when referring to Multnomah County Oregon; and
3. Use "Project Manager" to refer to Owner representative.

Writing Style

Adhere to the following:

1. Do not use specifications sections or portions thereof directly from previous projects or master specifications that belong to other clients.
2. Do not repeat the general requirements of Division 01 in the technical sections (Divisions 02 through 49).
3. Do not use broad statement requirements, such as, "Electrical requirements shall comply with Division 26". Instead, list the specific sections which establish the requirements for the subject specification.
4. Use multiples of 7 days to establish time requirements (e.g. "respond in 14 days") so that timelines contain multiples not fractions of weeks. Note the General Conditions define each "day" to be a calendar day (not business day or working day).

IV. CONTENT

Create and edit individual sections so that the content, intent, and meaning of the specifications incorporate the following.

Standard Requirements
The County establishes the following standard requirements, which shall be incorporated into individual specification sections wherever related discussion occurs.

1. Warranty: Specify individual product warranties only where greater than the two-year warranty requirement established by the General Conditions for formal bids or Exhibit A for informal bids.
2. Extra Stock: Specify additional material or parts beyond that required for proper installation and operation, only where required by Code.
3. Recycled Content: Specify recycled content building products to reduce the need for virgin materials and to support product recycling markets where practical. Recycled content products may contain post-consumer or post-industrial recycled content, or a combination of both.
4. Limit PVC Material: Where practical, specify alternatives to polyvinyl chloride products (e.g. ABS, HDPE, or recycled plastic).
5. Local Building Material: Where practical, specify locally extracted or manufactured building materials and products to reduce the environmental impact, time and cost of transportation, and to support the local and regional economy.
6. Fire-Related Material: Specify fire industry approved products for all fire-resistive assemblies (e.g. dampers, doors) including fire detection, annunciation and suppression.
7. Lists of Acceptable Products: Promote unlimited competition consistent with the type and quality of work, and to maximize the use of standard products and current models.
    a. Product lists with five or less items shall include “or approved substitution” (not “or equal”). The substitution phrase will invoke requirements of the Request for Substitution (rather than a judgment whether products are equivalent).
    b. Product lists greater than five do not need to include the substitution requirement.
    c. Product lists shall not exceed ten items and should represent the best choices available for the current project.
    d. Listed or referenced materials and products shall meet the requirements of the specification section and the current project.

Sole Source Exemptions
The Multnomah County Board of Commissioners has granted exemptions for a limited number of products, which shall be specified as sole source (i.e. no product alternates listed or accepted). These exemptions do not preclude the selection of different or additional products if it is determined to be in the best interest of the County.

1. Siemens Building Technologies Inc.: Building Automation Systems (BAS).
    a. Agenda Placement Request (2011 6 16): APPROVING THE SOLE SOURCE PROCUREMENT PROCESS TO CONTRACT WITH SIEMENS BUILDING TECHNOLOGIES, INC. FOR THE PURCHASE OF BUILDING AUTOMATION CONTROLS.
    b. Term: Five year period ending 2026 6 30.

Basis of Design
The A/E Service Provider shall use materials, products and systems preferred by the County as the basis-of-design or benchmark for acceptance, when specifying related items.

1. Access Control: Specify Kantech card reader systems as basis of design.

2. Wiring: Specify all electrical wires and cable, circuits and motor disconnects to be manufactured by ISO -9001:2008 certified firms.
3. Refer to *Appendix B – Architectural Basis of Design* for other items preferred by the County.
4. Refer to *Appendix C – Mechanical Basis of Design* for other items preferred by the County.
5. Refer to *Appendix D – Electrical Basis of Design* for other items preferred by the County.
6. Refer to *Appendix E – Building Control Basis of Design* for other items preferred by the County.

Delegated Design
The A/E Service Provider shall provide specifications for engineered designs (rather than "design/build" or "performance and design" specifications), except where the Project Manager provides written authorization or where delegated design is the most common practice (e.g. pre-engineered metal buildings, fire suppression systems). Where professional design services or certifications by a design professional are required of the Contractor, the A/E Service Provider shall provide specific performance and design criteria for those products and systems. **Delegated design submittals shall comply with the following County standards, which the A/E Service Provider shall attach to their specifications.**

1. Deliverable Standards: Submittals shall comply with Multnomah County A/E Deliverable Standards.
2. Revit Standards: Drawings shall comply with the *Multnomah County Revit Standards* (Google/PDF).

V. EDITING

Where they exist, the County may issue standard or modified specification templates for each project. The A/E Service Provider shall use those templates as a starting point for authorized project work.

Specification Templates
The County will continue to develop, modify and update standard specification templates. If authorized to prepare or modify standard specification templates, the A/E Service Provider shall:

1. Use the MASTERSPEC® section or County specification template (where it exists) that most closely reflects the work to be described in specification form. Create or modify editorial instructions in the style established by MASTERSPEC®.
    a. Use blue font, hidden text to provide general background information to the project specification writer.
    b. Use bold text with "< … >" as delimiters to convey specific editorial instructions to the project specification writer (e.g. to insert or modify text).
    c. Use bold text with "[…]" as delimiters to identify standard choices for the project specification writer.
2. Use the Microsoft Word ® "Track Changes" function (including automatic red font and underlining) to provide a paper trail for proposed additions, deletions and other modifications. When the final draft (e.g. section template) is approved, accept all changes and disable the track changes function.
3. Edit the header as if the specification template was developed as a Project. Edit the footer to indicate "Specification Template" in lieu of "Set Name".

Project Specifications

For each individual project, the County will issue specification templates and previous project record documents (specifications) where appropriate to the A/E Service Provider. The A/E Service Provider shall:

1. Insert project-specific information in the header and footer, including the current status of the specifications (e.g. Design Development, Construction Documents, or Bid Set).
2. When using MASTERSPEC® documents:
    a. Read the background information in blue font, hidden text. The template locates these comments prior to the paragraph to which they apply. When the final draft is approved, enable the hidden text function so that the comments are not automatically printed.
    b. Read the directions in bold text with "< … >" as delimiters. The template locates these directions within the paragraph exactly where they apply. Replace the directions text and their associated directional delimiters with text as instructed by the directions.
    c. Read the choices listed in bold text with "[…]" as delimiters. The template locates these choices where they will be included in the paragraph. Select one of the choices and convert the selected text to regular font. Delete the choices not selected and their associated bracket delimiters.
3. Use the Microsoft Word ® Track Changes function (in strike-out mode) to provide a paper trail for proposed additions, deletions and other modifications. When the final draft (e.g. Permit Set, Bid Set, or Construction Set) is approved, accept all changes and disable the track changes function.

Project Modifications

During the course of each project, the A/E Service Provider shall use the following editorial directions to issue modifications (e.g. Addenda, Change Orders, Construction Change Directives, or Minor Changes to the Work) as follows:

1. Use Microsoft Word ® Track Changes (in strike-out mode) to provide a written document preserving knowledge of facts or events for authorized additions, deletions and other modifications. Update the footer to indicate the revision date and modification Set Name (e.g. Addendum #2).
2. For the next revision to the same specification section, accept the previous insertions and deletions prior to "tracking" new changes. Update the footer to indicate the new revision date and modification Set Name (e.g. Addendum #3).
3. Refer to *Exhibit A4: Sample Project Modifications*.

Project Record Documents

At project closeout where authorized in writing by the Project Manager, the A/E Service Provider shall collect previously issued modifications (i.e. Addenda and Change Orders) and Contractor mark-up documents (i.e. "as-builts") into one set of Project Record Documents as follows:

1. Incorporate "as built" information as new insertions, deletions, and other modifications.
2. Indicate products selected and installed or used with bold font (e.g. in product lists).
3. Where Requests for Substitutions granted, use both bold text and "Track Changes".

VI. QUALITY

A/E Service Providers shall review and correct their documents prior to submission to the County. Pay special attention to the following, which lists the most frequent specification quality concerns.

1. Verify that the items in Related Sections exist for the current project.
2. Verify that all product lists end with “or approved substitution” (not “or equal”) unless provided a sole source exemption approved by the Multnomah County Board of Commissioners or the list contains more than five choices.
3. Verify that mechanical and electrical specification sections do not restate or contradict information in Division 1 – General Requirements (or Exhibit A).
4. Verify that edited specification sections read clearly and do not create conflicts internally or with other sections.
5. Advise the Project Manager where errors, omissions or discrepancies occur in any County-provided documents, templates, or other building information.
6. Check grammar and spelling in specification sections.

APPENDIX A: Samples and Templates

EXHIBIT A1: SAMPLE TITLE/CERTIFICATION PAGE

Multnomah County Oregon I.M. Architect
B119 – Justice Center
CP00000 – Remodel Jails

TITLE AND CERTIFICATION

PROJECT NO.

ARCHITECT:

<Name>
<Address> **<Seal/Signature>**

STRUCTURAL ENGINEER:

<Name>
<Address> **<Seal/Signature>**

MECHANICAL ENGINEER:

<Name>
<Address> **<Seal/Signature>**

ELECTRICAL ENGINEER:

<Name>
<Address> **<Seal/Signature>**

EXHIBIT A2: SAMPLE PARAGRAPH

Multnomah County Oregon I.M. Architect
B119 – Justice Center
CP00000 – Remodel Jails

1.1 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Content: The specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases:

1. In accordance with *CSI Manual of Practice*, skip a line between Articles (e.g. 1.1 and 1.2) and between Paragraphs (e.g. A. and B.). Also skip a line between subparagraphs of different indentation (e.g. a. or (1)). Do not skip lines between subparagraphs of same indentation.

2. Imperative mood and streamlined language are generally used in the Specifications.

a. Occasionally, the indicative or subjunctive mood may be used in the Section text for clarity to describe responsibilities to be fulfilled indirectly by Contractor or by others when so noted.

(1) The Words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

(2) Refer to *CSI Manual of Practice* and exhibits included therein for further guidelines and examples.

EXHIBIT A3: SAMPLE PROJECT MODIFICATIONS

Multnomah County Oregon I.M. Architect
B119 – Justice Center
CP00000 – Remodel Jails

1.1 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Content: The specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases:

1. In accordance with *CSI Manual of Practice*, skip a line between Articles (e.g. 1.1 and 1.2) and between Paragraphs (e.g. A. and B.). Also skip a line between subparagraphs of different indentation (e.g. a. or (1)). Do not skip lines between subparagraphs of same indentation.

2. Imperative mood and streamlined language are generally used in the Specifications.

a. Occasionally, the indicative or subjunctive mood may be used in the Section text for clarity to describe responsibilities to be fulfilled indirectly by Contractor or by others when so noted.

(1) The Words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

(2) Refer to *CSI Manual of Practice* and exhibits included therein for further guidelines and examples.

Acceptable Manufacturers:

Carnes.
Krueger.
Metalaire, Inc.; Metal Industries Inc.
Nailor Industries of Texas Inc.
Price Industries.
Titus.

Configuration: Diverting-damper assembly inside unit casing with control components located inside a protective metal or plastic shroud.

EXHIBIT A4: SAMPLE PROJECT RECORD SPECIFICATIONS

Multnomah County Oregon I.M. Architect
B119 – Justice Center
CP00000 – Remodel Jails

1.1 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Content: The specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases:

1. In accordance with *CSI Manual of Practice*, skip a line between Articles (e.g. 1.1 and 1.2) and between Paragraphs (e.g. A. and B.). Also skip a line between subparagraphs of different indentation (e.g. a. or (1)). Do not skip lines between subparagraphs of same indentation.

2. Imperative mood and streamlined language are generally used in the Specifications.

a. Occasionally, the indicative or subjunctive mood may be used in the Section text for clarity to describe responsibilities to be fulfilled indirectly by Contractor or by others when so noted.

(1) The Words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

(2) Refer to *CSI Manual of Practice* and exhibits included therein for further guidelines and examples.

Acceptable Manufacturers:
Carnes
Krueger.
Metalaire, Inc.; Metal Industries Inc.
Nailor Industries of Texas Inc.
Price Industries.
Titus.

Configuration: Diverting-damper assembly inside unit casing with control components located inside a protective metal or plastic shroud.

APPENDIX B: Architectural Basis of Design

EXHIBIT B1: GENERAL DISCUSSION

GENERAL NARRATIVE

The contractor is responsible for controlling all chemicals brought onto the site for the job. This includes the use, inventory, storage, labeling, and proper handling during the duration of the project compliant with County, local, state, and federal requirements. All chemicals must be approved by the Compliance Office and entered into the FPM Chemical's Inventory. The chemical's SDS only will be sent for approval and entered into the County's SDS system in situations when the contract holder/facilities project partner has concerns OR in situations when a chemical product becomes an indoor air quality (IAQ) issue. Also, Contractors are required to take any remaining chemicals/paints/lacquers with them at the completion of the job.

> *Exception: a county representative (Project Manager/Trades Lead) must sign for chemicals to remain. In this case, the NCRC will review the SDSs from the remaining chemicals that are submitted into the online chemical inventory system. These are the SDSs that belong in the 'permanent contractor sourced products' category.*

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC). Limit use of polyvinyl chloride (PVC) based materials.

A. Adhesives

1. Flooring Adhesives

Before specifying any flooring product, consult with manufacturers to determine the correct adhesive to use with their product and whether they have low VOC adhesives. The following guidelines provide VOC limits for adhesives.

***a. South Coast Air Quality Management District - South Coast Rule #1168*:** Use this rule as a guideline to reduce emissions of VOC from the application of adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, or any other primers. Refer to www.aqmd.gov.

Welding & Installation	VOC Limit (grams/Liter)
Indoor carpet adhesives	50
Carpet pad adhesives	50
Wood flooring adhesives	100
Rubber flooring adhesives	60
Subfloor adhesives	50
Ceramic Tile adhesives	65
Subfloor adhesive	50
VCT & asphalt tile adhesive	50
Drywall and panel adhesive	50
Cove base adhesive	50

EXHIBIT B2: WOOD AND PLASTICS

GENERAL NARRATIVE

The County encourages the use of wood products from sustainable forests certified by the Forest Stewardship Council (FSC). Certified forest products come from forests that have been independently audited and verified, as well managed to maintain the health of the total forest ecosystem. Pressure treated wood, cedar or redwood and composites for decking or non-structural work are preferable as a basis of design. Wood that is subject to moisture, wet conditions or susceptible to dry rot should be taken into consideration to be eliminated as a basis of design. Consult the following certified wood distributors to establish a basis of design:

A. Cabinetry: For detailed specifications see Exhibit B-11 Section B.
Specify recycled content building products to reduce the need for virgin materials and help keep the recycling market strong. Recycled-content products can contain post-consumer or post-industrial recycled content, or a combination of both.
B. Fiberboard Millwork: At least 25% of the fiber in these products is from post-industrial recycled resources, while the balance is certified as recovered fiber, consistent with U.S. EPA recovered fiber definitions. These products are made without formaldehyde-containing additives, and were shown in lab testing to be free of formaldehyde down to a detection limit of 0.05 ppm. Use of locally sourced vendor or distributor as the basis of design.

EXHIBIT B3: THERMAL AND MOISTURE PROTECTION

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC).

A. Cold Applied Bituminous Membrane Roof Installation Guidelines:
As a basis of design roof composition should comprise of the following industry standards:

1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight. Torch down roofs are not recommended due to building occupancy, hot mopping, flammable materials and the possibility of fire or explosion.

a. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

2. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency in accordance with ANSI/FM 4474, UL 580, or UL 1897, and to resist uplift pressures calculated in accordance with ASCE-7 and applicable code. Minimum ply for roofing installation should be 4 ply for hot and cap; 2 ply for cold installation per ASTM D4977 surfacing requirements in a multi-ply cold or hot configuration; Each application provides a 30 year warranty; layers should overlap.

a. All Zones (Corner, Perimeter, and Field-of-Roof) Uplift Pressures: As indicated on Drawings.

3. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to ANSI/SPRI ES-1.

4. Flashings and Fastening: Provide base flashings, perimeter flashings, detail flashings and component materials and installation techniques that comply with requirements and recommendations of the following:

a. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations.

b. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details.

c. Comply with requirements of Division 07 Section "Sheet Metal Flashing and Trim".

5. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

6. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency as basis of design.

b. Identify products with appropriate markings of applicable testing agency.

7. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

8. Energy Performance: Roofing system shall have an initial solar reflectance index of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

9. Cold-Applied Adhesive Materials

a. General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

i. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

ii. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Other Adhesives: 250 g/L.
d. Non Membrane Roof Sealants: 300 g/L.
e. Sealant Primers for Nonporous Substrates: 250 g/L.
f. Sealant Primers for Porous Substrates: 775 g/L.

iii. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile

Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Joint Sealers

Specify the following product(s) as the basis of design.

1. ***Mon-Eco Industries Inc.***
5 Joanna Court
East Brunswick, NJ 08816
(800) 899-6326
www.mon-ecoindustries.com
Products: Various mastics, sealants and adhesives

2. ***Sika Corporation***
201 Polito Avenue
Lyndhurst, NJ 07071
(800) 933-7452
Products: Sikaflex-1a

C. Skylight Sealants

Specify the following product(s) as the basis of design.

1. ***Dow Corning Corporation***
Corporate Center
P.O. Box 994
Midland, MI 48686-0994
(800) 248-2481
www.dowcorning.com
Brand: Dow Corning 791 - Silicone Perimeter Sealant
Attributes: Field apply to seal erected building components in both new and remedial applications (VOC: 46-48 grams/Liter)

D. Firestop Sealant

Specify the following product(s) as the basis of design.

1. ***TREMCO***
Tremco Sealant/Weatherproofing Division
3735 Green Road
Beachwood, Ohio 44122
(800) 321-7906
www.tremcosealants.com
Product: TREMstop IA
Attributes: Single component, water-based, intumescent acrylic firestop sealant (VOC: 55 grams/Liter)

E. Multiple-Component High Performance Polyurethane Sealant

Specify the following product(s) as the basis of design.

1. ***BASF Construction Chemical Company***
889 Valley Park Drive
Shakopee, MN 55379
(800) 243-6739
www.buildingsystems.basf.com

Product: Sonneborn Sonolastic Sealant Systems NP-2
Attributes: VOC: 80 grams/Liter less water

F. Adhesive Caulking
Specify the following product(s) as the basis of design.

1. ***DAP Inc***
2400 Boston Street, Suite 200
Baltimore, MD 21224
(800) 543-3840
www.dap.com
Product: Dynaflex 230
Attributes: (VOC less water: 49 grams/Liter)

2. ***Tremco***
3735 Green Road
Beachwood, OH 44122
(800) 321-7956
www.tremcocpg.com
Product: Vulkem 116

G. Interior Caulking: A non-toxic water-based elastic emulsion type caulking compound designed to replace oil caulk and putty for windows, cracks and general maintenance work. Use for caulking windows, sealing cracks, filling holes, door perimeters, walls and woodwork, air duct openings, venting and plumbing areas, siding openings and masonry cracks. Does not dry out or crack and does not release any solvents or obnoxious odors.

1. ***DAP Inc***
2400 Boston Street, Suite 200
Baltimore, MD 21224
(800) 543-3840
www.dap.com
Product: Alex Plus Acrylic Latex Caulk Plus Silicone

2. ***GE***
9930 Kincey Avenue
Huntersville, NC 28078
(877) 943-7325
www.siliconeforbuilding.com
Product: SCS1000 Contractors

H. Expansion Joint Sealer
Specify the following product(s) as the basis of design.

1. ***Flex Bon Paints/Sherwin Williams***
2131 Andrea Lane
Fort Myers, FL 33912
(239) 489-2332
www.flexbon.com
Product: Flex-Bon Pinnacle Acrylic Urethane Elastomeric Sealant.
Attributes: Low-odor paintable sealant that performs similarly to one-part urethane sealants, such as at expansion and control joints (Low VOC 42 grams/Liter)

EXHIBIT B4: DOORS AND WINDOWS

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify oversized doors (anything over 36 inches wide or over 84 inches tall) where carts, gurneys or materials are moved through the doorway. Glass panels in doors should not be located in the middle of the door adjacent to the lockset or middle hinge.

A. Doors

1. Wood Doors: Wood doors shall be solid core wood doors, clear finished or painted. All wood doors installed in fire wall assemblies shall be fire rated.

2. Metal Doors: All Steel Doors and Frames to comply with ANSI/SDI A250.8-2014.

3. Overhead Doors: All County overhead doors (i.e. roll-up and coil-up doors) shall be similar to/or R&S manufacturing made, and made locally sourced to expedite repairs and parts for continuity of operations. Sectional Doors shall be similar to/or Clopay and Wayne Dalton, and locally sourced to expedite repairs and parts for continuity of operations.

a. ***R&S Manufacturing Inc.***
7200 SE 92nd Ave Unit B
Portland, OR 97266
(503) 777-6370
www.rsdoorproducts.com

b. ***Clopay***
6821 NE Columbia Blvd.
Portland, OR 97218
(800) 225-6729
www.clopaydoor.com

c. ***Wayne Dalton***
5511 SE 26th Ave
Portland, OR 97202
(503) 234-0941
www.wayne-dalton.com

4. Overhead Door Operators: All operators shall be manufactured by Liftmaster for all gates, slider, overhead, roll-up, or sectional doors with the exception of bi-fold doors that utilize hydraulic ram arms. The operator motor shall match line voltage. The preference for roll-up gates is for rolled slate, but flat slate can be utilized based on demand. Safety light curtains, edges, beams, and loops shall be incorporated in all instances to ensure safety of occupants and equipment per site requirement.

5. Overhead External Controls: External controls for all the above shall be either push button and/or remote control. Electrical disconnect shall be installed near the operator as a safety measure to ensure lock-out-tag-out during malfunction and repairs.

Refer to: Electrical Specifications *Section I - Utilization Equipment*, paragraph 11: *Power for overhead doors, sliders, coiling doors, and gates that require power*

B. Door Hardware

Match existing building standards and applications where practical to maintain uniformity. Use of manufacturers other than listed preferred manufacturers should be reviewed by County Carpenters & Locksmiths. Where there are no building-specific standards in place or there will be significant changes throughout the building, use the following as basis of design:

a. Maintain building uniformity
b. Specify 626 finish for door hardware
c. Use NL as basis of design wherever appropriate
d. coordinate with electrical to provide plastic junction boxes for low voltage work such as card readers
e. specify construction cylinders to match building and keying systems so the County Locksmith may furnish and install final cylinders and keys
f. Match lever and hardware designs for lever and exit devices
g. Match building keyway with Primus cylinder

1. Exit Device: Use Von Duprin 99NL or 33NL where practical (but not 22NL) as basis of design. Where a card reader is indicated, coordinate with County Alarms to use Von Duprin with RX switches (or LX if approved by County) as basis of design. All trim for card reader exit devices will be storeroom function. If Von Duprin power supplies are required for type of hardware, order power supply with locks that are keyed alike to match County Standards. Trim and finish should match the existing levers of existing buildings being remodeled. When trim requires rim cylinders, use Schlage LFIC as basis of design for removable core rim cylinders. For electrified options, use Von Duprin Quiet Electric Latch as a basis of design. For delayed egress applications, use Von Duprin Chexit delayed egress option as a basis of design.

2. Power Assistance: Where power-assisted door operation is indicated, use LCN 4600 series (electro hydraulic) or LCN 4800 series (pneumatic) where practical, as basis of design for the auto-actuator. Do not specify a vertical “contact bar” style actuator.

3. Latch: For single unisex restroom, use occupancy indicator latch that is handicapped acceptable. Latches to be 2 3/4” backset or match existing building hardware.

4. Lock: Use Schlage only. (Refer to sole source exemptions.)

a. Exterior: Where a card reader is indicated for the building exterior, use Schlage with storage function lockset with C Primus cylinders as basis of design. Do not use “Everest” cylinders. Consult County Lock Shop when supplying locking hardware that will need to be keyed or match an existing master key system.

b. Interior: Where a card reader is indicated for the building interior use Schlage levers with storeroom function; use Von Duprin exit devices with Night Latch (NL) function (always locked when secured) and an LCN Door Closer. Where a card reader is indicated for building interior, use Allegion/Schlage ND80PDEU or EL with cylinders that match the existing building master key system if the building is using electric levers.

c. Restrooms & Wellness Rooms: Provide ADA-compliant “occupied” indicator for single user unisex restrooms. Use Schlage B571 with occupancy indicator or Schlage L9496 Mortise with occupancy indicator to match building hardware.

d. Cylinder Core: Provide all locksets with temporary construction cores.

e. Communication with Locksmiths/Lock Shop: Communicate information about all projects in new and existing buildings to Lock Shop. All Primus Cylinders must be County registered keyways approved by Lock Shop.

i. Keyway C: Use “C-1 Bitted” interior or Primus exterior typical.
ii. Keyway E: Use “E-1 Bitted” for building mechanical spaces.
iii. Keyway P: Use “P-1 Bitted” for elevator equipment room spaces.
iv. Everest: May be approved by Lock Shop on new construction.

5. Lock Keying: If cylinders are not construction keyed, provide Multnomah county lock shop with all keys for hardware and cylinders. Multnomah County Lock Shop does all keying unless factory-keyed.

6. Electric Strike: Use Von Duprin 6211 24VDC (cylindrical or levers) or Von Duprin 6210 24VDC(Mortise Hardware) as basis of design. Use the correct model of Electric Strike that is compatible with the hardware on the door. If retrofitting electric strikes, must have county trade personnel.

a. Electrically Locked: Verify whether to specify fail-safe.
b. Electrically Unlocked: Verify whether to specify fail-secure.

7. Levers: Use Schlage SPA or RHO (Rhodes) depending on existing hardware used in building as basis of design. Match existing levers and finish and should have large format interchangeable core cylinders.

8. Electrified Levers: Use Schlage ND80PDEU (Fail Secure) or ND80PDEL (Fail Safe) or Electrified Trim for Exit Devices. This hardware depends on application and/or Building standards. Electrified levers should be Allegion with RX switches and Molex connectors to avoid hard wiring. Leave slack in the wiring to allow for future replacement of faulty hardware. The lever and the finish of the lever should match the existing hardware.

9. Card Reader: Provided by County Alarms unless specified otherwise. Interior card reader: Use storeroom lever or exit devices with door closer.

10. Closer: Use LCN 4040XP as basis of design (not handed), except use LCN 4011 where 180 degree swing indicated. Where wall stops are not feasible, use closer to limit door swing. Do not place hold-open devices on fire/smoke doors (use magnetic holders).

a. Card Reader Door: Provide closer.
b. Fire/Smoke Doors: Provide closer.
c. Otherwise: Do not provide closer, unless required for acoustics or security.

11. Stop: Use wall stops (WS) where practical. Do not use floor stops, because they are trip hazards. Limit use of hinge stops, because they rack heavily-used doors.

12. Threshold: The following is recommended as a basis of design:

a. Door Seal: Installation shall take site conditions into consideration as a basis of design.
b. Gasketing: Provide where required to control fire, smoke, fumes, particulates, or sound.
c. Silencer: Use gasketing or weatherstripping instead, because silencers don't last 30 years.
d. Weatherstrip: Provide where exposed to weather or separating dissimilar micro-climates.

13. Plates: Provide at all exterior doors.

a. Armor Plate: Provide half-door kick plates, where doors are used for cart, gurney or material movement.
b. Kickplate: Provide at all exterior and stair doors.

14. Frames: ANSI Prep Only.

C. Windows

1. **Bird-Friendly Design Window Treatments** - When installing windows in a new facility or major renovation, including the replacement of over 50% of the structure's glazing, Multnomah County requires Bird Friendly Design considerations in order to reduce reflectivity and make exterior glass visible to birds.

2. **General Guidance:**

    a. At least 90 percent of the exposed facade material from ground level to 40 feet—
        i. shall not be composed of glass; or
        ii. shall be composed of glass employing—
            1. elements that preclude bird collisions without completely obscuring vision, such as secondary facades, netting, screens, shutters, and exterior shades;
            2. ultraviolet (UV) patterned glass that contains UV-reflective or contrasting patterns that are visible to birds;
            3. patterns on glass designed in accordance with a rule that restricts horizontal spaces to less than 2 inches high and vertical spaces to less than 4 inches wide, commonly referred to as the '2 × 4 rule';
            4. opaque, etched, stained, frosted, or translucent glass; or
            5. any combination of the methods described in this subparagraph.

    b. At least 60 percent of the exposed facade material above 40 feet shall meet the standard described in paragraph (a)(i) or (a)(ii).
    c. There shall not be any transparent passageways or corners.
    d. All glass adjacent to atria or courtyards containing water features, plants, and other materials attractive to birds shall meet the standard described in paragraph (a)(ii).
    e. Outside lighting shall be appropriately shielded and minimized subject to security and other mission related requirements.

3. Architect shall provide an analysis to Multnomah County describing site conditions and budget impact on the project. Project Managers shall consult with County stakeholders to determine the feasibility of meeting these requirements.

4. Projects that are included in Multnomah County's FAC-9 Green Buildings Policy are required to seek LEED Gold certification. If the project achieves Innovation: Bird Collision Deterrence Credit (or equivalent in future LEED versions) in the design strategy and selection of glazing or window treatment products,then this standard has been met.

5. **Additional Resources**
    a. Design teams may use the below documents as guidance in designing buildings and determining which products to employ:
        i. ABC's Bird-friendly Building Standard
        ii. Portland Zoning Code, 33.510.223
        iii. City of Portland Ordinance 190023

6. **Exceptions/Exemptions –**
    a. The requirements of this section shall not apply to any acquisition, new construction, or major renovation if the FPM Director, after consideration of

multiple options, determines that the use of the required building materials and design features would not be in the best interest of the County.

b. Exempt Buildings: Buildings with a Historic Resource designation.

7. Security

a. Assessment to determine whether window installations shall incorporate armourcoat ballistic protection is needed to ensure County buildings are protected from vandalism and building access secure, despite that it may void the window warranty. To be considered on a case by case basis due to site logistics, i.e., street level windows and program buildings such as the libraries and health department.

b. All county buildings should have graffiti film applied to windows on the first floor.

EXHIBIT B5: WALL SYSTEMS

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC).

A. Interior Steel Studs: Steel usually contains a minimum of 25% post-consumer recycled content. Such material comes from galvanized steel coils made up from a minimum of 25% recycled steel, using the Basic Oxygen Furnace process. Steel Studs should be 20 gauge or heavier. Specify the following product(s) as the basis of design.

1. ***Steeler™, Inc.***
10023 Martin Luther King Jr. Way South
Seattle, WA 98178
(800) 275-2279
www.steeler.com
Attributes: Steel studs are locally manufactured in Seattle, WA.

B. Gypsum Board: Mining raw materials, gypsum, limestone, clay, talc, mica, and perlite) produces spoil erosion, pollutant runoff, and habitat loss. Gypsum is nonrenewable, although a relatively abundant resource. Most gypsum board products are manufactured with paper backing from primarily recycled paper and gypsum core containing minimum 10 percent recycled gypsum. Percentages vary depending on the manufacturing facility, and are generally increasing throughout the industry as manufacturing facilities upgrade.

Gypsum has a non-combustible, dimensionally stable, gypsum core. The surfacing on both faces and on the long edges is 100% recycled paper. The front face and the long edges are an ivory color: the back face paper is gray. The ends are square cut, smooth finished with no paper facing. 100% of the facing paper used to make wallboard is recovered fiber. Approximately 5% is from post-consumer sources. Total recycled content is 13.96%. Post-industrial recycled content is 8.26%. Post-consumer recycled content is 5.70%. The recycled content in the core includes internal recycling, construction scrap, and synthetic gypsum. USGBC has determined that synthetic gypsum is post-industrial content.

All new gypsum board being installed shall be Type X with a minimum of ⅝" thickness. Green board shall be used in any area with high moisture content. Specify the following product(s) as the basis of design:

1. ***Georgia Pacific Building Products***
133 Peachtree Street NE
Atlanta, GA 30303
(800) 225-6119
www.gp.com
Product: Tough Rock ™ Light and Strong
Attributes: The local Tacoma Washington plant will use synthetic gypsum and recycle paper. Synthetic or flu-gas gypsum is a waste product obtained from stack scrubbers for removing sulfur from coal-fired power plant emissions.

C. Prefabricated Wall Systems: For areas with unique site conditions and compacted construction schedules, consider using prefabricated wall systems that can be manufactured to exact dimensions in a shorter amount of time. Using prefabricated systems also cuts down on waste by increasing flexibility and allowing for reconfiguration and reuse of materials as changes are requested. Walls are not load bearing or fire rated. See County DIRTT standards here: DIRTT Standards / PDF
Specify the following product as basis of design:

1. **DIRTT**
7303 30 Street SE
Calgary, Alberta T2C 1N6
www.dirtt.net
Local Vendor: Eteriors 919 SW Taylor Street Suite 800 503-334-2280

D. Parapet Walls: Parapet wall heights of 48" (total height to width) should be included in the design of a new building if any equipment is placed near the leading edge of a roof. This would eliminate the need for fall protection so workers can service the equipment. As a secondary option fall protection anchors could be designed so tie-off points are placed in the correct location for the work that needs to be performed.

E. Exterior Façade Performance Specs:Exterior façades shall be designed to be high performing, durable, low maintenance and provide for a weather-resistant exterior finish. Selections of primary material should take into consideration thermal performance, water infiltration, constructability, security, sophistication of materials and availability of contractors to maintain it. Façade materials shall be selected to reduce heat gain or loss through the envelope resulting in lower energy consumption for the building. Durable materials should be selected that allow for easy cleaning, minimal needed maintenance and ability to resist tampering or vandalism to reduce the building's life cycle costs.

1. Façade material selection can be distinguished as a primary material or a limited quantity material. Limited quantity materials in this section refer to an approved deviation in materials of less than 20% of the overall façade. Materials selected for limited quantity installations can be selected from the "not approved" list of materials, but must first obtain approval from the FPM Director for this deviation.

a. Based on these performance needs, **recommended** materials to be considered as the primary covering of the exterior include:

i. metal panel (inc. aluminum, copper, steel alloy)
ii. brick masonry
iii. porcelain tile
iv. concrete
v. metal shingles
vi. terra cotta panels
vii. structural glass
viii. glass-fiber reinforced concrete panels
ix. fiber cement lap or panel siding

b. Materials that are **not approved** due to not meeting performance needs include:
i. wood shingles and siding
ii. stucco
iii. exterior insulation and finish systems (EIFS)
iv. particleboard panels
v. exterior plywood
vi. hardboard panels
vii. supported stone veneer
viii. vinyl siding

EXHIBIT B6: CERAMIC TILE

GENERAL NARRATIVE

Specify recycled content building products to reduce the need for virgin materials and keep the recycling market strong. Recycled content products can contain post-consumer or post-industrial recycled content, or a combination of both. Specify 5% overage on ceramic tile.

A. Ceramic Tile: Most manufacturers reclaim their fired scrap materials. Tiles containing recycled glass are available. Recycled glass can contain pre-consumer and post-consumer industry waste such as windshield glass and waste from light bulb manufacture. Tile is an inherently low-toxic, durable finish material for flooring, walls, and other applications. Specify the following product(s) as the basis of design. Tile base on wall required when using in wet environments (i.e. bathrooms). Install grout line/spacing per manufacturer guidelines (typically thinner grout lines preferred). Seal grout unless using epoxy.

EXHIBIT B7: CEILING SYSTEMS

GENERAL NARRATIVE

The major constituents of acoustical ceiling tiles are mineral wool (fabricated from slag and rock, cellulose, starch (primarily from corn), clay (for fire-rated products), fiberglass and paint. Mining raw materials produces soil erosion, pollutant runoff, and habitat loss. Manufacture of acoustic ceiling tiles does not generate much waste because scrap material is recycled back into the process.

A. Suspended Ceiling Systems: Detention centers shall have at minimum a no. 9 slack wire for suspension systems. Specify the following product(s) as the basis of design: 2'x2' or 2'x4' tile dimension only.

EXHIBIT B8: FLOORING SYSTEMS

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC). Specify 10% overage on flooring products. Please refer to the flooring matrix for recommended products based on room type.

Flooring Matrix

A. Resilient Flooring and Adhesives: Specify materials that are considered rapidly renewable to help reduce the use of products that are considered long-cycle renewable materials. Rapidly renewable materials are typically planted and harvested in cycles of 10 years or less. These products tend to be more environmentally and economically friendly, use fewer natural resources, and require less labor to produce than other products. Specify slip-resistant textured flooring for stair landings and detectable warning tile on treads. Specify integral slip-resistant strip (1-inch minimum, full tread width) at each tread and landing edge, with a high-contrast color distinction (e.g. yellow non-skid strip on black treads).

Refer to FPM Interiors contract administrator to determine which manufacturers are available on contract; or assume product to be procured through General Contractor.

1. *Vinyl Flooring*: There are 2 types of vinyl flooring- heterogeneous layered and homogenous (solid color through). Heterogeneous will have more patterns and options. Homogenous will have few patterns to choose from but will withstand more wear and tear since the color goes through the entire thickness. Minimum requirements 20 ml wear layer. Orthophthalates and other forever chemicals must not be present in PVC. Integral cove needed in bathrooms and areas that have water. Preferred zero or low VOC's.

2. LVT (Luxury Vinyl Tile): Available in many patterns and style that mimic wood, stone, and others. Many are available in thickness similar to carpet that is helpful for transitioning different rooms and spaces. Will need to specify how product layout will be, because it will impact design. Minimum 20ml wear layer. Preferred zero or low VOC's.

3. *Slip-Resistant Flooring*: Slip-resistant flooring is necessary for public or industrial entryways, work areas and high traffic areas, particularly where exposure to water may occur. Walk-off mats are also good sources of soil removal from foot traffic entering a building.

4. ***Rubber Flooring****:* Rubber provides a highly durable, resilient, slip-resistant floor. All tile product, intended for areas that need a softer flooring, or where a lot of standing is done. Naturally low VOC. Installation is a glue down application.

5. **Linoleum Flooring**: Natural Linoleum is durable, low maintenance flooring made of linseed oil, pine rosin, sawdust, cork dust, limestone, natural pigments, and a jute backing. Adhesives for linoleum installation differ from vinyl flooring adhesives; a smooth, dry surface is essential for proper installation. For floor installations, specify heat-welded seams and integral cove flooring up vertical surfaces. Support cove at horizontal and vertical junction with cove strip to eliminate cracking. Do not install in high water use areas (i.e. bathrooms).

B. **Reclaimed Wood Flooring**: Reclaimed wood flooring is typically salvaged from buildings that are typically 70 to 200 years old.

EXHIBIT B9: CARPET

GENERAL NARRATIVE

Whenever feasible, carpet tiles, as opposed to broadlooms, should be used. When using carpet tile, and stairs are present, use rubber or vinyl stair treads and risers. All carpet design layout of broadloom carpet should minimize the number of seams. Accent colors and patterns should be limited to areas where carpet tiles are used.

Carpet tile or broadloom carpet glued to concrete slab on grade floors should have an adhesive that is compatible with possible moisture from the slab. All adhesive should be water based and phthalate free.Carpet tile should be installed with releasable adhesive to allow for the replacement of stained or damaged tiles.

All carpets, backings, cushion and adhesives shall meet the Carpet and Rug Institute (CRI) Green Label Plus testing program. Refer to https://carpet-rug.org. The purpose of this labeling program is to identify products that are truly low-VOC. The CRI Indoor Air Quality Carpet Testing Program informs the consumer that the product type has been tested by an independent laboratory and has met the criteria for very low emissions. Recommended carpet to be selected from the pre-approved Carpet Tile Standards document, available from the FPM Interiors Group or at this link:

Carpet Catalog 2022 (Google/PDF)

When deviating from the Carpet Tile Standards is required, use the exception form available from the FPM Interiors Group

A. Specification Preferences

1. ***Fiber Type***: Specify Nylon Type 6 or Type 6,6 fiber (or manufacturer's equivalent) as it tends to outperform other fibers due to the manufacturing process and the characteristics of the nylon being used. Being sustainable means the product will perform and last longer, hence reduce energy consumption to produce a newer replacement product and thus reduce premature disposal. More energy is ultimately consumed with a carpet that has a

shorter use life span. Therefore, the County prefers performance branded nylon Type 6 or Type 6,6 nylons over commodity products.

2. ***Local and Regional***: When possible specify carpet products that are manufactured on the west coast including some mills in California. Even though the distance is greater than the preferred 500 mile radius of a product considered local and regional, it is much closer than those products manufactured on the east coast. Using products that are manufactured locally helps reduce the environmental impacts resulting from their transportation and helps support the local economy.

3. ***Recycled Content***: Where possible, choose carpets with 40% pre-consumer recycled content 40% and 20% post-consumer content. This is in line with the requirements of LEED. Where not possible, selected carpets with the highest percentage of post-consumer content. This is preferable because it is less likely to end up in a landfill than pre-consumer waste.

4. ***Dye Method***: Specify solution dyed carpet.The traditional method of dyeing fibers involves first producing the fiber and then adding the color. In traditional dyeing methods, the fiber is produced in a colorless form after production, the fiber is then dipped in the dye to add the color. Solution-dyed fibers have color pigments added directly into the polymers (chemicals) at the initial stage of production. This means that when the fiber is extruded from the spinnerets, it is already the desired color. Solution-dyed fibers are much more colorfast than fibers dyed by other methods.

5. ***Density***: Specify carpet with a minimum density of 5,000 per cubic yard. The density of a carpet is one of many factors that determine a carpet's quality and overall performance. Carpet density refers to how close together the fibers are tufted into the carpet backing.

6. ***Fiber Twist Level:*** Specify carpet with a fiber twist level of minimum 5 TPI (Twist Per Inch). The twist number is a very good indicator of carpet quality. The higher the twist number the better the performance of the carpet. Twisting the fibers together increases their strength, resulting in a carpet that will be more able to withstand traffic and resist crushing. Fiber twist is a factor only in cut pile carpets. Looped styles are not gauged by twist because the yarns are looped back into the carpet.

7. ***TARR rating (Texture Appearance Retention Rating)***: Specify carpet with a minimum TARR rating of 3. The Texture Appearance Retention Rating gives buyers an indication of how well a specific carpet tile will perform in a specific end-use situation under expected levels of foot traffic. Carpet tiles are lab tested by simulating the impact of wear on the carpet over time- and it's this type of holistic testing that offers the best prediction of a carpet's performance over its lifetime.

8. ***Filament Type***: Specify carpet with a hollow or trilobal filament. Hollow filament refers to filaments with interior voids. Hollow-core fibers improve the soil-hiding ability of nylon by diffusing light passing through the fiber. Trilobal fibers help defuse the magnification of soil and scratches that occur with the round fiber.

9. ***Non Fluorinated stain repellents*****:** Some stain repellant treatments use poly- and perfluoroalkyl substances (PFAS). These chemicals are potent developmental and reproductive toxicants that persist in the human body and environment. People inhale or ingest these chemicals throughout the lifecycle of production, use, and disposal of carpet. Carpet manufacturing plants have polluted downstream drinking water supplies with stain repellents. Building occupants can inhale and ingest PFAS that migrates out of carpet. After use, workers and surrounding residents can breathe in PFAS released by carpet shredding operations, where dust fills the air. We should specify carpets with non PFAS chemistry to provide stain repellency.

10. ***Non halogenated and phosphate free flame retardants*****:** Some flame retardants used in carpet are halogenated (they contain chlorine or bromine). Halogenated flame retardants are among the chemical industry's most notorious products. They are linked to hyperactivity, learning disabilities, reproductive harm, and cancer. Common replacements for the halogenated flame retardants are organophosphate flame retardants, which are linked to

endocrine disruption and infertility. Flame retardants can be emitted from carpet into dust and the air both during use and from operations that recycle and dispose of carpet waste. Released into the environment, they can persist and bioaccumulate up the food chain. We should specify carpets free from halogenated and phosphate free flame retardants.

11. ***Free from antimicrobials with a health claim***: Antimicrobial preservatives often protect plastic ingredients from biological degradation. These include highly toxic triclosan and formaldehyde. Triclosan is an endocrine disruptor and formaldehyde is a highly potent carcinogen. While other preservatives may be more common, it is difficult to know as manufacturers rarely disclose the biocides that are in carpets. The safest way to approach this topic is to avoid antimicrobials that are added to a carpet that have a health claim associated with them.

12. ***Fly Ash – not intentionally added*****:** Fly ash, a by-product of coal-fired power plants, is widely used as a filler in carpet tile. Fly ash contains mercury which is a potent neurotoxicant. Manufacturers have used fly ash to load carpet with so-called “recycled content.” and some prominent green building certifications have rewarded recycled content regardless of its origin and contaminants. We should specify carpets that do not contain fly ash.

13. ***Carpet Tile***: Benefits of using Carpet Tile:

- **a.** Provides flexibility to change areas out without changing the entire floor (ie: stains, etc.)
- **b.** Works ideal with raised access floor system or open office system
- **c.** Easy for selective replacement of tiles in high traffic areas
- **d.** Attic stock is easy to store

14. ***Carpet Overage:*** Standard Overage Policy Rounded to the next full box

- **a.** 0 – 125 yards no overage, order 1 extra box
- **b.** 126 – 249 yards 4% overage
- **c.** 250 -749 yards 3% overage
- **d.** 750 -2499 yards 2% overage
- **e.** 2500 yards and up 1% overage

15. ***Walk off Mats***: Based on the information provided above for carpet tiles, specify walk off carpets that meet the same requirements for carpet tiles (Refer to Carpet Catalog 2022 (Google/PDF) to for walk off mat specifications)

- **a.** Fiber Nylon 6,6 or Type 6 (or equivalent)
- **b.** PVC Free (carpet & backing)
- **c.** Stain repellents are non-fluorinated
- **d.** Fly ash is not intentionally added to backing
- **e.** Anti-Microbial coating (with a health claim) free
- **f.** Flame Retardants are non-halogenated and phosphate free

EXHIBIT B10: PAINTING

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC).

A. Interior Paints: All paint products that are used in Multnomah County buildings shall comply with the **Green Seal Environmental Requirements** www.greenseal.org. This standard establishes environmental requirements for paints. The standard does not include stains, clear finishes, or paints sold in aerosol cans. Paints listed below meet the VOC limits as outlined by Green Seal-11 (GS-11) in the USGBC LEED Green Building Rating System. Multnomah County Paint Standards guide / PDF

Interior Paint	**VOC Limit (grams/Liter)**
Flat	50
Non-Flat	150
Exterior Paint	**VOC Limit (grams/Liter)**
Flat	100
Non-Flat	200

Specify the following product(s) as the basis of design.

1. ***Sherwin-Williams Company***
   30 NE Broadway
   Portland, OR 97232
   (503) 288-6477
   www.sherwin.com
   Products: see table below.

BASIS OF DESIGN: INTERIOR PAINTING (all facilities) – Use Sherwin-Williams as Basis of Design			
Manufacturer	**Product**	**Finish**	**Color**
Sherwin-Williams	Latex	Satin	Classic French Gray SW 0077
Sherwin-Williams	Latex	Satin	Agreeable Gray SW 7029
Sherwin-Williams	Latex	Satin	Versatile Gray SW 6072
Sherwin-Williams	Latex	Satin	Mega Greige SW 7017
Sherwin-Williams	Latex	Satin	Samovar Silver SW 6233
Sherwin-Williams	Latex	Satin	Silver Strand SW 7057
Sherwin-Williams	Latex	Satin	Lemon Chiffon SW 6686
Sherwin-Williams	Latex	Satin	Relaxed Khaki SW 6149
Sherwin-Williams	Latex	Satin	Kilim Beige SW 6106
Sherwin-Williams	Latex	Satin	Double Latte SW 9108

Sherwin-Williams	Latex/Promar 200	Semi-Gloss	French Roast * SW 6069
Sherwin-Williams	Latex	Satin	Creamy ** SW 7012
Sherwin-Williams	Latex	Satin	Quietude SW 6212
Sherwin-Williams	Latex	Flat or Eggshell (ceiling paint)	High Reflective White SW7757 ***

* Door and window trim color
** Serves as county P1 paint color
*** Ceiling color

Sherwin Williams Paint Products:

Resilience acrylic-latex. Use at: All Exterior work.

Super Paint acrylic-latex or Emerald acrylic-latex(Satin Sheen). Use at: All residential and commercial properties back and front of the house and high traffic areas.

Super Paint acrylic-latex or Emerald acrylic-latex(Semi-Gloss Sheen). Use at: Kitchens and restrooms.

Pro Mar 200 Hybrid (Semi-Gloss Sheen). Use at: Doors and trim.

B. Sealers: Use sealers in your buildings that meet the following criteria for Bay Area Air Quality Management District. Refer to http://www.baaqmd.gov. The purpose of these criteria is to limit the quantity of volatile organic compounds (VOC) in architectural coatings.

Sealants	**VOC Limit (grams/Liter)**
Architectural	250
Sealant Primer	**VOC Limit (grams/Liter)**
Architectural (non-porous) Architectural (porous) Other	250 775 750
Specialty Coatings	
Wood varnish	350
Stains	250
Waterproofing concrete/ masonry sealers	400
Waterproofing sealers	250
Primers, sealers and undercoats	200
Quick dry enamels	250
Quick dry primers, sealers, undercoaters	200
Recycled Coatings	250
Shellacs: Clear Opaque	 730 550

C. Lacquer Sealer for Metal and Wood: All sealers, caulking and adhesives listed below meet the VOC limits as outlined by the USGBC LEED Green Building Rating System. Specify the following product(s) as the basis of design.

1. *American Formulating and Manufacturing*
3251 Third AvenueSan Diego, CA 92103
(800) 239-0321
www.afmsafecoat.com
Product: Safecoat Acrylacq
Attributes: It is a clear high-gloss water-based replacement for high solvent content lacquers. Use on wood cabinetry and doors, paneling, furniture, wood railings, metal railings. VOC material is 124 grams/Liter). VOC Material less water is 281 grams per Liter.

D. Concrete and Masonry Sealer
Specify the following product(s) as the basis of design.

1. *AFM Safecoat*
3251 Third Avenue
San Diego, CA 92103
(800) 239-0321
www.afmsafecoat.com

Product: AFM Safecoat Penetrating WaterStop
Attributes: Improves water resistance and repellency in a wide variety of surfaces, including brick walls, concrete foundations, concrete block, stucco, stone and most unglazed tile. Because Safecoat Penetrating WaterStop is not toxic and low odor, it is ideal for use indoors instead of a typical high solvent content sealer; yet, it is durable enough for use outdoors. It is particularly useful as a periodic maintenance coat for surfaces originally treated with Safecoat WaterShield.

Product: AFM Safecoat Safe Seal
Attributes: It is a multi-use, water-based, low-gloss sealer for highly porous surfaces such as particle board, plywood, processed wood and porous concrete. It is used primarily to reduce toxic out-gassing. In particular, it is highly effective at sealing in formaldehyde out-gassing from processed wood such as plywood, particle board and pressed wood. It is virtually odorless on application and odorless once cured. Use on porous surfaces such as processed wood products, concrete, wood.

E. Doors and Trim
Specify the following product(s) as the basis of design.

1. *Sherwin Williams Company*
30 NE Broadway
Portland, OR 97232
(503) 288-6477
www.sherwin.com
Product: ProMar 200 Hybrid
Attributes: Interior waterbased acrylic-alkyd semi-gloss low odor paint. Very durable paint which works well in high impact locations such as doors and door trim.

F. Pavement

1. All traffic control markings comply with the ***MUTCD*** and/or the ODOT Traffic line manual.

2. All paint used is "Low VOC, Non Lead, solvent borne traffic paint". This is applied at a minimum of 15 mils wet.

3. Stall lines are "Yellow", except ADA areas.

4. ADA/ Handicap parking stalls, access aisles, and legends are "White", installed to current ODOT Standards, and marked using "Premark" brand preformed thermoplastic, 125 mil thickness lines, 90 mil thickness legends, all "High skid resistant" material.

5. Traffic legends (arrows, stoplines, crosswalks, etc.) are marked using FHWA style markings. These are marked using "Premark" preformed thermoplastic, 125 mil thickness.

EXHIBIT B11: SPECIALTIES

GENERAL NARRATIVE

Incorporate the following basis of design into the appropriate architectural sections of the specifications. Specify products that emit low volatile organic compounds (VOC).

A. Restroom Partitions

Recycled plastic is an excellent material for toilet partitions, due to the non-structural requirements of the product and the durability and cleanability of the material. These following products use recycled high-density polyethylene (HDPE) post-consumer plastic. Depending on the product, recycled content may vary from 30% to 75%. Specify the following product(s) as the basis of design.

1. ***Scranton Products***
801 East Corey Street
Scranton, PA 18505
(800) 445-5148
www.scrantonproducts.com

2. ***Bradley Corporation***
W142 N9101 Fountain Boulevard
Menomonee Falls, WI 53051
(800) 272-3539
www.bradleycorp.com

B. Cabinetry

1. Hinges: For cabinet hinges use: RPC five-knuckle overlay hinges with adjustable slots for screws as basis of design. Substitutions must be reviewed/approved by Multnomah County Carpenter's Shop.

2. Cabinet Doors and Drawer Fronts

a. Plywood doors: white glue, cold pressed.

b. Edging: 3mm PVC on door edges and drawer fronts with 1/8" bull nose.

3. Cabinet Attachment: Cabinets shall be attached to a wall or solid backing.

4. Drawer Glides: Full extension required on all drawer glides.

5. Cabinet Shelves: Adjustable shelves a minimum 1" thick over 32" wide. Maximum shelf width 36" wide.

6. Cabinet Construction

a. ½" minimum thick back on all cabinets.

b. Cabinets in sink areas and lab areas shall be constructed of a finished plywood product such as maple, birch or similar basis of design (bottoms and sides).

c. All cabinet bases to be constructed of plywood.

7. Countertops

a. Laminate or wood based countertops and backsplashes to be constructed of plywood (no particle board).

b. Solid surface material may be used.

C. Concrete Paving: When placing concrete paving adjacent to existing concrete paving, or patching existing concrete, use a concrete tint to darken the new concrete so it blends with the existing concrete. Specify the following product(s) as the basis of design.

1. ***Davis Colors***
3700 East Olympic Blvd.
Los Angeles, CA 90023
www.daviscolors.com
(800)356-4848
Product: Davis Color Cobblestone 860

D. Gender-Neutral Restrooms

1. Gender-neutral restrooms are toileting facilities, either single room or multiple stalls, which are designated for use by any person or persons, regardless of sex or gender identity.

2. The County shall make reasonable efforts to include gender-neutral restrooms in number and location appropriate to the building's use in any new building constructed by the County, or renovation of existing County facilities.

3. The inclusion of gender-neutral restrooms may be in addition to, and not to the exclusion or replacement of, pre existing gender specific restroom facilities.

E. Wellness and Lactation rooms

1. The following items should be addressed in all facilities whether leased or owned. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary.

a. At least one per facility.

b. See more information at: Multco Employee Wellness & Lactation Rooms

F. Fall Protection

1. Installation of appropriate permanent fall protection measures to support all preventative maintenance, and any unanticipated work, such as maintenance, repairs and replacement on drains and gutters, roof repairs, HVAC equipment, electrical equipment, solar panels and cameras, etc., for County building assets.

G. Roof Access

1. Installations which provide safe roof access for all County building assets are required to allow for routine maintenance. Refer to **OSHA standard** for minimum safety requirements of roof access installations:

a. OSHA - General Requirements (a) A stairway or ladder shall be provided at all personnel points of access where there is a break in elevation of 19 inches (48 cm) or more, and no ramp, runway, sloped embankment, or personnel hoist is provided.

2. Roof access on all County building assets shall be provided by one of the following:

a. Interior access through a roof hatch and fixed ladder when design allows, and should follow OSHA 1910.23 guidelines for minimum standards.

b. Exterior fixed ladder with walk thru guard only when interior access is not available.

c. Alternative installations must be approved by the Multnomah County Compliance group.

3. Roof Hatch Guard Requirements:

a. All roof hatches require the installation of a roof hatch guard. Roof hatch guards must have the following features to meet County standards:

i. 2’ landing between roof hatch curb and gate
ii. Self closing gate
iii. Non-penetrating installation
iv. Meets OSHA compliant fall protection standards
v. Made of steel with a galvanized or yellow powder coated finish
vi. Built-in grab bars are preferred but not required

b. Roof hatch guards that do not meet these requirements must be approved by the Multnomah County Compliance group.

H. Roof Walk off Mats:

1. Walkway Material: Walkway cap sheet strips, SBS-modified asphalt sheet, granular surfaced.

a. Basis of design product: Same product as roof system cap sheet.

b. Color: [Match cap sheet] [Color as selected from manufacturer's standard colors].

2. Protection Fabric: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

I. Backer Boards for monitors:

1. Material: ¾” MDO plywood that is primed and painted with a minimum ⅛” radius round over routed onto exposed corners. Plywood should be sized and mounted to be 2” inset from all edges of monitor or smart screen.

2. Anchoring:

a. For metal stud walls, use a minimum 1⁄4" x 20 toggle style anchors. Anchors should be mounted within 6” of center of stud and at all 4 corners of backer board. Units less than 150lbs, require a minimum of 4 anchor points. Units more than 150 lbs, require a minimum of 6 anchor points

b. For wood stud walls, use a minimum #10 screw, size screw length based on build up dimensions with minimum 1 ½” screw penetration directly into stud. Countersink as needed.

c. For plaster walls with metal lathe, use a minimum ¼” x 20 toggle style anchors. All units require a minimum of 6 anchor points. Depending on circumstances, through bolt wall with secondary support backing on the backside of the wall.

APPENDIX C: Mechanical Basis of Design

EXHIBIT C1: LANDSCAPE IRRIGATION SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for landscape designers and others to be used in the design and renovation of facilities for Multnomah County. Design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations may be made from these requirements with approval from Multnomah County. See related Plumbing System Design Guideline.

A. The following items should be addressed in all facilities whether leased or owned. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary. The County prefers that no irrigation systems be used with the exception of irrigation during the first year of establishing newly planted native plants.

1. The type of irrigation system selected (drip, mist, bubbler, rotating impact head, etc.) shall be consistent with optimizing water distribution for the plant materials and areas under irrigation. Basis of design: Hunter, Rainbird, or Toro. For large areas of turf, basis of design: Hunter type 'I-40" heads.

a. ***Hunter***
1940 Diamond Street
San Marcos, CA 92078
Tel: (1) 760-744-5240
www.hunterindustries.com

b. ***Rainbird***
970 West Sierra Madre Ave.
Azusa, CA 91702
www.rainbird.com

c. ***Toro***
8111 Lyndale Avenue South
Bloomington, MN 55420
(800) 348-2424
www.toro.com

2. Irrigation systems shall be equipped with an anti-siphon backflow prevention device in the form of an approved pressure vacuum breaker or as instructed by the AHJ. For a double check valve assembly, basis of design: Watts 007.

a. ***Watts***
815 Chestnut Street
North Andover, MA 01845
Phone: (978) 688-1811
www.watts.com

3. Require a licensed plumber to provide the point of connection (POC) of the domestic line and the irrigation system backflow assembly.

4. Irrigation systems shall be controlled by programmable, electronic controllers to permit efficient use of water. All system mains and laterals shall be installed with a minimum depth of 18 inches below grade. Design and equip the system for winterizing by compressed air evacuation.

5. Provide a sub-meter with pulse output to be integrated into the County BAS system inside the property line near the domestic water meter. Sub-meter shall be installed in an approved vault with allowance for service. Note date of installation for City of Portland sewer credit program. Requirements for meter:

a. Registers in cubic feet capable of BAS remote read.
b. Serial number is embossed or stamped into the lid of the register.
c. Totaling register of the "odometer" type.
d. Black digit on white dial with the two rightmost dials with white digits on a black dial or background.
e. Indicates not less than 98.5% and not more that 101.5% of the water actually passing through the meter at any rate of flow within the meter design limits.
f. Non-fogging registers.

6. All irrigation pipe and fittings shall be made with Schedule 80 rigid PVC or Schedule 40 steel pipe.

EXHIBIT C2: PLUMBING SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for mechanical engineers and others to be used in the design and renovation of facilities for Multnomah County. Engineering design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations may be made from these requirements as long as the result provides a safe, adequate, quality design and approval is obtained from Multnomah County. See related Landscape Irrigation System Design Guideline and Fire Protection Standards elsewhere.

A. The following items should be addressed in all facilities whether leased or owned. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary.

1. The plumbing systems within the building shall be a commercial grade and domestically manufactured. Below ground domestic water systems shall be Type K copper or pre-sleeved PEX piping below buildings and backfilled with a soft aggregate such as pea gravel or sand. Below ground PEX shall be installed with HDPE corrugated sleeving rated for installations in concrete or soil with expansion rings with stops at connection points. Above ground domestic water systems shall be Type L copper or Pex A with some exceptions for small extensions or branch lines of existing galvanized systems. No pipe straps allowed. Sanitary, vent, and storm sewer shall be cast iron no-hub with heavy-duty couplings for underground piping when work is accomplished under Division 15 (standard couplings may be used in Tier 3 buildings and when approved by MTS). All other sanitary and storm sewer shall be cast iron no-hub. Vent piping may be ABS or cast iron. Use Chicago faucet fixtures as basis of design.

2. Division 2 site water and sanitary sewer systems: The use of ductile iron pipe or cast iron is preferred over PVC. Cast iron and ductile iron pipe lasts 100 years, whereas polyethylene pipe only lasts fifty years. Cast iron and ductile iron pipe consists of 100% recycled material (Source: Environmental Resource Guide). PVC pipe lacks the strength of iron pipe and needs compacted bedding and tracer locator wires. Repairs present a problem and it is highly subject to expansion/contraction and vulnerable to vacuum and buckling.

3. Dishwashers are not allowed in office suite kitchens or breakrooms due to the risk of sanitation issues and water leaks if not properly maintained. Dishwashers are only allowed in shelters, detention facilities, and commercial kitchens.

County occupied non-residential buildings only (except tenant areas):

4. Provide water filters on all drinking water fixtures. (AP-200 for ice machines, Insta-Hot units and chilled water coolers must be pre-purged prior to filling the tank to prevent charcoal particulate contamination). All mixing valves shall have a hose connection at the discharge line for setting up new valves.

5. Each floor of a building shall have a drinking fountain or water cooler.

6. Domestic hot water systems shall have re-circulating pumps where appropriate to assure hot water to remote fixtures.

7. Break room sinks (or kitchens without stoves to heat water) shall be equipped with a commercial, instant hot water faucet and water filters.

8. All kitchen dishwashers shall be furnished with ventilation hoods. When sanitizing is required (180 deg), provide stainless steel sleeve in dishwasher opening to avoid destruction to wood cabinetry.

9. Restrooms have touchless fixtures. All touchless fixtures shall be hardwire to power when able.

10. Isolation valves located at each restroom, janitor closets, drinking fountains, kitchenettes/breakrooms, as well as the entire floor. With access panel size 12”x12” or larger. Use bronze ball valves – 2” and smaller.

B. The following items should be addressed in all new and remodeled facilities that are owned by the County and might be applicable to long-lease facilities, where instructed by the County. County-owned retail spaces may deviate from the guideline with Project Manager approval.

All buildings should include:

1. Piping over electrical rooms containing main distribution panels or motor control centers shall be avoided where possible. When piping is necessary in these areas, indicate leakage protection drawings or in specifications. The only allowed piping is for fire suppression of the space.

2. All mixing valves shall be designed for easy maintenance and long life. Basis of design: Powers.

a. ***Powers***
815 Chestnut Street
North Andover, MA 01845
(800) 669-5430
www.powerscontrols.com

3. Water metering: Water usage meters should be added for all irrigation, industrial and domestic usage applications.

4. Lavatory and sink faucets: Specify durable finishes for detention and security areas. Basis of design: Chicago or American Standard.

a. ***Chicago Faucets***
2100 S. Clearwater Drive
Des Plaines, IL 60018-5999
(847) 803-5000

www.chicagofaucets.com

b. ***American Standard***
1 Centennial Plaza
Piscataway, NJ 08855
(800) 442-1902
www.americanstandard-us.com

5. Lavatory: All lavatories shall have hot and cold water supplies. Provide rigid chrome plated supply pipes and stops and chrome plated outlet and trap drains. Provide chrome plated pop-up drains or stainless steel grid drains. Lavatories should have touchless fixtures. All touchless fixtures shall be hardwire to power when able. All lavatories and sinks shall be supported by either a lavatory concealed arm carrier or by a countertop. Basis of design: American Standard.

6. Shower fittings: Provide solid brass fitting with polished chrome finish. Basis of design: American Standard.

7. Urinals: Urinals shall be white vitreous china wall-mounted with chrome plated supplies, chrome-plated flush valve and stainless steel strainers for each drain opening as recommended by the urinal manufacturer. Basis of design: American Standard low consumption type fixture.

8. Water closets: Water closets shall be white vitreous china with chrome plated supplies. Furnish with manufacturer's suggested open front white seat with stainless steel check hinge/post. Wall-mounting is preferred. Electronic sensor for standard single flush as a minimum. Use standard gravity feed water flush system only. Basis of design: American Standard, Eljer, Kolher or Briggs.

a. ***American Standard***
30 Knightsbridge Road
Piscataway, NJ 08854
(855) 815-0004
www.americanstandard-us.com

b. ***Briggs***
300 Eagle Road
Goose Creek, SC 29445
(800) 888-4458
www.briggsplumbing.com

c. ***Eljer***
1 Centennial Avenue
Piscataway, NJ 08855
(800) 442-1902
www.eljer.com

d. ***Kolher***
444 Highland Drive
Kohler, WI 53044
(800) 456-4537
www.us.kohler.com

9. Provide all plumbing fixtures from a single manufacturer, if possible. Where applicable, all fixtures shall be white. Basis of design: American Standard.

10. Eye/Face wash stations: Provide plumbed tempered water delivery unless directed otherwise. Basis of design: Haws.

a. ***Haws Corporation***
1455 Kleppe Lane

Sparks, Nevada 89431
(888) 640-4297
www.hawsco.com

11. Water coolers and drinking fountains: Water coolers with remote chillers above the ceiling are not allowed. All drinking fountains shall have bottle fill stations included. All Drinking fountains shall meet ADA requirements. Drinking fountains must have front access to filters, system rest buttons, and water connections. Basis of design: Haws, Halsey Taylor, Oasis, Sunroc, or Elkay.

a. ***Elkay***
2222 Camden Court
Oak Brook, IL 60523
(630) 574-8484
www.elkayusa.com

b. ***Halsey Taylor***
1333 Butterfield Road, Suite 200
Downers Grove, IL 60515
(800) 260-6640
www.halseytaylor.com

c. ***Haws***
1455 Kleppe Lane
Sparks, Nevada 89431
(888) 640-4297
www.hawsco.com

d. ***Oasis***
222 East Campus View Blvd.
Columbus, OH 43235
(800) 646-2747
www.oasiscoolers.com

e. ***Sunroc***
3316 Conti Street
New Orleans, LA 70119
(504) 822-4886
www.sunrocwatercoolers.com

12. Flush Valves: All flush valves shall have electronic sensors for standard single flush as a minimum. Basis of design: Royal Sloan.

a. Infrared Flushers: Shall not be equipped with manual override flush buttons on the side because they are subject to vandalism. Basis of design: Sloan or Zurn.

i. ***Sloan***
10500 Seymour Ave.
Franklin Park, IL 60131
(800) 982-5839
www.sloanvalve.com

ii. ***Zurn Industries, LLC***
1801 Pittsburgh Ave.
Erie, PA 16502
(855) 663-9876
www.zurn.com

13. Install Isolation valves located at each restroom, janitor closets, drinking fountains, kitchenettes/breakrooms, as well as the entire floor. With access panel size 12”x12” or larger. Use lead free bronze ball valves – 2” and smaller.

14. Buildings which are in operation 24 hrs/day (like a jail, not a residential building), critical buildings and high rises shall be furnished with two backflow devices of identical size, make, and model on separate lines. All other non-residential buildings shall have a second backflow device one-half the size of the main backflow device on a service loop to avoid shutdown during regular business hours. Require a licensed plumber to provide the point of connection (POC) of the domestic line and the irrigation system backflow assembly. Basis of design: Febco or Conbraco.

a. ***Febco***
815 Chestnut Street
North Andover, MA 01845
Phone: (800) 767-1234
www.febcoonline.com

b. ***Conbraco***
701 Matthews-Mint Hill Road
Matthews, NC 28105
(704) 841-6000
www.apollovalves.com

15. Complete and fully automatic fire protection systems shall be provided in accordance with the National Fire Protection Association (NFPA) and/or County’s Insurance Underwriter for all non-residential buildings. All plans must be approved by Insurance Underwriter and be in an acceptable format. Refer to complete Fire Protection Standards elsewhere.

16. Natural gas pipe shall be schedule 40 steel screwed on 2-1/2 inches and below and over 2-1/2 inches welded.

17. Domestic water heaters shall be electric type where feasible. Tankless water heaters are acceptable for small areas or individual floors. Water heaters over 100 gallons shall be standard commercial grade and have a 10 year warranty. Do not specify PVI. Provide high efficiency and energy star approved water heaters.

18. Insta-hot units are acceptable in kitchenettes or break rooms when a central domestic hot water system is available.
a. ***InSinkErator (Insta-Hot)***
4700 21st Street
Racine, WI 53406
(262)554-5432
www.insinkerator.com

19. Provide floor drains or floor sinks at all “wet” equipment (i.e. ice machines, boilers, etc.) and as required for wet cleaning of floors. Restrooms with two or more stalls require a floor drain. Provide removable stainless steel mesh in addition to grilled drain cover to prevent entry of large particles of waste which

might cause stoppages. Location of floor drains and floor sinks shall be coordinated to avoid conditions where locations of equipment make removal of covers for cleaning difficult. Slope floor to drain.

20. Structural requirements for seismic restraints for all supported and suspended piping, including their attachment to the building structure, shall be reviewed and approved by a structural engineer when they are not shown on the drawings.

21. Use sectional glass fiber insulation on all domestic cold and hot water piping except under lavatories designed for handicapped usage use flexible foam plastic insulation.

22. In all “wet” environments, floor cleanout plugs shall be stainless steel. At all other locations in finished areas, cleanout plugs shall be bronze.

23. Equip all floor cleanouts, floor drain grates, and access panels with vandal proof screws where accessible to the public or in contact with inmates.

24. ALL motors and pumps which are served by a VFD are to be specified for 110%-120% capacity; or to operate at 80% of design criteria, and NOT to exceed 60 HZ.

25. Plumbing fixtures in security and detention areas shall be stainless steel. Where required to match existing, acceptable security ware fixtures are Bradley, Willoughby, or Metcraft. Basis of design: Acorn.

a. ***Bradley Corporation***
W142 N9101 Fountain Blvd.
Menomonee Falls, WI 53051
(800) 272-3539
www.bradleycorp.com

b. ***Willoughby Industries, Inc.***
5105 West 78th Street
Indianapolis, IN 46268
(800) 428-4065
www.willoughby-ind.com

c. ***Metcraft Industries, Inc.***
301 SE Thompson Drive
Lee’s Summit, MO 64082
(866) 382-7238
www.metcraftindustries.com

d. ***Acorn Engineering Company***
15125 Proctor Avenue
City of Industry, CA 91746
(800) 488-8999
www.acorneng.com

EXHIBIT C3: BOILER SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for mechanical engineers and others to be used in the design and renovation of facilities for Multnomah County. Engineering design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations may be made from these requirements as long as the result provides a safe, adequate, quality design and approval is obtained from Multnomah County.

A. The following items should be addressed in all owned and maintained facilities. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary.

1. Instantaneous type copper finned tube boilers are not allowed. Size boilers to allow standardization of replacement modules. Full boiler diagnostics shall be located on the front of the boiler. Basis of design: Honeywell controls. High efficiency only. Warranties: 10 years. Basis of design: Ajax, Modcon, Lochivar, HydroTherm.

a. ***Ajax***
P.C. McKenzie Company
P.O. Box 112638
Pittsburgh, PA 15241
(412) 257-8866
www.mckenziecorp.com

b. ***Modcon***
HTP, Inc.
PO Box 429
120 Braley Road
East Freetown, MA
(800) 323-9651
www.htproducts.com

c. ***Lochinvar, LLC***
300 Maddox Simpson Pkwy
Lebanon, TN 37090
(615) 889-8900
www.lochinvar.com

d. **HydroTherm**
260 North Elm Street
Westfield, MA 01085
(413) 564-5515
www.hydrotherm.com

2. Where possible, the number and arrangement of boilers shall be designed to provide heating to the facility despite the breakdown or routine maintenance of any one boiler. For larger systems (over 40K SF) specify two boilers such that each unit can handle 100% of the total heating load, and select two heating/hot water pumps that can each simultaneously deliver 100% of the required flow. For small systems, specify a single boiler with a single pump for the full capacity (pump controlled independently). Always provide redundant equipment or a supplemental heating source in 24/7 operations, such as a jail.

3. On large buildings (over 40K SF), boiler accessories including feed pumps, heat circulating pumps, etc., shall be designed to provide both normal and standby service.

4. An air separation device at the high point (i.e. Hoffman) should be supplied to eliminate trapped air. The system must also have a properly sized bladder type expansion tank installed close to the boiler on the suction side of the system pump.

5. Piping must be supported by padded hangers or floor stands allowing for expansion, contraction, and to reduce transmission noise. Follow current code requirements for seismic restraints.

6. The boiler controls shall be provided with a digital dry contact that interfaces with the Building Automation System when the boiler is in any alarm condition. A Hand-Off-Auto (HOA) switch shall also be provided on the boiler control and dedicated boiler water circulation pumps which allows for manual on and off and enable/disable override.

7. Do not locate boilers outside unless absolutely necessary. Boiler rooms shall be provided which have dedicated combustion air and are isolated from fans and other equipment. They shall be neat in appearance. All equipment shall be set on housekeeping pads at least 4-inches above the floor and the floor shall be sealed with a suitable surface. Box floor drains 6-8 inches deep shall be provided with the floor sloped to drain. The boiler blowdown should be piped to the drain.

8. Servicing clearances shall exceed the minimum by 25% wherever possible. The total volume of the space where the boiler is installed shall be at least sixteen times the total volume of the boiler unless direct venting is provided. Exhaust fans located in boiler rooms shall not deplete the combustion air supply and/or cause a downdraft in the venting system.

9. With or without secondary pumps, heating water boiler flow shall be constant unless otherwise designed and approved by the boiler manufacturer.

10. Secondary HW pumps shall be considered for any heating water system in which the boilers are not rated by the manufacturer to accept the expected extremes of HW flow, should 2-way coil valves be used. In this application an end-of-line three-way bypass and control valve is required. Secondary pumping systems shall also be considered where the design HW flow is greater than 200 gpm.

11. Engineering design should avoid boiler shock cased by low entering water temperatures entering the boiler. Hot water reset should only be on the

secondary loop. Do not attempt to adjust firing rates and setpoints at the boiler controls.

12. The design should provide unions and valves at the inlet and outlet of the boilers so they can be isolated for service.

13. Water connections at the boilers must be full size with no reducing bushing that could decrease the flow and result in boiler noise or other serious consequences.

14. Burner management systems shall meet Industrial Risk Insurers (IRI) requirements.

15. Boiler Manufacturer shall review and approve design application and installation.

16. Boiler Manufacturer representative shall conduct start-up of the equipment. Avoid the use of spec language that can be interpreted to allow persons other than the Boiler Manufacturer's official representative to conduct start-up. Allow up to two hours with Commissioning agent for post start up coordination and testing. Perform boiler blow-out in the presence of the Owner.

17. Boiler Manufacturer official representative shall instruct Owner personnel in operation and maintenance. The O & M manual for the equipment shall be provided to the County Trades at the time of demonstration. All start-up sheets shall be included in the package. Allow up to two hours of demonstration time.

18. Fit all boilers with dual low-water cutoffs complying with requirements of governmental agencies having jurisdiction.

19. Boilers shall have electronic boiler controls with electric ignition and low silhouette vents.

20. Heating water piping shall be black steel pipe, schedule 40 threaded or welded or Type K copper.

21. Boiler controls / sequencers will have physical connection to BAS System.

22. Start/Stop, alarms, setpoint, interface protocol to be determined by County.

23. Interface points to be used for monitor only, not in BAS control sequence.

24. Boiler Pumps to be controlled by boiler. Loop pumps to be controlled by BAS System.

EXHIBIT C4: CHILLER SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for mechanical engineers and others to be used in the design and renovation of facilities for Multnomah County. Engineering design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations

may be made from these requirements as long as the result provides a safe, adequate, quality design and approval is obtained from Multnomah County.

A. The following items should be addressed in all owned and maintained facilities. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary.

1. For optimum chiller plant efficiency, the plant must be designed to operate efficiently at low loads. The operation of a smaller chiller loaded to a greater percent of minimum is preferred to operating a single chiller at or near its minimum recommended value.

2. Induced draft cooling towers shall be equipped with fan motors on VFDs. Forced draft preferred.

3. Chillers should be provided with environmentally friendly (non CFC) refrigerant and selected for high efficiency of 50 KW/ton or better, if possible.

4. Avoid the use of hot gas bypass because it falsely loads chillers and results in a significant waste of energy. In applications where the unit air flow is low (less than 250 cfm/ton), the use of hot gas bypass is required to prevent the evaporator coil from freezing in conditions of unusually low load. Apply to lead compressors for VAV/VVT and make up air units.

5. Piping must be supported by padded hangers or floor stands allowing for expansion, contraction, and to reduce transmission noise.

6. Provide a minimum of two pumps per chiller.

7. When remodeling an existing system, consider installing adjustable speed drives on the existing chilled water and condenser water pumps, if feasible.

8. All secondary chilled water pumps shall be of identical capacity and head. An individual VFD shall control each such pump.

9. Secondary chilled water pumping systems shall be considered for all situations where the total chiller plant capacity is greater than 50 tons, where any cooling coils are not close to the chiller, and where there is sufficient load diversity that the chiller plant can be expected to operate at less than 80% capacity more than 25% of the time.

10. If total project area exceeds 25,000 square feet, the cooling system shall consist of a central chilled water system. DX cooling shall be considered only on a case-by-case basis.

11. For buildings requiring less than 240 tons of cooling capacity, the preferred solution is an air-cooled chiller with two or more modules> 40 tons shall include multiple scroll compressors, and dual independent refrigerant circuits. Basis of design: York.

a. ***York (Johnson Controls Inc.)***
PO Box 591
5757 N Green Bay Ave.

Milwaukee, WI 53201
(888) 401-9804
www.york.com

12. Use modular chillers in all applications. Basis of design: Multistack.
    a. ***Multistack, LLC***
    PO Box 510
    1065 Maple Ave.
    Sparta, WI 54656
    (608) 366-2400
    www.multistack.com

13. Chiller Manufacturer representative shall conduct start-up of the equipment. Avoid the use of spec language that can be interpreted to allow factory trained personnel or other persons other than the Chiller Manufacturer's official representative.

14. Chiller Manufacturer official representative shall instruct Owner personnel in operation and maintenance. The O & M manual for the equipment shall be provided to the County Trades at the time of demonstration. All start-up sheets shall be included in the package. Allow up to two hours of demonstration time.

15. Provide Point List (I/O) Summary in construction bid documents. Provide BAS interface directly to chiller controls. No gateways.

16. Interface Protocol to be determined by County. Interface points to be used for monitor only; not in BAS control sequence.

17. Chiller controls / sequencers will have physical connection to BAS System, Start/Stop, Alarms, and Setpoint.

EXHIBIT C5: FIRE PROTECTION SPRINKLER SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

Multnomah County (the County) considers fire protection sprinklers a desirable and critical life safety and property conservation feature of all its buildings. As such, planners and designers of remodels and new construction shall include fire protection sprinklers in projects for the County. In the projects where fire protection sprinklers will not be included, the A/E Service Provider shall assist the Project Manager to prepare a Life Safety and Property Conservation report for management approval.

A. Fire Protection Sprinkler Systems

1. The Life Safety and Property Conservation Report shall have sections that address each of the following topics:
    a. Risk of loss of life in the building without fire protection sprinklers;
    b. Risk of property loss due to fire with the maximum value of building and contents calculated;
    c. Potential loss of use of the building to the County and/or the public;

d. Loss in public confidence of the County to act as a steward of public property in the event of a fire; and
e. Applicable codes.
f. No report is required if fire protection sprinklers are included in the project.

2. Fire protection sprinklers shall be specified, designed, and constructed for a 50-year life span. Other goals are good engineering practice, a biddable project, and an easy to maintain system. To meet these design goals, certain design standards are better than code minimum. On fire suppression specify solder link sprinklers which have a 50 year life span.

3. A Professional Engineer, registered in Oregon, with a specialty in Fire Protection Engineering and approved by the County shall write fire protection sprinkler specifications for all County projects that include sprinklers. The Fire Protection Engineer shall complete a written submittal review of the component manufacturer's data sheets, sprinkler shop drawings, and hydraulic calculations prior to the installation of the sprinkler system.

Quality Assurance

4. Qualifications: Company specializing in fire sprinkler systems of similar type and scope with a minimum three years experience.

5. Company shall obtain and pay for all necessary permits for installation of a complete fire sprinkler system.

6. Apply the edition of codes enforced by the Authority Having Jurisdiction.

Submittals

7. 95% Construction Documents (CD) fire protection sprinkler specifications to County's property insurance provider.

8. Component manufacturer's data sheets, shop drawings, and hydraulic calculations (as one complete stand-alone package) to AHJ and Fire Protection Engineer. Provide proof of approval by AHJ of the installed sprinkler system to the Engineer on completion of work. Coordinate sprinkler system design with all other building systems.

9. Project Record Documents indicating as-built conditions as specified in Division 1 or one reproducible and two prints.

10. Test Reports: Underground and above ground piping hydrostatic test, water supply flow test: Code-required acceptance test: and manufacturer's operation and maintenance data.

11. Operations and Maintenance Manual: O & M manuals shall include Record Drawings, hydraulic calculations, manufacturer's data sheets, operation & maintenance instructions, servicing requirements, test reports, certificates, and NFPA 25.

B: Fire Protection Sprinkler System Description

1. Multnomah County requires any single-use and or single occupancy building to follow the current NFPA 13 standards for the hazards classification and level of protection within the building. If the building is a multi-use and/or multiple occupancy, the coverage should be no less than Ordinary Hazard Group 1 level of protection.

2. Each hazard within a building shall be described as a building section, occupancy classification per NFPA 13, sprinkler density, area of operation, maximum area per sprinkler, inside hose stream demand, and outside hose stream demand.

3. Hazards likely to be found in County buildings include office, health care, correction, animal control, road shops, courts, library, and residential.

4. Sprinkler system design shall include a 5-psi cushion for a demand point less than 50 psi, a 10 percent cushion for a demand point between 50 and 100 psi, and a 10-psi cushion for a demand point above 100 psi. A 15-psi cushion shall be provided if the sprinkler system is provided with a fire booster pump. The cushion shall be between the demand point and the water supply curve.

Flow Test

5. Water flow test data shall be included in the sprinkler specifications. Flow test data shall include static water pressure, flow rate, residual water pressure, location of flow test, test time & date, and who provided the information.

6. Judgment by the Fire Protection Engineer shall be used as to the suitability of the flow test in terms of location to project site and date of test.

Products

7. Pipe and fittings shall be of domestic manufacture.

8. Unlined cast iron should be avoided for all underground fire sprinkler systems.

9. Ferrous sprinkler pipe:
   a. 2-inch and smaller shall be Schedule 40 or better. UL listed or FM approved.
   b. 2 ½ -inch and larger shall be Schedule 10 or better. UL listed or FM approved.
   c. Ferrous sprinkler pipe used in dry pipe systems shall be galvanized inside and out.

10. Copper pipe with threaded, brazed, soldered, or mechanical fittings only. Glued fittings are not allowed.

11. Mechanical coupling and fittings: UL listed or FM approved.

12. Plastic pipe is allowed in residential occupancies only.

13. Air compressors for dry pipe and preaction systems shall be manufactured for sprinkler systems. Basis of design: Emglo, Gast, or General.

    a. ***Emglo***
    701 East Joppa Road

Baltimore, MD 21286
(888) 883-6456
www.emglo.com

b. ***Gast Manufacturing, Inc.***
2300 M-139 Highway
Benton Harbor, MI 49023
(269) 926-6171
www.gastmfg.com

c. ***General Air Products***
118 Summit Drive
Exton, PA 19341
(888) 863-7389
www.generalairproducts.com

14. Sprinkler heads:
    a. Shall be standard response only where allowed by the AHJ.
    b. Remodel areas shall match existing heads as close as practical.
    c. Shall be institutional type in holding cells, jails, interviewing rooms, or other areas where detainees may be left unattended.
    d. Unique sprinkler applications shall be specified by the Fire Protection Engineer.

Installation

15. The backflow prevention device for the fire sprinkler lead-in shall be approved by the local jurisdiction and the State of Oregon. Basis of design: Cla-Val, Conbraco, Febco, Watts, or Zurn.

    a. ***Cla-Val***
    1701 Placentia Ave.
    Costa Mesa, CA 92627
    (800) 942-6326
    www.cla-val.com

    b. ***Conbraco***
    701 Matthews-Mint Hill Road
    Matthews, NC 28105
    (704) 841-6000
    www.apollovalves.com

    c. ***Febco***
    815 Chestnut Street
    North Andover, MA 01845
    Phone: (800) 767-1234
    www.febcoonline.com

    d. ***Watts***
    815 Chestnut Street
    North Andover, MA 01845
    Phone: (978) 688-1811
    www.watts.com

e. ***Zurn Industries, LLC***
1801 Pittsburgh Avenue
Erie, PA 16502
(855) 663-9876
www.zurn.com

16. Utility Vaults:
    a. Valves in the flow path of fire protection sprinklers shall have hard-wired tamper switches.
    b. Provide an electrically powered sump pump within the utility vault including separate underground conduit for power.

17. Above ground sprinkler pipe:
    a. Install pipe to minimize obstruction to other work.
    b. Install pipe in concealed spaces above finished ceilings.
    c. Center heads in the middle or quarter points of suspended ceiling tile.
    d. Coordinate support of pipe 4-inch and larger with a structural engineer.
    e. Route flow test discharge water to a location that can accept the volume from a wide-open drain test that will not cause damage, including to landscaping.
    f. Provide access panels for all test valves, test drains and low point drains concealed by structure or finish.

EXHIBIT C6: FIRE PUMP SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

Fire pumps are contemplated to be required in areas with low water pressure relative to building height, in occupancies with large fire sprinkler water demand and in high-rise buildings.

A. Fire Pumps

1. Fire pumps shall be specified, designed, and constructed for a 50-year life span. Other design goals are good engineering practice, a biddable project, and easy to maintain system. To meet these design goals, certain design standards are better than code minimum.

2. A Professional Engineer, registered in Oregon, with a specialty in Fire Protection Engineering and approved by the County shall write the fire pump specifications for all County projects that include fire pumps. The Fire Protection Engineer shall complete a written submittal review of the component manufacturer's data sheets, fire pump shop drawings, and hydraulic calculations prior to the installation of the fire pump system.

3. Careful consideration shall be given to specifying the electric fire pump motor starter in any design where the motor is estimated to be in excess of 35 horsepower or in all designs where onsite emergency power is provided to the fire pump.

Quality Assurance

4. Qualifications: Company specializing in fire pumps of similar type and scope with a minimum three years experience.

5. Company shall obtain and pay for all necessary permits for installation of a complete fire pump.

6. Apply the edition of codes enforced by the Authority Having Jurisdiction (AHJ).

Submittals

7. 90% Construction Documents (CD) fire pump specifications to County's property insurance provider.

8. Component manufacturer's data sheets, shop drawings, and hydraulic calculations (as one complete stand-alone package) to AHJ and Fire Protection Engineer. Provide proof of approval by AHJ of the installed sprinkler system to the Engineer on completion of work. Coordinate sprinkler system design with all other building systems.

9. Project Record Documents indicating as-built conditions as specified in Division 1 or one reproducible and two prints.

10. Test Reports: Code-required acceptance test: and manufacturer's operation and maintenance data.

11. Operations and Maintenance Manual: O & M manuals shall include Record Drawings, hydraulic calculations, manufacturer's data sheets, operation & maintenance instructions, servicing requirements, test reports, certificates.

System Description

12. The Fire Protection Engineer shall estimate the fire pump capacity, boost, and horsepower requirements. The fire pump contractor shall complete final fire pump sizing.

13. On electric fire pump motors over 35 horsepower, a wye-delta closed transition reduced voltage starter shall be installed unless the Fire Protection Engineer and project Electrical Engineer specify otherwise.

Products

14. Jockey Pump manufacturer. Basis of design: Grundfos.

    a. ***Grundfos***
    Poul Due Jensens Vej 7
    DK-8850 Bjerringbro
    Denmark
    (913) 227-3400 (USA)
    www.grundfos.com

Installation

15. Provision shall be provided to discharge fire pump test flow to atmosphere.

EXHIBIT C7: STANDPIPE SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

Standpipes shall be specified, designed, and constructed for a 75-year life span. Other design goals are good engineering practice, a biddable project, and an easy to maintain system. To meet these design goals, certain design standards are better than code minimum.

A. **A Professional Engineer, registered in Oregon, with a specialty in Fire Protection Engineering and approved by the County shall write the standpipe specifications for all County projects that include standpipes. The Fire Protection Engineer shall complete a written submittal review of the component manufacturer's data sheets, standpipe shop drawings, and hydraulic calculations prior to the installation of the standpipe system.**

Quality Assurance

1. Qualifications: Company specializing in standpipe systems of similar type and scope with a minimum three years experience.

2. Company shall obtain and pay for all necessary permits for installation of a complete standpipe system.

3. Apply the edition of codes enforced by Authorities Having Jurisdiction (AHJ).

Submittals

4. 90% Construction Documents (CD) standpipe specifications to County's property insurance provider.

5. Component manufacturer's data sheets, shop drawings, and hydraulic calculations (as one complete stand-alone package) to AHJ and Fire Protection Engineer. Provide proof of approval by AHJ of installed sprinkler system to Engineer on completion of work. Coordinate sprinkler system design with all other building systems.

6. Project Record Documents indicating as-built conditions as specified in Division 1 or one reproducible and two prints.

7. Test Reports: Underground and above ground piping hydrostatic test, water supply flow test: Code-required acceptance test: and manufacturer's operation and maintenance data.

8. Operations and Maintenance Manual: O & M manuals shall include Record Drawings, hydraulic calculations, manufacturer's data sheets, operation & maintenance instructions, servicing requirements, test reports, certificates, and NFPA 25. As part of the project deliverables, complete the Project Closeout Transmittal (FPM121) listing new equipment and its manufacturer, model number, serial number, size and warranty information.

Products

9. Pipe and fittings shall be of domestic manufacture.

10. Ferrous standpipe pipe:
    a. 2-inch and smaller shall be Schedule 40 or better. UL listed or FM approved.
    b. 2 ½ -inch and larger shall be Schedule 10 or better. UL listed or FM approved.

11. Mechanical coupling and fittings: UL listed or FM approved.

EXHIBIT C8: HVAC SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for mechanical engineers and others to be used in the design and renovation of facilities for Multnomah County. Engineering design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations may be made from these requirements as long as the result provides a safe, adequate, quality design and approval is obtained from Multnomah County. See related sections elsewhere; Boiler Design Guidelines, Chiller Design Guidelines, Control System Design Guidelines, Mechanical Commissioning Guidelines, and Mechanical and Control Guidelines for Project Planning and Development.

A. The following items should be addressed in all facilities whether leased or owned. Also applies to buildings other than Tier 1 and 2. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary. For County-owned residential occupancies, apply minimum code requirements for HVAC systems with a provision for a 7-day programmable thermostat control. For County-owned retail tenant spaces, refer to Project Manager for deviations from the guideline.

Capacities

1. All HVAC systems shall be designed using, at a minimum, the geographical summer and winter outdoor design conditions of 10°F Winter - 100°F Summer dry bulb/68°F wet bulb, as per county policy Executive Order 268.

2. The system shall be capable of maintaining, at design conditions; the following temperature fluctuations during occupied hours, in all areas (including Conference Rooms and Training rooms at maximum people load) served by the HVAC system:

    a. Heating: 68-78° F (with a mean temperature target of 70° F with a normal control [drift] limited to +/- 2° F and dead-band of 5°F within which supply of heating energy to zone is shut off or reduced to minimum.)

    b. Cooling: 70-77° F (with a mean temperature target of 72° F with a normal control [drift] limited to +/- 2° F and dead-band of 5°F within which the supply of cooling energy to zone is shut off or reduced to minimum.) Detention areas 78 º F cooling and kitchen areas 80 º F cooling.

Distribution

3. Group spaces/ HVAC zones/rooms/ and areas of similar thermal occupancy so that offices are with offices and not with dissimilar rooms. Don't put east offices with south offices, etc. In general, corner spaces should be treated separately. Isolate areas which are often unoccupied if possible and provide separate units/zones for areas which are occupied after hours or on weekends. This does not apply to residential occupancies.

4. Systems that serve zones with dissimilar cooling and heating loads, and that have terminal units with no means of reheat are generally not acceptable.

    a. During new projects or retrofits, All Air handler types including DOAS units shall incorporate a full recirculation duct with automated damper to provide options during air quality events.

5. Do not provide separate zoning for rest rooms, vestibules, and corridors.

Exhaust Provisions

6. All toilet rooms shall be exhausted at 100 cfm/toilet fixture.

7. All toilet rooms, lunch rooms, high use copier rooms or other rooms generating smoke or odors shall be exhausted directly to the exterior without re-circulating.

8. All enclosed rooms shall have supply and return or exhaust provisions. This includes electrical, mechanical, recycle, storage, and other rooms. Powered exhaust must be used for boiler rooms, central storage, etc. All electrical rooms will have cooling to maintain a maximum of 78°.

9. All toilet exhaust and fume hood exhausts shall be connected to constant volume exhaust systems. Booster fans are generally not allowed.

10. The design of HVAC units that serve common areas and restrooms should utilize HRV or ERV systems.

11. X-ray darkrooms shall be designed to continuously exhaust at a rate of 12 air changes per hour.

12. Independent systems required: Chapter 5, IMC, states that exhaust systems from bath, toilet, urinal, locker, service sink closets and similar rooms shall be independent of other exhaust systems. Type I or Type II hoods shall be installed in kitchens above all commercial food heat-processing appliances. Considering this code requirement, whenever any tenant retail spaces are proposed for future, consideration shall be given to providing adequate exhaust and makeup air ducts for toilet rooms and kitchens. Provide Loren Cook exhaust fans with latched access lids as basis of design.

13. Non-commercial clothes dryer vents which exceed an equivalent of 20-feet in length shall be equipped with a booster fan at the terminus. Tied to operation of dryer or provided with timer mechanism. Code requires cleanouts at every change in direction. Access must be provided to the cleanout for maintenance. Basis of Design: Greenheck G-series.

    a. ***Greenheck***

PO Box 410
Schofield, WI 54476
(715) 359-6171
www.greenheck.com

Controls

14. All HVAC systems shall have a programmable setback capability. The system shall be setback/setup during unoccupied hours as follows:
    a. Heating setback: 10 – 15° F, not to drop below 55° F.
    b. Cooling setup: Shall not allow temperature to exceed 85° F.

15. Tel/data/electric and computer rooms shall be designed to maintain separate temperature range from the main HVAC system. Design for lower end of the temperature tolerance of 72 + 2º F. Design to maintain positive pressure with minimum outside air. A separate system shall be installed to act independently of the main system. Successful designs have incorporated a separate TU box on the main air handler for day mode and an inline exhaust with plenum discharge and transfer grille for night mode. Ductless split systems are also encouraged when feasible to minimize treatment of outside air. Units should be specified for low ambient operation. All telecom / electric rooms with supplemental cooling shall incorporate a room sensor or high temperature device to notify FM dispatch of a high temperature event. Not applicable to small telephone closets. PK units shall have a program timer. Basis of Design for cooling only ductless split system: Mitsubishi Series MS or PK with matching outdoor unit and BAS interface.

    a. ***Mitsubishi Electric & Electronics USA, Inc.***
    HVAC Advanced Products Division
    3400 Lawrenceville Suwanee Rd.
    Suwanee, Georgia 30024
    (800) 433-4822
    www.mitsubishicomfort.com

    b. ***Daikin***
    13600 Industrial Park Boulevard
    Plymouth, MN 55441
    (212) 340-7400
    www.daikin.com

Indoor Air Quality:

16. Standard filtration shall be rated 25-30% efficiency per ASHRAE standard 52-76. Basis of Design: 2” thick pleated throw away type filters with welded wire support. Basis of Design: Farr 30/30, Air Handler.
    a. Minimum filtration of MERV 13 rating or equal to for all new HVAC equipment; prioritize higher filtration than minimum whenever possible.

        i) ***Farr Air Pollution Control***
        3505 South Airport Road
        Jonesboro, AR 72401
        (844) 479-7632

www.farrapc.com

ii) ***Air Handler (W. W. Grainger, Inc.)***.
100 Grainger Parkway
Lake Forest, IL 60045
(800) 472-4643
www.grainger.com

17. Internal insulation on terminal units shall be designed to prevent fiberglass entering the air stream.

18. VAV box minimum air volumes should not create a stuffy environment – never allow the minimum air volume to fall below four air changes per hour when the zone is occupied. All plans shall have equipment schedules indicating min/max air volume.

19. To avoid stagnant air in occupied spaces, design for at least .8 – 1.0 ft2 air movement.

Quality Assurance

20. The HVAC system shall be designed by a registered, professional, mechanical engineer specializing in HVAC systems, and the HVAC drawings shall bear his or her State of Oregon stamp.

21. All HVAC systems shall be tested and balanced prior to occupancy by a professional system balancer. Actual test and balance data shall be taken from field measurements by certified technicians and instruments. Note deficiencies and provide reports to the County.

Noise

22. Transfer Ducts in Conference Rooms and Private Offices: Include at least one elbow to maintain privacy and minimize transference of sounds to adjacent spaces. Use oversized flex duct in lieu of rigid ductwork. Provide interior sound attenuation.

23. Avoid designs which situate fans in ceilings over occupied spaces to minimize fan noise transference and facilitate maintenance.

24. Avoid using HVAC units that use filters that are physically located in the space, which will need to be replaced on a regular basis. Filters can be located in major corridors for access, but mechanical rooms or roof equipment are preferred locations.

Energy

25. Specify high efficiency units when possible (A SEER of 14 or better, when available in size required). Higher EER is not the complete answer to reducing energy costs. Properly size the unit, keep infiltration and leakage losses to a minimum, increase building insulation, and reduce unnecessary internal loading.

Other

26. Economizer Cooling: Each fan system shall have an air economizer system capable of modulating OSA & return dampers and powered exhaust to provide up to 100% of the design supply air quantity as outdoor air. Only in certain cases will the County allow areas to reduce the amount of mechanical ventilation or to use operable windows for primary ventilation. Though natural window ventilation for some rooms may be employed, mechanical ventilation should be available.
Economizer basis of design: MicroMetl, Honeywell(Jade).

    a. ***MicroMetl***
    905 Southern Way
    Sparks, NV 89431
    (800) 884-4662
    www.micrometl.com

    b. ***Honeywell International***
    101 Columbia Road
    Mailstop - M6/LM
    Morristown, NJ 07962
    (877) 841-2840
    www.honeywell.com

    Economizer Controller basis of design: Honeywell Jade

27. All TB isolation rooms and Respiratory Precaution Rooms in new buildings shall be designed to meet ASHRAE 170 standards by: Providing equal to or greater than 14 air changes per hour, provide 90 percent supply filtration on supply, 100% exhaust, greater than 125 cfm differential between supply and exhaust, 0.01 in w.g. pressure differential, and have low exhaust and high supply air directed into the room. All fans associated with TB isolation rooms shall be dedicated (independent from other systems) constant volume units and on emergency power or shall have a contingency plan for power outage approved by the occupants. Redundant or back-up systems are generally not needed for Respiratory Precaution Rooms. Note: TB Isolation Rooms shall be a sealed room with walls to structure or hard capped ceilings with less than 0.5 sq. ft. leakage. Where converting an existing building, apply reasonable measures to meet the requirements as much as possible.

28. Air Handling equipment schedules shall indicate the area served by each unit.

29. All new mechanical equipment shall have a unique identifier. For instance, if there are four identical exhaust fans, they should each be identified by a unique label like EF-1 or EF-2, regardless of their similarity in capacity. Always coordinate with Facilities Management and existing naming strategy. The exception to this requirement is for small residential bathroom exhaust fans.

30. All fire dampers shall be dynamically rated. Fusible links are preferred. Combination Fire/Smoke dampers meeting UL Standard 555 and 555S (Multi-blade dynamic rated). Use Belimo fire Dampers as a basis of design.

31. For electrical equipment spaces such as UPS rooms, etc., provide an accurate load calculation to ensure that adequate cooling is provided without excessive equipment and utility costs or excessive air velocity. Intake air must be effectively filtered to keep dust and other contaminants from building up in the electrical equipment.

32. Roof access shall be provided for rooftop equipment. Refer to Exhibit B11: Section G for details.

B. **The following items should be addressed in all new and remodeled facilities that are owned by the County and might be applicable to long-lease facilities, where instructed by the County. Normally not relevant to Tier 3 buildings. For County-owned residential occupancies, apply minimum code requirements for HVAC systems with a provision for a 7-day programmable thermostat control. See Residential System choices below for further information. For County-owned retail tenant spaces, refer to Project Manager for deviations from the guideline.**

System Choices

1. If the total project area exceeds 25,000 square feet, the cooling system should consist of a central chiller/cooling tower. DX cooling shall be considered on a case-by-case basis.

    a. Closed circuit evaporative cooling towers should not be used for replacement/new installations unless otherwise approved by county HVAC trades.

2. VAV systems should be designed with fan and duct system static pressure regulation to limit duct pressure build-up and poor operating performance. The static pressure controller should reset both the supply air fan and return air fan. Building static sensors should be installed on each floor.

3. In the schematic phase of a project, the engineer shall present the County with system options for consideration prior to design development. For instance, for free-standing buildings, evaluate the life cycle cost and feasibility of a chiller, boiler, and air handling system versus a roof-mounted, self-contained packaged system. The analysis should be based on a minimum 20-year life cycle assumption, a future discount factor of 7 % annually, and all cost variables such as operation and maintenance.

4. VAV systems incorporating more than six terminal units shall be considered central air handling systems for the purpose of applying these guidelines.

5. Future modification and expansion as defined by the County (appropriate for buildings that are subject to a change of use or occupancy or buildings that are planned for future expansion. Not appropriate for medical clinics, for instance)

a. Size equipment and systems for future expansion
   1) Distribution main runs shall have 15% expansion capability
   2) Air-side equipment shall have 15% additional capacity
b. Position equipment and systems for future modifications. (For example, add space for future cooling coils, etc.)

6. All heating coils should be hot water. Electric coils shall be avoided in almost all applications. If electric reheat coils are used, low airflow protection must be provided (i.e. airflow switch).

7. Heat pump systems are desired. All-electric heating systems are generally not favored. If a building has a central system, additions or remodels to the building should expand the existing mechanical system. Expansion of central systems is not required when a separate system is needed to isolate tenant utility bills or when a zone schedule varies appreciably from the remaining zones on the central system. Ductless systems should be avoided if possible for occupied areas. If a ductless system is the only and best option to temper a space, reference Exhibit C8, Section A15 for description of ductless systems.

Residential System Choices:

8. Provide high efficiency direct vent gas furnaces.

9. Provide high efficiency (over 90%) condensing units and heat pump units to provide 14 to 18.0 SEER.

10. Provide pleated filter, minimum 2” thick, to improve indoor air quality.

11. All habitable rooms shall be provided with heating facilities capable of maintaining room temperature of 70 degrees.
12. Select package equipment with high static fan assemblies for increased filter ability.

Distribution and Other Design Considerations:

13. No diversity should be used in sizing duct branches and run-outs to terminal units.

14. All return air systems should be ducted and well distributed. Ceiling return plenum designs with return air through light fixtures are generally not acceptable. If a ceiling return plenum is required due to ceiling space limitations, provide adequate return air openings in sufficient location and quantity to assure good air circulation. Generally design return openings closest to the return intake at 500 fpm and return openings farther away at 200 fpm.

15. Provide equipment that uses non CFC-based refrigerants when available in size (usually > 5 tons) and configuration from selected manufacturer.

16. Electric motors 1 hp or more and which serve built-up HVAC systems shall have efficiencies corresponding to values set forth in the current code. This rule does not apply to packaged equipment.

17. Variable Speed Drives: Fan and pump motors of 5 hp and greater which serve variable flow systems shall be controlled by a variable speed drive.

18. ALL motors and pumps which are served by a VFD are to be specified for 110%-120% capacity; or to operate at 80% of design criteria, and NOT to exceed 60 HZ.

19. Simple system Relief Dampers: Includes supply fan and economizer with relief dampers. Locate relief damper close to the space (e.g., behind a louver over the exit doors). Provide motorized damper operation to reduce leakage. When packaged unit relief damper options are inadequate in the opinion of the engineer, provide a separate relief system, such as a roof-mounted relief hood with barometric or motorized dampers.

20. Medium to Complex system Powered Relief/Exhaust: Includes powered-relief or powered-exhaust with capacity control to maintain building pressure within an acceptable range, e.g. variable-speed drives, discharge dampers, or multiple staged fans. Design shall prevent potential problems with fluctuating building pressure controls, negative building pressures at low outdoor air rates and control instability with high pressure drop return air systems. For constant volume systems, a return fan is required.

21. The bottom of outdoor air intakes serving central systems shall be as high as practical, but at least 6 feet above ground level.

22. Heat recovery should be evaluated by the engineer for systems with significant dehumidification requirements or 100% exhausted areas, if deemed appropriate by the Owner. If heat recovery systems are chosen, a recirculation tank and/or three-way valves on the air handlers and main system are required to provide necessary flow to assist with System reliability during low load conditions.

23. Mitered elbows in supply and return ducts are not allowed except where unavoidable when obstacles are encountered during the construction process. Construction documents should not indicate acceptance of mitered elbows where radius elbows can be used.

24. DX coils should have wide fin spacing to reduce the effect of frost build up on low temperature applications.

25. Design ductwork at 0.05”/100’ pressure drop, if space and system allows, to reduce velocities and to reduce system pressure requirements.

26. Upsize air handling unit cabinets to reduce velocities through the fan cabinets to approximately 400 fpm.

27. Specify mini-pleat type filters as a strategy for reducing average pressure drop across filters.

28. Where appropriate, select direct drive plug fans as a strategy for eliminating drive losses and maximizing overall mechanical efficiency of fans.

29. Rooftop gas equipment shall be provided with flue extensions to extend flue above the unit.

30. All ventilation equipment for emergency generators shall be connected to emergency power. All back-up cooling equipment for telecom/data rooms and

computer room AC systems in critical buildings (as defined by County) shall be connected to emergency power. (Coordinate with Electrical standards)

31. Use perimeter heaters where wall/glass construction dictates high loads. The perimeter heating system shall also be used to maintain winter set-back temperatures during unoccupied hours and shall be either in the form of floor-mounted, finned tube radiant heaters, fan coil units, or other radiation systems consistent with design.

    [Rule of Thumb: If heat loss exceeds 450 Btu/Hr. per lineal feet of wall, heat should be provided from under the window or from the base of the wall. If heat loss is between 250 and 450 Btu/Hr. per lineal feet of wall, heat should be provided from under the window or from the base of the wall. If heat loss is less than 250 Btu/Hr. per lineal feet of wall, heat should be provided from under the window or from the base of the wall, or from overhead diffusers located adjacent to or slightly away from the perimeter wall, discharging air directed at or away from the exposed wall or windowed area.]

32. Provide flexible connections at point of connection to equipment in all ductwork systems connected to air handling units, fans, and other equipment.

33. All rectangular duct taps should be made with 45 degree fittings.

34. All ductwork shall be constructed of sheet metal, except where flex duct is provided for attachment to grilles and diffusers. Other exceptions may include return air or transfer ducts upon approval.

35. Balancing Dampers: All supply and return branch ducts shall have balancing dampers, regardless of the length of the duct runs. Avoid using balancing dampers in the grille neck (opposed blade dampers). If a solid ceiling is present, provide an access hatch.. At branch ducts, provide manually operated dampers of the type and arrangement shown on the drawings, two gauges heavier than the duct in which installed, and equipped with locking quadrants.

36. Where an existing duct board is discovered during the design phase of a remodeled area, the engineer shall provide recommendations for repair or replacement.

37. Air Distribution Products: Shall be by the same manufacturer.

38. Central air handling systems with hydronic systems equipment. All newly purchased air handling units should be reviewed by County HVAC lead / BAS. Basis of design: Haakon, Huntair, or Racan Carrier.
    a. ***Haakon***
       11851 Dyke Road
       Richmond, BC V7A 4X8, Canada
       (604) 273-0161
       www.haakon.com

    b. ***Huntair***
       19855 SW 124th Ave.
       Tualatin, OR 97062
       (503) 639-0113

www.huntair.com

c. ***Racan Carrier***
2025, boul. Dagenais Ouest
Laval, QC, Canada H7L 5V1
(514) 324-5050
www.racan.ca

39. Rooftop packaged equipment:

d. ***Carrier***
One Carrier Place
Farmington, Connecticut 06032
(800) 227-7437
www.carrier.com

e. ***Trane***
234 W. Florida St. 6th Floor
Milwaukee, WI 53204
(877) 667-9177
www.trane.com

f. ***York***
5757 N Green Bay Ave
PO Box 591
Milwaukee, WI 53201
(866) 392-6487
www.johnsoncontrols.com

g. ***Daikin***
13600 Industrial Park Boulevard
Plymouth, MN 55441
(212) 340-7400
www.daikin.com

h. ***AAON***
2425 South Yukon Ave
Tulsa, OK 74107
(918) 583-2266
www.aaon.com

40. Heat Pump packaged units. Basis of design: Carrier(18,000-60,000 BTUHS).

41. Water source heat pumps shall be furnished with condensate pumps with non-adjustable float switches for intermittent pump operation and a secondary float that activates a safety switch wired to cut off the heat pump if the condensate pump fails. Basis of design: Little Giant deep well pump.

a. ***Little Giant***
9255 Cloverdale Road
Fort Wayne, IN 46809
(800) 701-7894

www.little-giantpump.com

42. Direct Expansion Fan Coil Units. Multi-speeds and quiet, efficient operation should be the criteria for selection.
    f. For up to 7.5 tons. Basis of design: Carrier FA, FB, or FC Series or better.
    g. For small tonnage units. Basis of design: Carrier FV4A Series.

Controls

43. All central HVAC control systems shall be remotely adjustable from Facilities and Property Management main headquarters at 401 N. Dixon. The following types of control systems are acceptable:

    Siemens (all buildings that are designed to be operated by a central BAS system). The system shall be integrated into our Siemens Apogee system with the Siemens Apogee product line.

    All RTUs will be terminal strip connection only with electro/mechanical hardwired controls. Economizer controllers will be hard wired with the cooling circuits and not networked within the unit.

    Package units connected via BACnet will have either all of the sensor points requested to be transferred over BACnet or the sensors will be hardwired back to the County's BAS system. Control preference will be terminal strip connection if available. If not then Bacnet integration with full unit control will be available through the BAS system to include the ability to test each mode (cool / heat / fan / exhaust / bypass / as needed)

    a. ***Siemens***
    300 New Jersey Avenue
    Suite 1000
    Washington, D.C. 20001
    (800) 743-6367
    www.usa.siemens.com
    Product: Apogee

44. Electrical equipment and Elevator equipment rooms shall be designed to maintain 80 º F maximum temperatures. If mechanical cooling is not required, a thermostatically controlled, dedicated ventilation system shall be provided to remove heat. Not applicable to small electrical closets.

Indoor Air Quality

45. All buildings will have a minimum of 1 AQI exterior sensor and 2 AQI indoor sensors for air quality particulate monitoring. All new air delivery systems will include an airflow monitoring system with the CFM values calculated into our BAS system. Basis of design: Interior: Siemens QSA2700D/ Exterior: Purple Air PA-II.

46. Where appropriate, specify UV-C or other microbial control systems for general disinfection with a pre-filter.

47. Where applicable, design all building spaces at a positive pressure relative to the outside.

48. The mechanical design shall indicate on the plans the required minimum outside air CFM for each air handling unit.

49. The use of upper-room ultraviolet germicidal irradiation technology is encouraged as an economical and effective substitute for increased mechanical air exchange rates in homeless shelters, medical exam waiting rooms, and jail waiting rooms and holding cells where County employees may be subjected to exposure to poor air hygiene and increasing communicable airborne disease transmission. (Lumalier, for example)

50. Duct wrap is preferred unless lining is needed for acoustical purposes or where ductwork is exposed or the quantity of work is minimal. If duct lining is used, it shall be a rigid liner board made from glass fibers bonded with resin, protected on the edges with an acrylic coating. If existing lined ductwork is reworked in a renovation project, the liner seams and punctures shall be resealed. New air delivery systems without heat exchangers shall include: Airflow monitors, supply and return air temperature/ Relative humidity %/ CO2 sensors. All new air handlers with heat exchangers will have the same as above and include temperature and CO2 on the return duct and temperature on all 4 sides of the heat exchanger. All of the points above shall be available either from the equipment through Bacnet or controls sensors from our existing system. Basis of design: Permacote Linacoustic R-300 made by Johns Manville or ToughGard by Certainteed.

    a. ***Johns Manville***
    717 17th St
    Denver, CO 80202
    (303) 978-2000
    www.jm.com

    b. ***Certainteed***
    750 East Swedesford Road
    Valley Forge, PA 19482
    (800) 233-8990
    www.certainteed.com

Quality Assurance

51. All test and balancing at County buildings shall be performed by a firm certified by the NEBB or AABC Approved firms: Air Balancing Specialty, Inc, Accurate Balancing Agency, Inc., Neudorfer Engineers, Inc., Northwest Engineering Services, Inc., Professional Air Balance Service, and Pacific Coast Air Balance.

52. Equipment Manufacturer representative shall conduct start-up of the equipment. Avoid the use of spec language that can be interpreted to allow factory trained personnel or other persons other than the Manufacturer's official representative.

53. HVAC Equipment Manufacturer official representative shall instruct Owner personnel in operation and maintenance. The O & M manual for the equipment shall be provided to the County Trades at the time of demonstration. All start-up sheets shall be included in the package. Allow up to two hours of demonstration time.

54. All rooftop gas equipment shall have at least two stages of heat and scroll compressors with unloading capabilities. Basis of design: Carrier

55. Projects with any HVAC and/or automatic controls require some level of commissioning by an approved commissioning agent. The Commissioning Agent is hired by the County. Use the County Commissioning Master Specification in the construction documents to inform the contractor of responsibilities and coordination efforts required.

C. **The following items shall be considered for all County owned and maintained facilities, except Tier 3 facilities. Not applicable to residential occupancies.**

1. Provide UL approved power shutoff with disconnect lockout protection on HVAC equipment. Switch shall be externally accessible.

2. Provide a covered externally accessible 115-V convenience outlet with 15-amp GFCI receptacle on rooftop equipment.

3. Provide a freezeless roof hydrant within 50 feet of cooling equipment for maintenance.

4. Provide hinged access panels permanently mounted to rooftop units, for the filter/indoor-fan motor, compressors, evaporator fan, and control box areas. Provide "tie back" retaining devices to hold the doors in the open position while servicing the unit.

5. Provide easy access to components: locate at floor level, or provide ladders, access doors, and platforms. This applies to pumps, valves, compressors, fans, motors, gauges and meters, drives and gear boxes, etc.

6. Provide space for access, to work, remove, and replace components. Include space around the pumps, compressors, and other typical components. Include space to inspect, work on, and pull components, including items such as boiler tubes.

7. Rooftop units (chilled water cooling only) over 40 tons shall be built-up systems designed with walk-in service corridors to permit maintenance personnel to service the equipment without being exposed to the elements. Basis of design: Haakon.

8. Fans serving exhaust systems located at the discharge are preferable.

9. Roof exhaust fans shall be curb-mounted with hinged or removable cover for easy access. Where practical, exhaust fans shall have V-belt drives, with 1.5 service factor and adjustable sheave on the motor.

10. Engineering design options shall consider redundant equipment for all 24-hour operations.

11. Air-handling duct systems shall be designed with accessibility for duct cleaning, and shall meet the requirements of NFPA 90A.

12. Choose water coils which have drainable circuits to facilitate cleaning.

13. Where surface-mounted piping on roof surfaces is unavoidable, provide a minimum 18” clearance under all multiple pipes and ducts over 30-inches wide for roof maintenance. Provide 12’’ clearance for smaller ducts and pipes.

14. Provide accessible air duct grilles in jail cells. Provide grilles that are the correct grille size and patterning which is recommended by the National Institute of Justice suicide prevention guidelines. Return air applications shall consider the provision of an accessible filter at the grille. (“Corrections News” July/August 1999)

15. Coil racks on built up air handlers shall permit each individual coil in the coil bank to be pulled without disturbing the others.

16. Provide isolation valves on branch lines serving each floor, and each equipment connection. For large floors (over 40,000 sq.ft.), provide isolation valves for every quadrant.

17. All attempts shall be made to locate terminal units and fan coil units where they are accessible by no more than an 8-foot ladder and not in confined areas over desks, cubicle partitions, and equipment that cannot be moved. Ample room for access to the controls, fan assembly, and induction intakes shall be provided.

18. All duct smoke/fire detectors and damper locations shall be shown on the Mechanical Record Drawings and on a chart similar to a valve chart which lists type and location. This is a requirement for JCAHO facilities but would also be desirable at all County facilities to assist in NFPA required testing.

19. Drain pans on fan units with coils shall be removable and positively sloped in every plane to assure proper drainage and help maximize protection from microbial growth. For superior corrosion resistance, provide a stainless steel drain pan.

20. Plenum unit fan assemblies shall be easily serviced. Provide a hinged, fold down and removable fan assembly.

21. Provide an area within the mechanical room for storage of air filters, drawings, manuals, and operating instructions. If no mechanical room is provided, find a suitable space elsewhere for this purpose.

D. The following warranty items shall be considered for all County owned equipment, except residential. (Exception: Equipment on Tier 3 facilities)

1. Compressors shall have 5 year manufacturer's warranties.

2. Heat exchangers shall have 10 year manufacturer's warranties.

EXHIBIT C9: PIPE LABELING STANDARDS

General Narrative:

Facilities and Property Management (FPM) assists with or is involved with the installation, maintenance, repair, and replacement of a variety of piping and Heating, Ventilation, Air Conditioning (HVAC) ductwork within County buildings. This procedure will describe the minimum standards for how to label the piping and HVAC ductwork along with any hazards within. This procedure applies to the following: all County Departments, Contractors, and Landlords of leased buildings that FPM maintains.

A. Pipe Labeling

Process

1. General:

a. All pipes will be labeled as described below with the exclusion of conduits for electrical and low voltage.
b. The pipe label should describe the contents with corresponding color code regarding the characteristics of the hazard and the direction of flow.
c. Additional information may be needed to describe additional hazard(s) such as high pressure or extreme temperatures.
d. The pipe shall be labeled for Asbestos hazards.
e. Labels can be either stenciled, taped, wrapped or use adhesive to attach to the pipe.

2. Location of Labels:

a. Labels need to be applied where there are transitions such as pass through of walls, floors or ceilings as well as adjacent to changes in direction which includes bends and branches; along with valves and flanges.
b. Labels will be applied at the beginning and end of a continuous pipe run.
c. For continuous pipe run greater than 50 feet, labels shall be placed every 25 feet. For pipe running longer than 20 feet but shorter than 50 feet, a label shall be placed in the middle of the run.

3. Visibility of Labels:

a. Labels must be easily visible from a standing position.
b. If the pipe is located above or below normal line of sight, the label should be placed below or above the centerline of the pipe.

4. Text Sizing and Text Font for Labels

a. The text sizing for labels are based on the size of the pipe per the current ASME A13.1 definitions. See Attachment A.
b. The typeface shall be Sans Serif / font name Arial Bold.
c. The text must fit in the designated overall length of the color field. See Table A.

5. Globally Harmonized System (GHS) Pictograms

a. GHS pictograms can be used on the pipe label to help better describe the hazard within.
b. GHS pictograms shall be placed after the verbiage when used.

6. Coloring Code for Labels

a. The color code for the labels shall follow the current ASME A13.1 definitions. See Table B.
b. If multiple hazards are present, the color code for the most hazardous substance shall be used.
c. Additional definitions are as follows:
    i. Graywater - Safety Gray Color with White Letters
    ii. Sewage - Safety Black Color with White Letters
    iii. Specialty Water (e.g. reclaimed water) - Safety Purple Color with White Letters

7. Label Verbiage

a. Standardized verbiage shall be used for the contents of the pipe. See Table C.

    i. The verbiage can be condensed due to the amount of space on the pipe to place the label.
    ii. The condensed verbiage must be easily understood by anyone.

b. Secondary verbiage shall be used to assist in describing contents of the pipe. See Table D.
    i.. The secondary verbiage shall be the same size and font as the main label.
    ii. The secondary verbiage can be condensed due to the amount of space on the pipe to place the label.
    iii. The condensed secondary verbiage must be easily understood by anyone.

B. Heat, Ventilation, Air Conditioning (HVAC) Ductwork Labeling

Process

1. General

a. Ductwork that contains possible hazards shall be labeled.
b. If access and space allows, all ductwork can be labeled.
c. The ductwork label should describe the use or hazard. See Table E.
d. The ductwork shall be labeled for Asbestos hazards.
e. The label should include the equipment that is supplying, moving, or exhausting the air, e.g. AHU-1.
f. The label shall include the direction of airflow.
g. Labels can be either stenciled, taped, wrapped or use adhesive to attach to the ductwork.

2. Required Ductwork to Label

    a. The following list shall be labeled:
        i. Respiratory isolation exhaust ducts
        ii. Chemical testing exhaust ducts
        iii. Medical exam rooms exhaust ducts
        iv. Kitchen exhaust ducts

3. Location of Labels

    a. Labels need to be applied where there are transitions such as pass through of walls, floors or ceilings as well as adjacent to changes in direction which includes bends and branches.
    b. Labels will be applied at the beginning and end of a continuous duct run.
    c. For continuous duct runs greater than 50 feet, labels shall be placed every 25 feet. For duct runs longer than 20 feet but shorter than 50 feet, a label shall be placed in the middle of the run.

4. Visibility of Labels

    a. Labels must be easily visible from a standing position.
    b. If the duct is located above or below normal line of sight, the label should be placed where it is easily visible.

5. Text Sizing and Text Font for Labels

    a. Viewing distance of 6 feet or less the text size is to be 1½ inches or larger.
    b. Viewing distance of 6 feet or greater the text size is to be 2½ inches or larger.
    c. The typeface shall be Sans Serif / font name Arial Bold.

6. Coloring Code for Labels

    a. For hazardous exhaust ducts - Red with White Letters
    b. For supply air - Green with White Letters
    c. For return air - Yellow with Black Letters
    d. For exhaust duct - Blue with White Letter

Table A: Text Sizing

Outside Diameter of Pipe Covering, in. (mm)	Length of Color Field, in. (mm)	Size of Letter, in. (mm)
3/4 to 1 1/4 (19 to 32)	8 (200)	1/2 (13)
1 1/2 to 2 (38 to 51)	8 (200)	3/4 (19)
2 1/2 to 6 (64 to 150)	12 (300)	1 1/4 (32)
8 to 10 (200 to 250)	24 (600)	2 1/2 (64)
Over 10 (over 250)	32 (800)	3 1/2 (89)

Table B: Color Code

Fluid Service	Background Color	Letter Color
Fire Quenching Fluids (1)	Safety Red	White
Toxic and Corrosive Fluids (2)	Safety Orange	Black
Flammable and Oxidizing Fluids (3,4)	Safety Yellow	Black
Combustible Fluids (5)	Safety Brown	White
Potable, Cooling, Boiler Feed, and Other Water	Safety Green	White
Compressed Air	Safety Blue	White
To be defined by the User	Safety Purple	White
To be defined by the User	Safety White	Black
To be defined by the User	Safety Gray	White
To be defined by the User	Safety Black	White

1. This classification includes water, foam and CO2 used in sprinkler systems and fire fighting piping systems.
2. This classification includes fluids that are corrosive or toxic, or will produce corrosive or toxic substances when released.
3. This classification includes fluids, which, under ambient or expected operating conditions, are a vapor or produce vapors that can be ignited and continue to burn in air.
4. Oxidizing fluids is any gas or liquid that may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does.
5. This classification includes fluids that can burn, but are not flammable.

Table C: Color Code

Label Name	Condensed Label Name	Label Color (Background/Letter)
Boiler Blow-Down	Boiler Bl-Dn	Green / White
Cold Water Return	Cold W Ret	Green / White
Cold Water Supply	Cold W Sup	Green / White
Compressed Air	Comp Air	Blue / White
Condensate Drain	Cond Dra	Green / White
Condensate Return	Cond Ret	Green / White
Condensate Supply	Cond Sup	Green / White
Condenser Water Return	Cond W Ret	Green / White
Condenser Water Supply	Cond W Sup	Green / White
Domestic Cold Water	Dom Cold W	Green / White
Domestic Hot Water	Dom Hot W	Green / White
Hot Water Return	Hot W Ret	Green / White
Hot Water Supply	Hot W Sup	Green / White
Natural Gas	N Gas	Yellow / Black
Non-Potable Water	Non-P W	Gray / White
Potable Water	Pot W	Green / White
Roof Drain	Roof Dra	Green / White
Sewage Drain	Sewage	Black / White
Sprinkler Water	Sprink W	Red / White
Steam	Steam	Green / White
Storm Drain	Storm Dra	Green / White
Tower Water Return	Tower W Ret	Green / White
Tower Water Supply	Tower W Sup	Green / White
Waste Water	Waste W	Gray / White

Table D: Secondary Pipe Labels

Secondary Label Name	Condensed Secondary Label Name
Asbestos	
Vent	Vent
High Pressure	Hi Press
Low Pressure	Lo Press
High Temp	H Temp
Low Temp	L Temp

Table E: Standard Duct Labels

Label Name	Condensed Label Name	Label Color (Background/Letter)
Outside Air	Out Air	Green with White Letters
Supply Air	Sup Air	Green with White Letters
Return Air	Ret Air	Yellow with Black Letters
Relief Air	Rel Air	Blue with White Letters
Exhaust Air	Exh Air	Blue with White Letters
Negative Pressure Exhaust	Neg Press Exh	Red with White Letters
Medical Isolation Exhaust	Med Iso Exh	Red with White Letters
Chemical Testing Exhaust	Chem Test Exh	Red with White Letters
Kitchen Exhaust	Kit Exh	Red with White Letters

APPENDIX D: Electrical Basis of Design

EXHIBIT D1: ELECTRICAL & LIGHTING SYSTEMS

GENERAL NARRATIVE:

This standard is presented for electrical engineers, system designers, installing contractors and others to be used in the design and renovation of facilities for Multnomah County. The following specifications shall be addressed in all facilities whether leased or owned. This standard shall be applied to existing systems to determine the need to bring the existing systems to this standard. All of these standards are above the code minimum and have been developed over the years of lessons learned from projects, repairs maintenance and calibration requirements.

These standards are designed to maximize the overall cost of electrical system ownership and take into account electrical safety, testing compliance, inspections, installations, alterations, repairs, and end of life replacement. County and Safety policy is to shut power off before working on systems for worker safety. Systems will be designed to limit electrical hazards to the electrical staff, County staff and the public that use our buildings. Deviations may be made from these requirements as long as the result provides a safe, adequate, quality design and written approval is obtained from the Multnomah County Supervising Electrician.

1. FPM follows the Dark Sky Lighting Standards, described in Multnomah County Ordinance 1236, when practical and consistent with security and other mission related requirements by reducing exterior building lighting and site lighting for each County owned building. The intent is to protect and promote public health, safety, and welfare and minimize obtrusive aspects of exterior lighting uses that degrade the nighttime visual environment and negatively impact wildlife and human health. Fatal collisions should be considered in all aspects of Lighting System Design.

2. Among the many green building practices for County owned buildings are to incorporate measures to reduce bird strikes and fatalities including:
    a. Minimizing glare
    b. No up-lighting or light beams
    c. Installing full cut-off shielded or directional lighting
    d. Installing time switch control devices, occupancy sensors or non-emergency interior lights that can be programmed to turn off during non-work or other designated hours.
3. References:
    a. Multnomah County Energy Policy
    b. Multnomah County Dark Sky Policy (Ordinance 1236)
    c. FAC - 9 Green Buildings Policy
    d. Bill HR 919 Bird-Safe Buildings Act of 2019

A. LIGHTING & CONTROL STRATEGY:

This strategy is to meet the needs of the Building occupants, electrical installation and energy code. At no time shall the needs of the Building occupants, operations or maintenance be sacrificed for cheaper electrical installation or less energy use. This strategy is broken out into six parts: General Lighting, Lighting Control, Egress Lighting, Parking Lot, Exterior and Interior lighting. Lighting fixture specifics are found under the Utilization Equipment section.

1. General Lighting

a. The IES lighting standards shall be used for all lighting installations.
   i. Measure light outputs are taken at the top of the computer monitor and at the top of the desk while seated.
   ii. General lighting should be in the range of 20-30 foot candles and take into account light level mitigation by windows during sunny days.
b. All fixtures shall be located in an accessible location and where possible accessible from an 8 foot ladder. In the event of high ceilings use pendant hung fixtures with up lighting.
c. LED lights with occupancy sensors and dimming shall be the basis of design for all interior, exterior and parking lot lights.
d. LED control systems shall be set with the top end set between 70 and 80 percent of the rated fixture output and can be raised as the light dims over time.
e. All integrated lighting and controls are preferred when light fixtures and controls are approved by the lighting control manufacturer.
f. All fixtures should have field replaceable parts and be readily available from local vendors.
g. All Parking lot and exterior lighting color temperatures should comply with International Dark-Sky Association recommendations where possible
h. All parking lot lights and exterior lights shall have occupancy controls and allow for a dusk till 10pm on and 10pm till dawn occupancy on function. 10pm is a general rule of thumb and will be set by building.
i. Any retro-fit lighting needs to use UL listed packages. If it is advantageous to use custom retro-fits a field UL listing will need to be completed and overseen by the County Supervising Electrician.
j. Can lights should not be used for lighting and shall not be used with battery backup.
k. All lighting shall have a sequence of operations identifying all lighting operations and included in the print set.

2. Lighting Control

a. There are four lighting control systems that have been vetted and approved by County Electrical Services Manager, Supervising Lead Electrician, County IT and approved to be used in County Buildings. The entire building will be controlled with one of the following systems:

   i. Standard switching options. Use regular in-wall commercial grade or better switches, in-wall sensor switches or other in-wall hardwired switches. If using switch packs and occupancy sensors the switch packs need to be located above a door.
      1. For in wall occupancy, dimmer switches use Leviton DVS15-1LZ as the basis of design for a smart switch.

ii. Lutron
    1. Quantum 3.4 is the basis of design for Lutron selected control systems and can be changed with review from the Electrical Service Manager and the Supervising Lead Electricians.
    2. Lights shall have integrated sensors with occupancy, be dimmable and have daylight harvesting.
    3. Eco wire coloring shall be different in color than 0-10v dimmer wiring that is purple and gray.

iii. NLight
    1. Envysion is the basis of design for lighting control systems for the County and uses all LED light fixtures.
    2. Lights shall have integrated sensors with occupancy, be dimmable and have daylight harvesting.

iv. Wavelinx/Trellix
    1. All LED light fixtures shall have integrated sensors with occupancy, be dimmable and have daylight harvesting.
    2. WAC's shall be fed from POE switches. If using POE injectors they will be located in the TR room and fed from the Building Support UPS.
    3. WAC shall be designed to a 60% device capacity.

v. Alternate systems shall be submitted to the Electrical Shop and approved by the Supervising Electrician.

b. For local control switch only systems can use a Belden Plenum cable with gray jacket and a 300v minimum.
c. Data cabling for lighting controls shall be purple or other color as approved by Signing Supervising Electrician.

d. Restrooms shall have motion and sound sensors where necessary for occupancy detection.
e. Wiring changes shall be included as part of the lighting control upgrade. Switch legs shall be replaced with correct circuit color and neutrals separated and striped to match the circuit color.
f. Parking lot lights and exterior lights shall be controlled from the same controller as the interior lights. The lights should have occupancy and dimmable capabilities. For example the lights will be on from dusk till 10pm and from 10 pm till dawn they will be off (or dim) till they sense motion then turn on full bright.
g. Contractors should be available for up to (2) site visits within the first year of completion of lighting control work to adjust lighting systems as needed. This should be included all warranty language for lighting control projects.

3. Emergency Lighting Design

a. Definitions
    i. Emergency lighting - a combination of the code required egress lights and exit signs plus non-code required lights for safety. Half the lights in electrical rooms, mechanical rooms, TR rooms, restrooms shall be on the emergency lighting ATS or UPS.
b. Emergency lighting shall be fed by the preferred method of a generator Life Safety transfer switch. If there is no generator then a UL924 UPS shall be used.
c. Built-in battery back-up ballasts can be used with approval from the Signing Supervising Electrician and only be used for small buildings like boat houses where a generator is not applicable and Life Safety UPS is not safe to use. This type of battery back-up is very costly to own due to labor intensive testing requirements and costs associated with replacement.
d. UL 924 relays shall be located next to the Life Safety UPS. If locating them by the UPS is not feasible then they shall be located above a doorway, not obstructed and identified on a print.
e. Any egress changes that should happen as a result of a modification, an A&E firm shall be used to provide an updated egress map that is approved by building inspector.
f. An updated Egress map shall be located by each exit and be protected in a plastic cover.
g. The Egress pathway, emergency lights and signs shall have it's own print page pdf and be reviewed by the Electrical Services Manager and Supervising Lead Electrician.

4. Parking Lot lighting design

a. Parking lot lighting includes all exterior lighting supported from a structure other than the County Building.
b. Parking lot lights shall have a redundancy of coverage provided by exterior lighting. This is to provide time to get a lift and replace parts or fixtures while the light is out and still provide safe levels of lighting. This is also to provide lighting from another source should the wiring be compromised and not drop all lighting to provide safe levels of lighting.
c. Parking lot lights shall not be controlled by an internal photocell, unless approved by Signing Supervising Electrician prior to installation.
d. Wiring shall not be smaller than #10 Cu. stranded wire and conduits shall not be smaller than ¾" with space for future wiring needs.
e. Rooftop and on wall exterior wiring should start with XHHW for the basis of design. All underground wiring shall be XHHW.
f. Where applicable dark parking lots with power on motion sensing shall be used and approved by the Signing Supervising Electrician.
g. Parking lot lights owned and operated by the County shall have a metal tag with identification nomenclature durably fixed to the pole light.

5. Exterior lighting design

a. Exterior lighting includes all lighting attached to exterior walls, under canopies, in ground and roof tops of a County building.
b. All exterior lights, even under a canopy or other cover, shall be designed for wet locations and be vandal resistant.
c. Exterior lights shall provide a level of redundancy for Parking Lots to provide safe light levels in the event of Parking lot light failures.
d. In ground light fixtures shall be protected with GFCI's and not used unless approved by the Supervising Electrician.

6. Interior lighting design

a. Interior lighting includes all lighting attached to the interior of a County building and excludes lights that are part of furniture assemblies or free standing lights.
b. Interior lighting color levels shall be matched to the lighting in the building.
    i. Medical spaces like exam rooms and dental operatories shall have a lighting temperature of 5000K.
    ii. Libraries can utilize 2700K lighting or higher for staff and public spaces.
    iii. General spaces shall have a lighting temperature of 3000K or 4100K but match the color temperature of the rest of the lighting in the building. In no case shall one floor be a different color temperature from the next.
    iv. Electrical, mechanical and IT equipment rooms have a color temperature of 3000k - 4000k.
    v. Any variations require prior approval from the Supervising Electrician.

c. Photo metrics shall be provided to prove the following:
    i. Library shelving has a minimum of 10 foot candles at the bottom shelf
    ii. General office and public spaces have 20-30 foot candles at the desktop surface.
    iii. Egress pathways have approximately 10 foot candles at floor level.
    iv. Electrical rooms have no less than 20 foot candles in front of the panels.
    v. Equipment lighting shall have no less than 10 ft candles.

d. Changing switch legs out to match the line voltage wiring when using programmable switches for Lutron, nLight, Wavelinx needs to be accounted for.
e. Light fixtures should dim or change color over the entire fixture as a default. To split light tuning and dimming across a fixture needs prior approval from Supervising Lead Electrician.
f. Take into account that light fixtures are no longer code compliant as access for junction boxes above a ceiling and access for those boxes need to be accounted for.
g. All light fixtures shall have occupancy sensors or be controlled by an occupancy sensor.
h. All fixtures shall have dimming capabilities.

B. ELECTRICAL PRINT SETS:

Multnomah County electrical prints shall be in the Revit Electrical Project Model and have PDF copies. Electrical print sets shall consist of the following:

1. Architectural print base used for the following
    a. Commercial power distribution equipment locations
    b. Generator power distribution equipment locations
    c. UPS power distribution equipment locations

2. Power and data print base
    a. Commercial power receptacles
    b. Gen receptacles
    c. UPS receptacles
    d. GFCI receptacles

3. Reflected ceiling print base
    a. Commercial power lighting
    b. Life Safety Egress lighting
    c. Safety Lighting

4. Diagrams
    a. One line diagram shall be made in Revit and have names and the available fault currents listed at Service and Distribution panels.
    b. A second one line diagram shall be made in Easy Power
    c. Life Safety relay wiring diagrams shall show the wiring and note location of lights.

C. EGRESS PATHWAYS:

1. Egress pathways shall meet NFPA 1, NFPA 101, IES standards, Chapter 10 of the International Building Code.
2. Egress lighting's preferred power source is a generator with a dedicated Life Safety transfer switch. If there is no generator on location then a Life Safety UPS shall be used.
3. Egress pathways should be designed to initial illumination of 10 foot candles with a minimum of 1 foot candles along the pathway at the walking surface. IBC 1008.3.5
4. At the end of a 90 minute test illumination levels shall not decline to less than 0.06 foot candles. IBC 1008.3.5 & 1008.3.5
5. Stairways IBC 1009.3
6. Areas of refuge IBC 1009.6

D. SAFETY LIGHTING PATHWAYS:

1. Mechanical rooms, Electrical rooms, Fire Pump rooms, Generator rooms and shall be considered Safety Lighting. IBC 1008.3.3

E. EQUIPMENT LABELING AND FORMAT:

1. Multnomah County uses this equipment identification strategy to help quickly identify the type of equipment, power characteristics and general location. Engraved plastic labels or an approved label maker is preferred for larger components of the power distribution system used for the Service panel, Distribution panels, transformers, MCC's, panelboards and similar equipment. Label maker tape is used for smaller components, for disconnects, receptacles, motors, VFD's, hand dryers, switches, lights and similar parts. All labels shall be able to withstand the environment they are installed in.

2. Engraved plastic labels shall be no less than 1" x 3" with lettering no smaller than 1⁄2" tall. Labels made with a portable label maker shall range from ½" to 1". All labels shall use the color code below:

    a. Black background and white lettering - Utility power source equipment ID
    b. Green background and white lettering - Photovoltaic power source equipment ID
    c. Clear background and black lettering - Plug and switch circuit ID
    d. Red background and white lettering - Emergency power source equipment ID
        i. Except the emergency power sources listed in e and f
    e. Blue background and white lettering - UPS emergency power source equipment ID
    f. Yellow background and black lettering - Life Safety emergency power source equipment ID

3. The equipment ID is built using five parts to make the equipment ID name. Looking at the example below the first spot is the voltage designator, the second spot is the power source designator, the third, fourth and fifth are used for the equipment type designator, the sixth and seventh spot is the floor designator and the 8th spot is the equipment designator.

    Example: 2E-ATS-07B

    The 2 identifies the electrical power is 120/208v - 3Ø, the E identifies generator backed up power, the ATS identifies the equipment as an automatic transfer switch, the 07 identifies it is on the 7th floor and the B identifies this as the second automatic transfer switch on the 7th floor. The following is the rest of the identifiers used:

    a. Voltage designator:
        i. 1 = 230/400v - 3Ø
        ii. 2 = 120/208v - 3Ø
        iii. 3 = 120/208v - 1Ø on 3Ø
        iv. 4 = 277/480v - 3Ø
        v. 5 = 120/240v - 3Ø
        vi. 6 = 120/240v - 1Ø
        vii. 7 = Placeholder
        viii. 8 = 2400/4160 - 3Ø
        ix. 9 = 7200/12470 - 3Ø

    b. Power Source designator:

i. P = Utility power
ii. E = Generator backup power
iii. U = Building Support UPS backed up power
iv. S = Life Safety emergency backup power
v. V = Photovoltaic power

c. Equipment Type designator:
   i. The equipment abbreviations will be no greater than three letters and follow Revit standards (Google/PDF) except as shown below:

GLP = General Loads Panelboard	LSR = Light Safety Relay	UPS = Uninterruptible Power Supply
MSD = Main Service Disconnect	MCP = Motor Control Panel	DGU = Diesel Generator Unit
MSG = Main Service Gear	DSC = Disconnecting Means	PGU Propane Generator Unit
MLP = Mechanical Loads Panelboard	MTR = Motor	GGU = Gas Generator Unit
MDP = Main Distribution Panels	EWH = Electric Wall Heater	ATS = Automatic Transfer Switch
LLP = Lighting Loads Panelboard	VFD = Variable Frequency Drive	NGU = Natural gas Generator Unit
SDP = Sub Distribution Panels	IBT = Intersystem Bonding Terminal	MTS = Manual Transfer Switch
XMR = Transformer	PBT = Power System Bonding Terminal	GPS = Generator Paralleling Switchgear
MCC = Motor Control Center	LBB = Low Voltage Bonding Backbone	
LRP = Lighting Relay Panel	PBB = Power Distribution Bonding Backbone	

d. Floor designator - The floor the equipment is located on 01 = first floor
e. Equipment designator - A is the first in the series on the floor

Equipment ID name examples:

- 4E-VFD-7D-AHU.1
  - 480v VFD on the 7th floor that is the 4th one and is part of AHU.1
- 4E-MTR-7D-AHU.1
  - Is the 480v motor load side of the VFD for AHU.1
- 42P-XMR-BA
  - 480 pri to 208 sec, utility power transformer in the basement and the 1st on the floor
- 24P-LRP-3A
  - Lighting relay panel with 120v and 277v loads on the 3rd floor and the 1st on the floor
- 4P-MSD-1A
  - The main 480v service breaker for the building on the first floor
- 4E-MDP-1A
  - 480v generator main distribution panel on the first floor
- 4S-ATS-2A
  - The life safety ATS at IJ. 480v, Life Safety ATS, second floor

F. ELECTRICAL ROOMS, AREAS, AND WORK SPACES

1. At Multnomah County there are multiple types of electrical spaces and rooms utilized for electrical power distribution and equipment. All electrical power distribution needs to be designed to be in a space that is not accessible by public, staff and non-facilities personnel for safety. Rooms are the approved spaces with electrical closets and spaces require approval of the Supervising Electrician.

    a. **Power entrance facility room** - is where the utility or generator power enters the building and is connected to the building electrical service gear or transfer switches.
    b. **Satellite electrical rooms** - are rooms where power distribution equipment is located that are load side of the electrical service gear and to distribute branch circuits to building loads.
    c. **Satellite electrical closets** - are closets where power distribution equipment is located in a closet that is on the load side of the electrical service gear and to distribute branch circuits to building loads.
    d. **Satellite electrical spaces** - are spaces where power distribution equipment is located in a wall space that is on the load side of the electrical service gear and to distribute branch circuits to building loads.

2. All rooms shall be no smaller than 15’ x 15’ with a minimum height clearance of 10’ and closed off to public and non-electrical shop staff. These rooms can hold other related power distribution gear and are sized to allow a minimum of 4’ of working clearance from all surfaces.
3. All closets shall be no smaller than 5’ x 15’ with a minimum height clearance of 10’ and closed off to public and non-electrical shop staff. The doors must open to a minimum of 90° and open into a space that can be blocked off for electrical safety.
4. All spaces shall be no smaller than the equipment in the space, shall not be located in a

main hallway and have a secondary pathway to allow blocking of the hallway for electrical safety.

5. The temperature and humidity of all electrical rooms, closets and areas shall maintain a 24 hours, 365 day operation in order to maintain operating ranges of 62° F to 70° F with 30% to 55% relative humidity. The ambient temperature and humidity shall be measured at any point 5 feet above the floor level after equipment is in operation. A positive pressure differential with respect to the surrounding area shall be maintained.
6. Doors for rooms shall match the fire rating of the walls, have crash bar hardware on the inside of the room to allow for emergency exit and swing out of the space for proper egress. All doors shall have card access, signs posted on the outside clearly identifying the space, potential dangers, announcing restricted entry and suitable to withstand the environment.
7. Four feet of wall space shall be allocated for future expansion of electrical infrastructure and all walls shall have a minimum of a 2 hour fire rating.
8. All equipment supported from the floor shall be mounted on house keeping pads no smaller than the equipment they support and no less than 4 inches high.
9. All lighting shall be controlled locally with no occupancy monitoring less than 4 hours to allow for make up work in equipment that requires little to no movement.
10. All working clearances for electrical equipment shall be clearly marked in these spaces with yellow and black striped marking tape suitable to withstand the environment. Lettering no smaller than 1 inch shall be stenciled on the floor indicating “Keep area clear”. All workings spaces shall use Table 110.26(A)(1) Working Spaces as modified below:

2017 NEC Table 110.26(A)(1) Working Space

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
~~0–150~~	~~900 mm (3 ft)~~	~~900 mm (3 ft)~~	~~900 mm (3 ft)~~
~~151–600~~	~~900 mm (3 ft)~~	~~1.0 m (3 ft 6 in.)~~	~~1.2 m (4 ft)~~
601–1000	900 mm (3 ft)	1.2 m (4 ft)	1.5 m (5 ft)

11. All electrical room doors shall be equipped with hardware that holds the door open and allows for 180 degree opening or greater. This can be attached door stops, cabling, door hold-open hardware or by other mechanical means. This needs to be reviewed and approved by the signing supervising electrician based on job hazard analysis.

G. POWER MONITORING, SURGE PROTECTION AND POWER QUALITY STRATEGIES

1. Power Monitoring

a. Monitoring equipment will be mounted inside the equipment that is monitored and designed to reduce collateral damage from failure and to reduce the safety gear required to service the monitoring equipment.

b. Nexus 1500+, Shark 200 and Shark 200MP are the Basis of design for metering.

i. The control power to the unit needs to be 120v and is fed from the Building Support UPS. The voltage sensing will be fed from a 3 pole 20 amp breaker in the Service, distribution panel or panelboard depending on what is being monitored.
ii. A Nexus 1500+ shall be on the Main Service Disconnect or for a partially owned space the main utility fed feeder from the Distribution.
iii. A Nexus 1500+ shall be on the Generator Main Distribution Panel.
iv. The box that the Nexus comes in will have CT shorting blocks that do not require screws that can be removed to short them out, the voltage sensing leads will terminate in DIN rail mounted fuse blocks, and the CT's will be a 5 amp secondary.
v. Generic Nexus part number is ENCNX1500+-120-D2-60-20-V1-485P-X-X-X.
vi. General ordering number for CTs: This will very depending on the ampacity, window size and lead length needed.

EI-WC4-400-RA05 400/5 A Split Core CT with 1.3" X 1.7" Window with 6' Leads

c. A Shark 200 or Shark 200MP shall be used for other monitoring points like LEED and PV arrays.

d. The Nexus shall be fed from the BS-UPS.
   i. ***Electro Industries/GaugeTech***
   1800 Shames Drive Westbury
   NY 11590
   (516) 334-0870
   www.electroind.com

e. There shall be one Protocom Backnet device purchased from ETI/Hubble and located next to the Siemens field panel. This device will require one County network drop.

2. Surge Protection Devices

a. Surge Protection Devices (SPD). Use a multilayered surge protection strategy. This will include SPD's staged throughout the feeders at the Service/distribution and panelboards.
b. Branch circuit surge protection will be achieved by plug in devices since this is the most economical way to deal with differing levels of protection and improving technologies.
c. SPD's shall be installed separately from the service gear, distribution gear and panelboards to minimize any collateral damage referred to in IEEE PO62.72 (Draft L. 1 November 2005)[B-2], including compromising the insulation system with subsequent L-L and L-G faults.
d. SPD's shall have a means to disconnect them from the service gear, distribution gear and panelboards that are located inside the gear and does not require access to the gear interior when servicing the SPD.

e. SPD's shall have a set of fault contact that can be tied into the Nexus meter I/O card.

3. Power Quality

An Easy Power one-line shall be maintained for all fault current and other trip setting documentation.

4. Grounding & Bonding

a. Ground wires shall be installed with space to allow a clamp to easily go around the wire
b. Intersystem Bonding Terminals(IBT) and Power Bonding Terminals(PBT) shall not be smaller than 2" x 4" x 1⁄4"
c. Mechanical connections to ground plates shall be bolted using mechanical lugs
d. The grounding electrode conductor or other grounding connections to IBT or PBT shall be identified at the termination

H. POWER DISTRIBUTION

1. Electrical Service

a. The Building Electrical Service shall be labeled Main Service Disconnect (MSD) or Main Switch Gear (MSG).
b. The basis of design is to have a Main Service Disconnect (MSD) and Main Distribution Panel (MDP) in separate enclosures. This is to allow repairs and maintenance in everything but the MSD to be done without having to schedule the Utility to shut off power at the transformer.
c. Refer to "Label Format" for size, lettering and color code.
d. Label shall have voltage, phase, and available fault current identified
e. All breakers shall have the load identified
f. The Electrical Service should be located in an electrical room that requires card access, has crash hardware that opens out of the room, and is out of staff and public areas.
g. Generator main breaker shall have Form C contacts wired back to the Nexus meter.
h. The Main Service Disconnect should be designed so it is possible to disconnect power to everything inside the building with one breaker. Under the Counties PM program we test the breakers every three years using Primary or Secondary injection testing. We would like to limit the number of breakers we test where the utility has to disconnect power to the building.
i. Calculate the Service to have a minimum 200 amp multi-phase capacity.
j. Must have extra feeder breaker space in the gear for electric vehicle charger power distribution support.
k. Must have extra feeder breaker space in the gear for PV system connections.
l. All equipment shall be located on housekeeping pads.

2. Distribution

a. Refer to "Label Format" for size, lettering and color code.
b. Label shall have voltage, phase, and available fault current identified

c. All breakers shall have the load identified
d. All Distribution should be located in an electrical room that requires secured access and is out of staff and public areas.
e. Must have extra feeder breakers in the gear for electric vehicle charger power distribution support.
f. All equipment shall be located on house keeping pads

3. Transformers

a. The Transformers shall be labeled per the “Electrical Equipment Identification Designation” for example 42-XMR-2A.
b. Do not bond inside of the transformer. Bond the neutral to ground in the disconnect or in the panelboard with a loop for clamp meter testing.
c. Transformers smaller than 45KVA shall only be used for Life Safety systems, and must be approved by Signing Supervising Electrician.
d. Transformers larger than 150KVA require approval from the Signing Supervising Electrician.
e. Transformer should feed panels and equipment on the same floor they are located on to limit interruptions to the building operations.

4. Panelboards

a. All load side branch circuit wiring from the breaker to the load shall be stranded copper wiring. No solid wire or MC.
b. The Panelboards shall be labeled per the “Electrical Equipment Identification Designation”.
c. Refer to “Label Format” for size, lettering and color code.
d. All panelboards should be located in an electrical room that requires secured access and is out of staff and public areas. Installation of panelboards in hallways is prohibited.
e. For power quality and other reasons panel loads will be divided across different designations shown below: (1) GLP – General Loads Panelboard (2) MLP – Mechanical Loads Panelboard (3) LLP – Lighting Loads Panelboard
f. All panelboards shall have a main breaker disconnect. No MLO panelboards shall be installed. This is to meet OSHA and NFPA 70E requirements and the safety of personnel to shut down power. This requirement allows us to shut off power and limit the number of people that will experience a loss of power.
g. All panelboards shall have bolt on breakers
h. All panelboards shall have at a minimum 20% spare capacity, no penetrating conduits smaller than 3/4” trade size and have 4 spare conduits stubbed out.
i. Flush mount panelboards shall have no less than 8 spare conduits stubbed out to an accessible location.
j. All home runs out of panels must be a minimum of #10 regardless of circuit breaker rating.
k. All panelboards shall have door-in-door front hinged covers. This is to make our thermal imaging PM plans quick by eliminating the time needed to remove screws and clamps when taking the cover off for inspection. Below is an example of a Siemens panel:

Door in Door Front (14 Gage Standard /12 Gage optional)

5. Photovoltaic Systems

a. Shall have micro-inverters as basis of design. Alternate designs shall be reviewed by the Electrical Services Manager and Supervising Lead Electrician.
b. Shall have remote monitoring
c. Alterations require prior approval from the Signing Supervising Electrician
d. All photovoltaic systems requires Shark 200 or Shark 200mp V3 meters to monitor the output of the solar array with Bacnet communication abilities.

6. Generators - NFPA 110, 30, 37

a. The Generators shall be labeled per the “Electrical Equipment Identification Designation”.
b. Refer to “Label Format” for size, lettering and color code.
c. Generators shall be Cummins, Caterpillar, Kohler or MTU.
d. Each generator unit shall have the ability to be monitored remotely and the ability to connect to the County network.
e. Generator main breaker shall have Form C contacts wired back to the Nexus meter.
f. Shall have digital or analog/digital combination meters on the HMI
g. Shall have a stationary load bank capable of loading the generator to 100% load.
h. Shall have Veeder-Root TLS-4C unit and be connected to the County network
i. Fuel tanks shall be large enough to provide a 24hr run fuel capability as standard and can be changed with Signing Supervising Electrician approval

j. Battery chargers shall be OEM or Sens FC/A series
k. All equipment shall be located on housekeeping pads.
l. Shall have 1 operations and 1 repair manual at the equipment

i. Cummins
1400 73rd Ave. NE
Minneapolis MN USA 55432
(800) 286-6467
www.cumminspower.com

ii. Caterpillar
501 Southwest Jefferson Avenue
Peoria, Illinois USA 61630
(888) 614-4328
www.caterpiller.com

iii. Kohler
444 Highland Drive
Kohler, WI 53044
(800) 544-2444
www.kohlerpower.com

iv. Sens
1840 Industrial Circle
Longmont, CO 80501
(866) 736-7872
www.sens-usa.com

v. MTU
100 Power Drive
Mankato, MN 56001
(800) 325-5450
www.mtuonsiteenergy.com

7. Transfer Switches

a. The Transfer switches shall be labeled per the “Electrical Equipment Identification Designation”.
b. Refer to “Label Format” for size, lettering and color code.
c. Transfer switches with elevators shall have no other loads
d. Transfer switches shall be designed to avoid loads larger than 200 amps and use a per floor design.
e. Transfer switches with loads larger than 200 amps can only be used with Signing Supervising Electrician approval.
f. Each generator unit shall have the ability to be monitored remotely and the ability to connect to the County network using a Nexus 1500+
g. Shall have a separate momentary switch separate from the HMI to initiate the monthly generator testing.
h. All equipment shall be located on housekeeping pads.
i. All transfer switches shall have maintenance bypass.
j. Shall have 1 operations and 1 repair manual at the equipment.
k. Automatic Transfer Switches basis of design shall be primarily Eaton or ASCO..

i. ***Eaton Corporation***
1000 Eaton Boulevard
Cleveland, OH 44122
(877) 3862273
www.eaton.com

ii. ***ASCO***
1050 Dearborn Drive
Columbus, OH 43085
(614) 888-0246
www.asco.com

8. Generator Load Banks

a. Load banks shall beat 100%.
b. If the load bank is 100% then the docking station shall only require temporary generator connections.
c. If the load bank is 50% then the docking station shall require a temporary generator and load bank connections so we can bring in an external 50% load bank.
d. Load banks shall have the controller as near as possible to the generator control panel.

9. Docking Stations

a. Trystar docking stations are the basis of design and shall be reviewed by the Signing Supervising Electrician.

10. Fuel and Monitoring

a. The basis of the design is the Veeder-Root model TLS-4C. Different fuel monitoring can be used with prior approval from the Signing Supervising Electrician with the ability to be connected to the County network.
b. Veeder-Root can be substituted with prior approval from the Signing Supervising Electrician.
c. Veeder-Root shall have a minimum fuel tank probe and leak/annular monitoring
d. Permanent fuel polishing systems are allowed with approval from Signing Supervising Electrician.

i. ***Veeder-Root***
125 Powder Forest Drive PO Box 2003
Simsbury, CT 06070
(888) 561-7942
www.veeder.com

11. Fire Pump Electrical

a. Fire Pump controllers shall comply with NFPA 20 codes and be reviewed by the Signing Supervising Electrician.
b. Sprinkler system jockey pumps shall be fed from a generator backed up panel.

12. Building Support UPS systems

Building Support UPS systems utilize dual conversion power supplied by Eaton 9PX, Blade and 93PM UPS units. UPS units shall be configured with 2 battery strings or in a N+1 configuration as directed by the Signing Supervising Electrician. These systems cover The UPSs shall be labeled per the "Electrical Equipment Identification Designation":

a. Refer to "Label Format" for size, lettering and color code.
b. Basis of Design for ystems is Eaton 9px, BladeUPS or 93PM
c. shall be modular and set up with a plus one concept
d. shall have built in communications card
e. Shall have remote battery monitoring as directed by the Signing Supervising Electrician
f. UPS systems shall have a maintenan sized
g. All equipment shall be located on housekeeping pads.
h. All equipment shall be located on housekeeping pads.

County data centers, detention electronics, BAS, County IT equipment, phones, cameras, lighting control power, nexus meters and other critical loads

i. Building Support UPS s
j. All Building Support UPS units
k. All Building Support UPS units
l. All equipment shall be located on housekeeping pads or located in the middle of the Rack
m. ce bypass
n. Shall have one manual at the equipment and one electronic copy for BDMC
o. For any general use in wall receptacles attached to building support UPS power there shall be a Blade UPS or larger.

i. ***Eaton***
8609 Six Forks Road
Raleigh, NC 27615
(800) 356 5794
www.eaton.com

ii. ***Emerson-Liebert***
8000 West Florissant Ave, PO Box 4100
St. Louis, MO 63136
(314) 553-2000
www.emersonnetworkpower.com

iii. ***Myers Power Products***
44 S Commerce Way
Bethlehem, PA 18017
(610) 868-3500
www.myerspowerproducts.com

13. Life Safety UPS Systems

a. Life Safety UPS systems use UL924 Myers illuminator UPS units.
b. Life Safety UL924 UPS emergency lighting UPS systems shall not have a side scrolling HMI
c. Life Safety UL924 UPS emergency lighting UPS systems shall have an HMI with at least two full lines to view information

d. Life Safety UL924 UPS emergency lighting UPS systems shall have an HMI with 0-9 numerical interface button control
e. UPS systems shall have a maintenance bypass e. Shall have form C contacts that get connected to the Nexus I/O card.
f. All equipment shall be located on house keeping pads.
g. Basis of design for Life Safety UPS systems is the Myers Illuminator

i. ***Myers Power Products***
44 S Commerce Way
Bethlehem, PA 18017
(610) 868-3500
www.myerspowerproducts.com

14. Life Safety Battery back-up ballasts

a. Battery back-up ballasts shall be Lithonia power sentry 1400 or equivalent that has the quick disconnect wiring harness.
b. Exit signs shall be LED and self-monitoring

15. Raceways for Data, Signaling, Line and Low Voltage

a. Cable trays can be run side by side with power raceways on the same trapeze with a 4 inch space between or on it's own trapeze. Cable trays shall not be run under a trapeze with conduits run above the Cable trays.

Wiring for Feeder, Branch and Signaling Circuits

16. Branch circuits

a. Run a dedicated neutral for each phase conductor
b. Auto door operators, drinking fountains, electrical wall heaters and similar can share the same circuit as code ampacities allow.
c. General use circuits that are in hallways, conference rooms, offices, and similar areas shall not have utilization equipment on them.
d. Neutral wiring will be striped to match phase conductor color
e. Neutrals will be identified as to what phase conductor it is paired with using appropriate number wire markers in all panels and in addition any junction boxes where there are splices present.
f. Underground raceway basis of design shall be schedule 80 PVC or better for the entire length, including 90 degree bends.
g. All underground pull strings will be mule tape only. Nylon striped pull twine is not allowed.
h. Kitchen areas shall have dedicated circuits for each receptacle for small appliances.
i. Rooftop raceways shall use EMT whenever possible and only use flex conduit as needed. The entire raceway shall not be flexible conduit on a rooftop.
j. Small appliances that are 10 amps or more (coffee pots, microwaves, 1500w hot plates, toaster ovens, etc) shall be on a dedicated circuit.
k. Small appliances 10 amps or less can share a small appliance circuit as long as the load added is:
    i. less than 16 amps for a 20 amp circuit
    ii. less than 12 amps for a 15 amp circuit

17. DIRTT Modular Systems

a. Electrical components shall be standard pipe and wire methods only.
b. Pre-wired plug and play modular devices, cable harnesses or wiring will not be allowed.

18. Junction Box Accessibility

a. Junction box should be safely reachable from an A-frame ladder.
b. Junction box should be located within the width of the access hatch.
c. Junction boxes should not be higher than 18” above top of hatch.

I. UTILIZATION EQUIPMENT

1. HVAC

a. HVAC equipment shall have non-fused disconnects and the wiring will not use taps for power, control or other loads.

2. Motors and controls - NFPA 79

3. MCC

a. The MCC’s, shall be labeled per the “Electrical Equipment Identification Designation”
b. Refer to “Label Format” for size, lettering and color code.
c. MCC’s, shall have remote monitoring capabilities as approved by the Signing Supervising Electrician
d. MCP Motor control panels, shall be UL508 listed
e. Motors with VFDs shall have the input wiring in a separate raceway than the output wiring

4. Motors - Motor control panels, shall have adequate space for testing

5. VFD

a. The VFDs shall be labeled per the “Electrical Equipment Identification
b. Designation” with note to the Equipment designator EX-1.
c. Shall be ABB brand, 12 pulse or greater
d. Indoor VFD’s will be of the enclosed box style UL type 12 unless the signing Supervisor approves the vertical style UL type 12.
e. Shall have a maintenance bypass and P1 communication protocol capability
f. VFDs shall be designed with harmonic mitigation.
g. VFD input power shall be routed separate from the power output to the motor.
h. Shall have 1 manual at the equipment and 1 electronic copy for BDMC

i. ***ABB***
16250 W. Glendale Drive
New Berlin, WI 53151
(800) 435-7365
www.abb.com/us

6. **Hand Dryers**
    a. Hand dryers shall be energy efficient
    b. New and replaced hand dryers in Libraries shall be World Dryer Slimdri

        i. ***World Dryer***
        5700 McDermott Drive Berkeley, IL 60163
        (800) 323-0701
        www.worlddryer.com
        Product: SLIMdri

7. **Electric Wall Heaters**
    a. Electric wall heaters, should be limited in use
    b. Electric wall heaters, place an equipment ID label using a sharpie or a label maker on inside of the cover

8. **Elevator electrical -** Must be reviewed by Signing Supervising Electrician prior to installation.

9. **EV charging stations** - Must be reviewed by Signing Supervising Electrician prior to installation.
    a. Raceway from distribution to chargers shall not be smaller than 1” conduit.
    b. Add two extra 1” conduits from building to charger area for future expansion.
    c. EV chargers shall be equipped with RFID technology in order to aid in the ease of activating the charger and evaluating program requirements.
    d. EV chargers shall be on dedicated circuits.

10. **Commercial kitchen hood electrical - NFPA 96, 17**
    a. Must be reviewed by Signing Supervising Electrician prior to installation.

11. **Power for overhead doors, sliders, coiling doors, and gates that require power**
    a. Power to units should be 480v or 208v 3-phase and have a local non-fused knife switch disconnect with lock-out-tag-out capabilities within sight of the unit. If an exception is needed, please contact the Multnomah County Electrical shop. The electrical shop is under no obligation to approve exceptions.

12. **Drinking Fountains**
    a. All drinking fountains shall have a chest level, faceless, motor-rated GFCI that feeds the receptacle that is behind the equipment access hatch.

J. DEVICES

1. **Receptacles**
    a. Receptacles shall be commercial grade or better.
    b. Receptacles shall be color coded as follows:
        i. Normal power = Ivory, White, Brown, Gray

ii. Generator emergency power = Red
iii. UPS emergency power = Blue

c. All receptacles shall be Tamper Resistant (TR) rated.
d. Use hospital grade TR receptacles in all exam rooms
e. All plug and switch wall plate covers shall default to stainless steel unless
f. otherwise specified.
g. Secured locations, where people in custody are likely to be, shall use tamper proof screws for all covers.
h. Secured locations, where people in custody are likely to be, shall use security wall plate covers. Example: Hubbell Cat # SWP26.
i. All receptacles shall be hardwired; no stab-in or plug-in receptacles unless reviewed by the signing supervisor.
j. Any outlet within 7 feet, plus or minus 6 inches, of the edge of a sink should be GFCI protected.
k. All GFCI receptacles shall be Tamper Resistant (TR) and Weather Resistant (WR) rated.
l. Any equipment that is blocking access to a receptacle that it is plugged into that requires GFCI protection must have a faceless motor rated GFCI located at or near the equipment accessible for testing.

2. Switches
a. Electrical switches shall be commercial grade or better.

3. Disconnects
a. Jail kitchen disconnects shall be stainless steel.
b. Disconnecting means shall have lock out tag out capabilities.
c. Disconnecting means shall be defeatable unless a snap switch is used.

EXHIBIT D2: Alarms, Access Control, Low Voltage Systems

A. SECURITY

1. Design Principles: Layered Approach to Security
a. All exterior accessible points (doors, hatches, etc.) are to have security contacts which are to be wide-gapped type to prevent false activation.
b. All reasonably accessible glass is to be monitored with acoustic glass break detection. Interior protection of motion detection (minimum dual technology PIR and microwave or better) to be strategically placed by area value and likelihood of traffic.
c. When a building is of sufficient size or use it is to be divided into separate controllable compartments (partitions) which will have there egress doors monitored (security contacts which are to be wide gapped type to prevent false activation) and interiors monitored with motion detection (minimum dual technology PIR and microwave or better. Each partition should be equipped with its own keypad and arming station.

d. High value areas to have additional security monitoring (ideally a separate security partition) and physically hardening of location.
e. Environmental sensors for off site reporting- such as temperature sensors in Telecom rooms and water leak detection sensors- are to be connected to the security panel.
f. Duress buttons are to be placed where there is interaction with the public and assistance may be required. When the location is a fixed location these are to be hard wired (e.g counters) and wireless when these are attached to movable furniture. Reporting and annunciation will be coordinated with the client. Product:

i. ***Digital Security Controls (DSC)***
3301 Langstaff Road
Concord, Ontario, Canada
L4K 4L2
(905) 760-3000
www.dsc.com

B. ACCESS

1. Design Principles:

a. Access control is appropriate for exterior doors, doors that provide separation from staff and public, along with doors that provide access to high value locations or areas that need tracking. RFID readers are the current technology used.
b. Doors are to be monitored for position, either with a door contact or sensor integral with the access hardware; also a request-to-exit device is to be used (currently PIR REX).
c. Forced opens are to be monitored and at times are also monitored by the security system as part of area protection.
d. Access and security system to be integrated to provide arming and disarming control by access control system.
e. Elevator control to allow individual floor control by user.
f. Where there are monitored guard stations, events and alarms will be provided along with instructions via the access system.
g. Magnetic locks are not to be used unless there are no other viable options.
h. Where possible maintain the same access door hardware for location (strikes or electrified latch).
i. All power supplies shall be equipped with a local disconnect switch.

Products: Kantech (controllers, software, ioProx XSF card readers and cards)

i. ***Kantech***
9 Roszel Road
Princeton, NJ 08540

(888) 526-8324
www.kantech.com

C. FIRE

1. Design Principles:

a. At a minimum meet current code along with providing detection in all paths of egress, high value or critical locations. Voice evacuation system are preferred. All devices are to be addressable and “intelligent”
b. Mechanical labeling is to be used to identify all initiating devices with addresses as displayed on the annunciator. All labels shall be of sufficient size and font to be easily read.
c. On relays and monitoring devices, an additional mechanical label shall be installed describing the function of such device on the device and on its cover, i.e. “elevator ALT recall” .
d. Mechanical labeling is to be used to identify all notification devices numbered in sequential order for each circuit. The final device on the circuit shall also display that it is the end of line device.
e. Any junction box with more than 3 cables shall be connected with terminal blocks and mechanically labeled.
f. The FACP needs to be supplied with either dry contacts or a relay so a global general alarm can be received from the panel.
g. Any duct detectors installed above a ceiling or in an area not easily accessible, shall have a remote test switch installed. They shall also have a dry contact installed with them so the BAS controls can be tied to the alarm outputs.
h. Any junction box or panel shall be mechanically labeled. In addition, any fire alarm panel fed with 120VAC power, shall be mechanically labeled with the information of the electrical panel and its location on the inside cover.
Products: Notifier

i. ***Notifier***
12 Clintonville Road
Northford, CT 06472
(800) 289-3473
www.notifier.com

EXHIBIT D3: Electronic Services

A. ELECTRONIC SERVICE STANDARDS

1. Closed Circuit Television (CCTV Non-Detention)

a. All cameras shall be Axis IP(or owner approved substitute) based with appropriate resolution and Field of View.
b. VMS shall be exacqVision Z Series Server/Professional Win10 OS or owner approved substitute.
c. Coverage shall at minimum include public entry, public waiting lobbies, public elevator lobbies, exterior staff doors, and public/staff parking areas.
d. Video retention shall be 30 days of motion detected 24/7 continuous recording at 15/fps/full resolution. Additional storage is available at customers expense.
e. IP Camera network switches shall be Axis Layer 3 with IEEE 802.3af POE or better with 15% spare ports.
f. IP Camera data infrastructure shall comply with “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
g. CCTV head end equipment shall be collocated in tell/data/LVE closet.
h. This equipment will be served by a UPS backed emergency power.

2. Medical Call/Intercom System (Detention)

a. Detention Medical Call/Intercom systems shall be IP based with digital signal processing and have the capability of multiple master stations with external input for call steering capability.
b. The system shall have 20% supplied expansion capability.
c. The system shall be a closed industrial “air gap” secure network.
d. Network switches shall be Layer 3 with IEEE 802.3af POE or better with 20% spare ports.
e. Data infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
f. Medical Call/Intercom head end equipment shall be collocated in tele/data/LVE closet.
g. This equipment will be served by a UPS backed emergency power.

3. Intercom

a. Intercoms shall be IP based Airphone or owner approved substitute.
b. Master Stations shall be located at Security Guard posts and or Reception personal locations with external input for call steering capability.
c. Data infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
d. Intercom head end equipment shall be collocated in tell/data/LVE closet.
e. This equipment will be served by a UPS backed emergency power.

4. Telephone Paging

a. Paging system shall be of centralized amplifier configuration
b. Paging controller shall be Bogen IP Based or owner approved substitute.

c. Paging amplifier shall be 25/70 volt with 25% overhead.
d. Minimum of 2 spare zones shall be provided on paging controller.
e. Speaker spacing shall be consistent with manufactures design guide.
f. All speakers shall have individual accessible volume controls.
g. Conference rooms shall have wall mounted volume controls.
h. No more than 6 speakers per 18/2 stranded shielded home run.
i. Cabling infrastructure shall comply with the “Multnomah County “COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
j. Paging head end equipment shall be collocated in tell/data/LVE closet.
k. This equipment will be served by a UPS circuit.

5. Sound Reinforcement (Medium to Large Conference room)

a. The sound system shall be of a mix-minus configuration utilizing a Digital Automatic Matrix Mixer.
b. The mix-minus output configuration shall have a minimum of 4 zones.
c. 4 Channel 70V amplifier.
d. An infrared Assisted Listen Device system shall be installed to meet ADA requirements.
e. Cabling infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
f. Sound Reinforcement head end equipment shall be collocated in tell/data/LVE closet.

6. Sound Reinforcement (Boardroom)

a. The sound system shall be of a mix-minus configuration utilizing a Digital Automatic Matrix Mixer to include digital signal processing (DSP).
b. The mix-minus output configuration shall have a minimum of 4 zones. Dias, presenters, gallery, and overflow gallery.
c. Digital telephone hybrid for off site call in participation.
d. Phone bridge for offsite monitoring of audio presentations.
e. Integrated A/V projector with video conferencing capabilities.
f. Minimum 4 Channel 70V amplifier with 25% overhead.
g. Microphone inputs shall be as follows: Dias (multiple microphones), Clerk, Support Staff, Presenters x4, and two wireless microphones.
h. An infrared Assisted Listen Device system shall be installed to meet ADA requirements.
i. Closed Captioning system with local display capability and consistent with contracted captioning vendors technical requirements.
j. Video switching system for media devices.
k. Programmable touch panel master volume control, input level control and lighting control to be located at the Board Clerks’ work station.
l. Cabling infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).

m. Sound Reinforcement head end equipment shall be collocated in tell/data/LVE closet.

7. Distributed Antenna System (Public Safety)

a. Ability to provide at least -85dBm signal quality throughout the required coverage area in the building.
b. Supervised monitoring of system status by building fire notification system.
c. Cabling infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
d. Coordinate system design with City of Portland Bureau of Emergency Communications.
e. DAS head end equipment shall be collocated in tell/data/LVE closet.
f. This equipment will be served by a UPS backed emergency power.

8. Distributed Antenna System (Cellular Provider)

a. Ability to provide at least -85dBm signal quality through the required coverage area in the building.
b. Multiple carrier coverage to include but not limited to Verizon, Sprint and AT&T.
c. Contractor responsible for coordination with providers.
d. Cabling infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
e. DAS head end equipment shall be collocated in tell/data/LVE closet.

9. Sound Masking

a. Installed where required or requested by client.
b. Use Cambridge headend as standard.
c. Each controller will be capable of 6 zones with coverage of at least 72,000 square feet.
d. System will include 2 audio inputs programmable by zone for building notification or background music.
e. Zone independent equalizer and volume controls.
f. Configuration and control via networked browser based interface.
g. CAT-6 emitter wiring, with plenum rated emitters.
h. Cabling infrastructure shall comply with the “Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS” document (Google/PDF).
i. Sound Masking head end equipment shall be collocated in tell/data/LVE closet.

10. County Radio Communication Antenna System

a. Provide 4 each LMR-400 plenum/riser rated coax cables from building Security Desk/ Emergency Operations Center or designated location to exterior roof of structure.
b. Interior coax to be terminated in wall box with labeled N-Female coaxial connectors. Exterior coax to be terminated through a lightning protection device with N-Male coaxial connectors with appropriate weather sealing.
c. Roof penetration to be 3" conduit with weather head installed to County roofing system specifications.
d. Cabling infrastructure shall comply with the "Multnomah County COMMUNICATIONS FACILITIES REQUIREMENTS" document (Google/PDF).
e. This equipment will be served by a UPS backed emergency power.

11. Detention Electronics System (DE)

a. DE System integration of door control, movement intercom, cell intercom, CCTV, duress alarms, interlock overrides, touch panels (HMI), and radio communication logging, shall be controlled by a Schneider Electric Modicon Quantum PLC (or owner approved substitute) and programmed with the Schneider Electric Unity Pro IDE.
b. Touch Panel HMI devices shall be of an open source hardware design consisting of current Windows OS PC running the Schneider Electric Citect software. The HMI device shall be an ELO touch display or owner approved substitute.
c. Ladder logic, Scripting, and DFB programming techniques are approved; 'Boolean word manipulation' is not an acceptable programming technique.
d. Movement and Cell intercom shall be of Harding manufacture or owner approved substitute.
e. All CCTV switching shall be RS-232/USB communication from HMI workstation to video workstation.
f. All field devices shall have relay isolation between device and PLC I/O.
g. This equipment will be served by a UPS backed emergency power.

12. Electronic Signage Controller/LED Signage

a. Self contained media playback hardware.
b. 1080P HDMI, USB, VGA, GPIO, Ethernet.
c. Interactive display capability as needed.
d. Network enabled for administration and media updates
e. Supports multiple media feeds

EXHIBIT D4: TELECOM AND IT

A. TELECOM STANDARDS

1. Entrance Facility Room

a. This is the location where communication utility services enter the building from outside Service Providers or Access Providers to service occupants of a building. Size of this room is directly determined by building square footage and number of floors. The minimum size requirement for an EF room is 12' x 10'. Minimum clear height in the room shall be 9.5 feet without obstructions with outside walls built to ceiling structure. The access door to the room shall be at least 42 inches wide and 80 inches high, with doorsill, door swings out of room, and shall be fitted with a card access entry lock. All communication rooms must have a two hour fire rating.

These services may be for:

i) Campus distribution –Local area networks, private automatic branch exchange.
ii) An Inter-exchange Common Carrier.
iii) A Central station system for Fire or Burglar Alarms.
iv) A Community antenna television (CATV) network.
v) A closed circuit television (CCTV) network.
vi) Building Automation Systems (BAS)
vii) Distributed Antenna System (DAS)
viii) Audio/Video System including Sound Masking systems
(Some of these services will have equipment located in Equipment Rooms & Telecom Rooms.)

2. Main Switchroom for Telephone and Data Networking Equipment

a. The main telephone/data equipment switch room typically houses the data switch equipment cabinets; equipment racks for data core networking equipment; the wall field for cross-connecting the equipment cables, riser cables, intercampus BET cables, and ILEC/CLEC entrance cables; a work station; security card access control units, and storage space for maintenance spares, tools and test equipment.

b. At Multnomah County, there are typically two types of switchrooms: 1) the main switch room (ER) which houses the central core switch cabinetry that serves the entire campus; and 2) satellite switchrooms (TR) for remote phone/data switches that are connected via leased or MC owned outside plant facilities back to the main campus switchroom. Since the main switch room for the campus is in place and rather permanent in nature, this facilities requirement addresses ***satellite switchrooms which typically are required for new off campus buildings or similar major facilities construction projects*** where it's more efficient and effective to install remote data cabinets versus extending additional plant facilities to serve extensions directly off the main core.

c. The minimum size requirement for a main switch room (ER) is 12' x 15'. Minimum clear height in the room shall be 9.5 feet without obstructions with outside walls built to ceiling structure. The access door to the room shall be at least 42 inches wide and 80 inches high, with doorsill, **door swings out of room**, and shall be fitted with a card access entry lock. A minimum of two walls should be covered with rigidly fixed (3/4 trade size) A-C plywood preferably void free, C side facing structural wall , 8ft. high, capable of supporting attached equipment. Plywood should be either fire rated or covered with two coats of fire retardant paint on all

six sides. If fire rate plywood is selected two coats of off white paint should be applied with the fire rated stamp exposed for inspection. Must have 2 hour fire rated walls.

d. A separate power supply circuit serving the switch room shall be provided and terminated in its own electrical panel. Power shall be sufficient to support the equipment load and supporting facilities for the switchroom. **All power circuits** in EF, ER, & TR's shall be serviced by the building generator and/or building UPS service.
A 1-½ trade-size conduit shall be provided from the switchroom to the building-grounding electrode. This is to allow grounding cable not to be installed in designed 4" risers. Grounding cable needs to be in its own riser conduit system and not shared with low voltage vertical riser systems.

e. The preferred location for the switch room is the first floor (or ground floor). It is desirable to locate the switch room close to the main backbone network and buildings EF (Entrance Facility) for ease of connectivity to these network and distribution facilities. **No water** or **other liquid pipes** should be located above or run through all communication rooms.

f. When selecting the room site, avoid locations that are restricted by building components that limit expansion such as elevators, core, outside walls or other fixed building walls. Ease of accessibility to the space is important for the delivery of large equipment. The switch room shall be located away from sources of electromagnetic interference at a distance that will reduce the interference to 3.0 V/m throughout the electromagnetic frequency spectrum. Special attention shall be given to electrical power supply transformers; motors and generators; x-ray equipment; radio, cell phone or radar transmitters; and induction sealing devices. Need to avoid close proximity to elevator equipment rooms or exposed to vibration equipment like HVAC Chillers. The switch room shall be located with ready access to the main HVAC delivery system to ensure sufficient airflow and cooling. Not tied to building HVAC supply.

g. HVAC shall be provided on a 24 hours a day, 365 days-per-year basis. The temperature and humidity shall be controlled to provide continuous operating ranges of 64° F to 72° F with 30% to 55% relative humidity. The ambient temperature and humidity shall be measured at a distance of 5 feet above the floor level, after the equipment is in operation, at any point along the equipment aisle. A positive pressure differential with respect to the surrounding area should be provided.

h. The switch room shall be provided with the proper fire suppression system. Appropriate portable fire extinguishers shall be provided and maintained within the switchroom. They should be located as close as practicable to the switch room entry or exit. Additionally, some form of temperature alarm system should be installed to provide an early warning to a remote monitoring site of temperatures exceeding 75° F.

i. The interior finishes of the switch room shall be light in color to enhance room lighting. The floors, walls, ceiling and door shall be sealed to reduce dust. The switch room (ER) should not have grid tile or hard lid ceiling, but walls need to run to a structure with a minimum 9.5 feet in height. Flooring materials having antistatic properties shall be used. Lighting shall be a minimum of 540 lx (50 candles) measured 3 feet above the finished floor in the middle of equipment

aisles between cabinets. One or more switches located near the entrance door to the room shall control the lighting. ***Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.*** Emergency lighting and signs should be properly placed in the room where absence of light would hamper emergency exit.

3. Telephone Rooms for Telephone and Data Networking Equipment

a. There shall be at least one telecom room (TR) per floor. Additional Telecom Room (TR) should be provided when the floor area exceeds 10,000 sq. ft. or the horizontal distribution distance to the workstation exceeds 90 meter (300 ft). Rule of thumb would not have a workstation more than 150' from a TR. There are typically two size scenarios for terminal rooms: 1) The ideal situation where there is ample space to provide a minimum room size of 12 ft. by 10 ft. with a single door at least 36 inches wide and 80 inches tall, opening out; and 2) the limited space scenario where the TR size should be a minimum of 7 ft. wide and 8 ft.deep, both of which are inside dimensions, provided the TR is accessed via double doors which **swing out away** from the Telecom Room (TR). ***In either scenario, the TR should be at least 9.5 feet high.***

b. ***Each TR shall have sufficient power and lighting***. MC's minimum power requirements are a dedicated 20 amp duplex power outlet per TR. Additionally, **each TR shall have adequate airflow to ensure that operating temperatures do not drop below 50° F or exceed 80° F.**

c. Telecom Rooms (TR) shall be "centrally located" on each floor, or located so that horizontal station wires runs to user work stations and phones do not exceed 200 feet. The preferred standard for workstations to be within 150 feet from TR. In a multi-story building TR's **should be stacked in the core area** of each floor.

d. Each TR shall have sufficient sleeves, slots, conduits, or similar floor penetrations necessary to allow for ease of installation of telecommunications cabling and wiring. In new construction there should be (2) 2" conduits penetrating to the roof with weather heads; preferably terminating within the TR room. Such penetrations shall be properly fire stopped per the applicable building codes. A minimum of two walls should be covered with rigidly fixed (3/4 trade size) A-C plywood preferably void free, 8ft. high, capable of supporting attached equipment. Plywood should be either fire rated and covered with two coats of white or light color paint. Detailed specifications document will be provided per project scope.

4. Conduit

a. Conduit types include electrical metallic tubing, rigid metal conduit, and rigid PVC. Conduits shall be of the type permitted under the appropriate electrical codes. Metal flex conduit or plastic flex is not allowed due to cable abrasion problems and is not covered in this standard. Fish tape or pull cord/string shall be installed in all conduits. Standard work station wall outlet installation shall have at least a 1" conduit from the 4 gang box with single gang mud ring extended into the interstitial space and stubbed with non abrasive grommet. No ring and string construction for vertical wall cable installation.

b. Any single conduit run extending from a telecommunications terminal closet shall not serve more than two communications outlets. Conduit shall be sized per Table 1.1 and be incrementally increased in size from the furthest outlet toward the telecommunications room. No section of conduit shall be longer than 30 m (100 ft) or contain more than two 90° bends between pull boxes. A third bend may be acceptable in a pull section without derating the conduit's capacity if the run is not longer than 10 m (33 ft) or the conduit size is increased to the next trade size. This third bend needs to have **prior approval** from MC Telecom project designer.

c. Vertical conduit sleeves that run between TR's shall have 1" to 3" exposure above floor and vertical conduit sleeves coming into the TR's from the ceiling should be extended to the top of the 8' backboards.

TABLE 1.1

CONDUIT			NUMBER OF CABLES								
INTERNAL DIAMETER		TRADE SIZE	WIRE O.D. mm (in)								
			3.3	**4.6**	5.6	6.1	7.4	7.9	9.4	13.5	15.8
Mm	(in)		(.13)	**(.18)**	(.22)	(.24)	(.29)	(.31)	(.37)	(.53)	(.62)
15.8	0.62	½	1	**1**	0	0	0	0	0	0	0
20.9	0.82	¾	6	**5**	4	3	2	2	1	0	0
26.6	1.05	1	8	**8**	7	6	3	3	2	1	0
35.1	1.38	1 ¼	16	**14**	12	10	6	4	3	1	1
40.9	1.61	1 ½	20	**18**	16	15	7	6	4	2	1
52.5	2.07	2	30	**26**	22	20	14	12	7	4	3
62.7	2.47	2 ½	45	**40**	36	30	17	14	12	6	3
77.9	3.07	3	70	**60**	50	40	20	20	17	7	6

5. Pull Boxes

a. Pull boxes shall be used for the following purposes:

   i. Fishing the conduit run.
   ii. Pulling the cable to the box and then looping the cable to be pulled into the next length of conduit.

b. Pull boxes shall be placed in an exposed manner and location, and readily accessible. Pull boxes shall not be placed in a fixed, false ceiling space unless immediately above a suitably marked, hinged panel.

c. A pull box shall be placed in a conduit run where:

   i. the length is over 30 mm (100 ft);
   ii. there are more than two 90° bends; or,
   iii. if there is a reverse bend in the run.

d. Boxes shall be placed in a straight section of conduit and not used in lieu of a bend. The corresponding conduit ends should be aligned with each other.

e. Vertical sleeves routed through Telecom Rooms should extend at least 3” above floor surface and extend to top of 8’ backboards if coming into TR from ceiling penetrations.

6. Surface Raceway

a. Surface raceway, consisting of base, cover, couplings, elbows, and similar fittings, mounts directly on wall surfaces at appropriate work levels to provide a continuous perimeter pathway. Telecommunications outlets are located in cover fittings along the raceway. The electrical contractor shall provide faceplates for the surface raceway.

b. The practical capacity for telecommunications wiring in perimeter raceways ranges from 30% to 60% fill depending on cable-bend radius. The pathway size shall be calculated as follows: the summation of the cross-sectional area of all cables divided by the percent (expressed as a decimal fraction) of fill.

7. Grounding and Bonding

a. The electrical contractor will be responsible to bring in the grounding system. Locations will be provided by MC Telecom Project Designer. This ground wire shall run in its own conduit and not in the conduit sleeve system designed for low voltage cabling.
Grounding shall meet the requirements of the NEC and additionally grounding bonding shall conform to ANSI/TIA/EIA-607. When applicable, horizontal cabling and connecting hardware must be grounded and bonded in compliance with ANSI/NFPA 70 requirements and practices. When grounding telecommunications cabling, ensure that the installation conforms to proper practices and codes (ANSI/TIA/EIA-607, ANSI/NFPA 70, and local building codes).

a. An approved ground is available at the telecommunications rooms for:

i. Cross-connect frames.
ii. Patch panel racks.
iii. Active telecommunications equipment.
iv. Test apparatus used for maintenance and testing.

b.

a. Design Specifications should be listed in a Master Format under the Construction Specification Institute (CSI). The Master Format:

i. Division 25 – Integration Automation
ii. Division 27 – Communications
iii. Division 28 – Electronics Safety & Security

8. Pathways

a. Horizontal pathways and spaces consist of structures that conceal, protect and support horizontal cables between the workstation outlet and the

telecommunications terminal TR. When designing a building, the layout and capacity of the horizontal distribution systems must be thoroughly documented in the floor plans and other building specifications. FM PM or A&E design team must provide written specifications that the interstitial space is plenum or non-plenum return.

b. Every ceiling distribution system must provide proper support for cables from the telecommunications terminal TR to the work areas it serves. ***Ceiling panels, support channels (T-bars), and vertical supports are NOT proper supports.*** Ceiling conduits, raceways, cable trays, and cabling must be suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight. The pathways must have adequate support to withstand pulling the cables and be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bar) to ensure accessibility.

c. Cable trays, wire baskets, or ladder trays are to be **designed and installed by county low voltage contractors**. Design and implementation that requires seismic bracing that requires a seismic structured engineering should be included in A&E scope.

d. Fire rated devices for wall penetration shall be designed by A&E and provided, which then will be installed by county low voltage contractors. All fire rated devices and sealers should be designed and specified by A&E; provided and installed by county low voltage contractors.

APPENDIX E: Building Control Basis of Design

EXHIBIT E1: CONTROL SYSTEM DESIGN GUIDELINE

GENERAL NARRATIVE:

This guideline is presented for mechanical engineers and others to be used in the design and renovation of facilities for Multnomah County. Engineering design fees and construction budgets shall consider the costs associated with employing these requirements. Deviations may be made from these requirements as long as the result provides a safe, adequate, quality design and approval is obtained from Multnomah County Planning and Development Technical Planning Branch. See related sections elsewhere; Control Sequences Guidelines, Boiler Design Guidelines, Chiller Design Guidelines, and HVAC System Design Guidelines. County Master Specifications are also available for application of the Siemens DDC.

A. **The following items should be addressed in all facilities whether leased or owned. Where practical apply the design parameters to existing systems to determine the extent of redesign necessary.**

1. HVAC system controls are designed such that simultaneous heating and cooling, reheating, and re-cooling are minimized.

2. Individual zone temperature conditions during occupancy are maintained within a heating/cooling range (initial setpoints, 68F heating/75F cooling) Zone temperature heating/cooling setpoints incorporate a dead band of 5 F degrees. County policy provides that no mechanical heating shall occur to satisfy room temperatures over 70 degrees or that mechanical cooling occur to satisfy room temperatures below 75 degrees.

3. Avoid shutting off air completely to isolated offices and conference rooms in occupied areas unless provisions are made to use occupancy sensors tied to the operation of fans or dampers that will respond immediately to fluctuating occupancy levels.

4. Final location of all devices shall be approved by Facilities and Property Management, Operations and Maintenance Division.

5. Final approval of all programming prior to installation in panels shall be approved by Facilities and Property Management, Operations and Maintenance Division.

6. Site operator stations may be required. Final determination shall be by Facilities and Property Management, Operations and Maintenance Division. The project shall provide all necessary hardware and software for the workstation in a room which is well lit and has adequate power.

7. Adequate time for training shall be provided for all new systems. A rule of thumb is 10 minutes/point.

8. Every Siemens BAS field panel will require a network drop on the county's secure network at each field panel location.

B. **The following items should be addressed in all new and remodeled facilities that are owned by the County and might be applicable to long-lease facilities, where instructed by the County. Not applicable to residential buildings, which should be equipped with a 7-day programmable thermostat. For County-owned retail tenant spaces, refer to Project Manager for deviations from the guideline.**

1. All central HVAC control systems shall be remotely adjustable from Facilities and Property Management main headquarters at 401 N. Dixon. No new pneumatic control systems are allowed.

C. **The following items should be considered to determine what kind of control system to use on projects:**

1. When the existing building operates using a Siemens system, all future controls in the building will be Siemens.
    a. ***Siemens***
    300 New Jersey Avenue
    Suite 1000
    Washington, D.C. 20001
    (800) 743-6367
    www.usa.siemens.com

2. All new large buildings with central air handling systems and hydronic systems distributed throughout the building shall use the most appropriate manufacture DDC Controls as determined by the mechanical engineer and Multnomah County Facilities Management.

D. **Refer to County Master Control Specifications for programming requirements. The following items should be addressed in all facilities where a DDC system is specified:**

1. All Packaged or split system DX HVAC units will be controlled via:

    a. If the location does not have Bacnet infrastructure available then terminal strip connection will be implemented. With Siemens TEC/DXR
    b. If the location has a Bacnet infrastructure then the Package HVAC units with factory controls that have HMI interface controllers included with the units can be connected via BACnet/IP or BACnet/MSTP, if the infrastructure at the location is available and we can easily bring in the View/writable points. The unbundled BACnet points that we expect to see will be discussed on a project by project basis, but will typically include the following standard:

        i. VFD- Supply/Return/Exhaust-Stpt-Actual-alarm-status
        ii. Sensors- DA-RA-RH%-MA
        iii. AQI- Temp- RH%-C02 - IAQ 2.5
        iv. Doas- Sensors on all 4 sides of the HX
        v. Air monitoring -supply and return
        vi. Cooling and Heating stages and status %
        vii. Economizer Stpt and actual

If the unit does not come from the factory with the above BACnet points then the control contractor will install additional sensors/points to meet the above requirements.

Telecom/Electric room HVAC systems will typically be stand alone with a local thermostat. If the mini split units can be integrated into the BAS then they should be, otherwise. We need a room sensor in the room for monitoring purposes that is tied into the county's Siemens BAS system. Integration will be discussed on a case by case basis and should be approved by the BAS/HVAC groups.

c. AHU's that are controlled by internal controllers shall have a terminal strip or sensors available for industry standard BAS inputs and outputs including, as relevant to the unit:

i. Fan start/stop or enable/disable (EMS digital out, DO).
ii. Fan proof of flow status (DI).
iii. Filter status (DI).
iv. Supply air temperature (AI).

2. All non-continuously operating air-handling systems with heating capability (in unit and/or at terminal units) shall have an optimal start /stop sequence.

3. Night purge, when available with the selected control system, shall be incorporated into the design.

4. All non-continuously operating fan systems shall have a night low limit sequence.

5. All non-continuously operating fan systems serving spaces whose temperatures might rise above 85 deg during unoccupied hours when the fans are not operating shall have a night high limit sequence, if available.

6. Economizer cooling shall be provided.

7. All heating, cooling, or heating and cooling air-handling systems that serve more than one zone shall be provided with discharge air temperature reset, if available.

8. All fan powered terminal boxes with reheat shall be equipped with discharge air temperature sensors.

9. All fan powered terminal boxes serving MIS, telecom and electrical rooms shall have a DI point for operational status.

10. Humidification and dehumidification control shall only be provided for single zone systems or zone-based systems.

11. Each terminal equipment controller shall be served by its own space and duct temperature sensor.

12. Identify areas that require HVAC occupant override. Generally, these are areas that will be subject to frequent after-hours operation or are temperature critical areas.

13. Provide freeze protection on all air handling systems with a maximum outside air percentage greater than 25% as well as all units with hydronic coils and outside air.

14. Smoke detection shall be provided per code, installed by the fire and life safety contractor.

E. **The following items should be addressed for the specific type of HVAC system proposed. Refer to County Master Control Specifications for programming requirements:**

1. The detailed location for each OSA temperature sensor shall be defined by the Designer and the one that will be used for algorithms and fan systems shall be identified.
    a. Large buildings where the OSAT is to be used as a global point for more than one algorithm shall have two (2) outdoor air temperature sensors.
    b. An OSA sensor will be installed in each panel using OSA temperature in algorithms for equipment control.

2. When boiler staging is controlled by packaged boiler controls, then all output signals and alarms from the packaged boiler controls shall be accessible to the DDC system. In this case, primary heating water (HW) pumps will be controlled directly by the boiler control unit or by the DDC system, as a function of the signals from the boiler control unit. The intent of this is that the boiler and primary HW pump controls be coordinated. When optimal stop is utilized, the pump is controlled by the DDC system. Interface protocol to be determined by the County. Interface points to be used for monitoring only, not in BAS control sequence. Boiler controls / sequencers will have physical connection to BAS System. Start / Stop, alarms, setpoint, boiler pumps to be controlled by boiler. Loop pumps to be controlled by BAS system.

3. Built-up air handling units (generally >75 tons) shall have the following minimum points:

    a. Fan start/stop or enable/disable (DO).
    b. Fan proof of flow status (DI).
    c. Filter high differential pressure status (DI).
    d. Heating (1 or more DOs or AO).
    e. Cooling (1 or more DOs or AO).
    f. Discharge air temperature (AI).
    g. Mixed air temperature (AI).
    h. OSA damper minimum enable (DO).
    i. OSA damper modulation (DO).
    j. Fire/smoke alarm (DI).
    k. Supply air pressure setpoint or fan speed signal (AO) (VAV systems).

4. Minimum points required for control of VFDs on built-up air handling units are:

    a. Start Stop (DO).
    b. Fan Speed or Hertz (AO).
        (1) Minimum flow condition when the fan is off, ramping up gradually to required flows.

c. Fan Proof (amperage) (AI).
d. Fault (DI).

5. VFD Supply fan volume shall be controlled to maintain the duct static pressure setpoint. High limit/low limit conditions will shut down fans and register an alarm. Static pressure control per County Master Specifications for Siemens. VFD shall utilize native P1 and P2 communication protocol.

6. VFD Return/Relief fan volume shall be controlled by building static pressure. Differential static pressure setpoint typically will be between 0.015" and 0.05" W.G. building static pressure control.

7. VFD Return/Relief fan volume shall be controlled by speed tracking.

8. If a Mechanical Contractor(s), under the Engineers direction, elects to use or is required to use packaged equipment with self-contained controls, it shall be the responsibility of the Control Contractor to coordinate the interface of the DDC System with the Engineers or Mechanical Contractor's packaged equipment. This coordination shall be in advance of project bid date to insure compatibility and further ensure cost of required equipment and software development is included in the Control Contractor's bid.

F. Graphic Requirements for DDC Projects.

1. The main page for the building should have the features listed:
   a. Should have the County title bar with the building name.
   b. OSA temp.
   c. All major equipment status and supply temp "AHU's, chillers, boilers, etc."
   d. If there are more than one floor in a building. A graphical side view of the building with links for each floor.
   e. All equipment shown should have a link to the page for that equipment. By clicking the mouse over the picture or the name of the equipment.
   f. For chillers and boilers, show supply and return temps and equipment alarms.

2. Graphics for each floor in a building should have the features listed:
   a. The floor plan should be from the Revit model, if one is provided by M.C.
   b. Room numbers should be on the floor plan for each floor.
   c. The floor should show locations of room sensors, and HVAC equipment.
   d. The floor should be broken up with different color areas to show each HVAC zone.
   e. The HVAC equipment like VAV boxes should show box name, room number, and space temp. The points that are shown for each VAV …etc. should allow the user to drag and drop for the floor plan to the default graphic for that application number.
   f. The points used for TEC room temps should be the sub-points not manually un-bundled points created by the staff or Siemens Building Technologies
   g. Each floor drawing should have a way to go between floors with links.
   h. Each floor should have an OSA temp point.
   i. Each floor should have a link to the air handler that supplies that floor or area

3. All points that are alarmable should have a graphic associated with them. This will allow drag and drop features from the alarm screen.

4. Graphics for major equipment should use “green” for “on” and “blue” for “off’. All pumps, fans, chillers, etc… should have some part of the drawing associated with the command point to show the state colors.

5. All graphics should have links to the main page for the building. And any needed links like “chiller page” also should have links to needed “pump pages” and “cooling towers.”

6. All graphics should have the County title bar at the top with building name and the background color be Micrographic designer color RGB 0 128 128.

G. Building Specifications for New Installations

1. All graphics shall meet the standards listed above “Graphic Requirements for DDC Projects”

2. All point meet new standard of building number then point. Example “B119.A02EE”

3. All TEC’s meet new standards for building number then TEC number, example “B119.01010”

4. All TEC point shall be the auto-unbundled points no manually unbundled points are allowed.

5. All default user accounts must be changed to County standard when the site is connected to the server. This will be for County administrators use only. Each Contractor or user must have a separate login at the field panel.

6. All scheduling of equipment, start/stop and optimization will be done through Scheduler no PPCI calculations to control the Start/stop and Optimization.

7. All new county networks will have a BLN speed of 38,400 baud. Siemens Spec wire for install.

8. All TEC’s shall have a discharge air sensor installed on each box.

EXHIBIT E2: CONTROL SEQUENCE DESIGN GUIDELINE

GENERAL NARRATIVE:

All HVAC system controls shall be designed such that simultaneous heating and cooling, reheating, and re-cooling are minimized. This applies as well to non-mechanical treatment of mixed air (e.g. outside air, heat recovery, etc.) which must then be mechanically reheated or re-cooled.

A. General Controls

1. When several pieces of equipment (or different operational modes of one piece of equipment) must operate in an integrated way, they shall not be controlled from individual setpoints or by non-integrated controllers. For example, in a boiler plant, the heating water pumps and the boilers should be interlocked by either hardware or software, rather than enabling each by its own outside air setpoint.
2. Alarms: Except as directed otherwise by the County, all alarms will be registered at the building operator's terminal as well as at the Robert W. Blanchard Education Service Center (401 N. Dixon Street, Portland Oregon 97227-1865) remote operator's station. Alarms are to be registered with a message explaining the nature of the alarm and which building the alarm is in.
3. A minimum of two outdoor air temperature sensors shall be installed in any building where the outdoor air temperature is to be used as a global point for more than one algorithm. The designer will define the detailed location for each OSA temperature sensor, and will direct which sensor signal, or average, will be used for which algorithms and fan systems.
4. If microclimate conditions can be expected to affect various HVAC systems in the building differently, consider additional outdoor air temperature sensors at appropriate locations.
5. Whenever a setpoint is referred to as "adjustable" in these standards, the setpoint is to be easily and directly adjustable at the operator's terminal and Blanchard Building remote operator's station, and is not to require any code modification. In general, this will require assigning virtual points to all adjustable setpoints. Frequently adjusted points, including space temperature setpoints, shall be adjustable from the graphics screen.
6. Use averaging sensors for mixed air temperature, multi-zone hot and cold deck temperatures, and other situations where stratification of more than 2 F degrees across the duct section is likely. For multi-zone hot and cold deck temperatures, if spatial conditions do not permit use of an averaging sensor, use two single point sensors in different plenum locations, and average the two signals.
7. Programmable time-of-day (start/stop) control shall be implemented for all HVAC equipment, except for:
    a. Equipment that is interlocked with other equipment under direct start/stop control (e.g. exhaust fans interlocked with an air handling unit)
    b. Equipment that must run continuously for reasons of safety
    c. As otherwise noted in these standards

B. Air Handling Systems

1. *Packaged Air Handling Unit EMS interfaces*

a. If packaged air handling units are controlled by internal controllers, then the Designer will consider, with County input, the advisability of having all internal controller inputs and outputs accessible and controllable at the DDC system operator's terminal and at the Blanchard Building remote operator's station via a gateway or similar interface. In general, such an interface may be advisable if the project has at least 3 air handling units with internal controllers, or if 2 or more such air handling units exceed 60 tons in combined total cooling capacity. Analysis shall consider energy, operation, maintenance, and installed interface equipment costs. BACnet communications according to ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008. Native communication protocol must be Siemens Apogee P1 or P2. Communication Drivers and Gateways are not allowed.

b. If the Designer determines that the expense of a gateway is not warranted, air handling units with internal controllers shall have a terminal strip available for industry standard EMS inputs and outputs including:

c.
(1) AHU start/stop (DO)
(2) occupied/unoccupied mode (BO)
(3) occupied/unoccupied mode (DI)
(4) zone cooling setpoint (AO)
(5) zone heating setpoint (AO)
(6) supply air pressure setpoint (AO)
(7) dirty filter (DI)
(8) supply fan failure (DI)
(9) refrigeration failure (DI)
(10) heating failure (DI)

d. The Designer shall ensure that any control sequences that are not standard to the internally controlled packaged air handling unit will be achievable with the points that are available to the EMS.

2. ***Supply Fan Volume Control (Variable Air Volume Systems)***

a. This section applies to supply fans that are modulated by variable frequency drives (VFD), inlet vanes, variable pitch blades or vanes, inlet cones, and other such fan control devices.
b. With all modes of control, the fan control devices shall move to the minimum flow condition when the fan is off, and shall ramp up gradually to required flows.
c. Duct static pressure high limit control is required in all systems where a potential for over-pressurization of ductwork exists. High limit conditions will shut down the fan and register an alarm.
d. Select one of the following modes of control:
(1) Static Pressure Control: Supply fan volume is controlled to maintain the duct static pressure at setpoint, as sensed at a static pressure sensor(s) located at 75% to 100% of the distance from the first to the most remote terminal. Static pressure setpoint shall be determined by the air test and balance agency such that at that static pressure the damper serving the zone with the greatest cooling load is between 90% and 98% open at the same time that the majority of other zones are under a moderate to heavy cooling load (a load roughly equal in magnitude to the design building cooling diversity).
(a) Static pressure reset should also be considered for large fan systems. This involves resetting the duct static pressure setpoint as a function of duct velocity.
(b) The duct static pressure shall be the average of the values from two sensors located close together. If the differential between the two sensors is greater than 0.3”, an alarm will be registered.
(2) Control as Function of Damper Position: Supply fan volume is controlled such that the primary air damper serving the zone with the greatest cooling load is 95% open. Note that, though this sequence theoretically gives very efficient fan control, in practice it may be very difficult to tune to avoid excessive fan and damper hunting.

3. ***Return / Relief Fan Volume Control (Variable Volume Systems)***
   a. This section applies to return and relief fans with variable frequency drives (VFD), inlet vanes, variable pitch blades or vanes, inlet cones, and so forth.
   b. With all modes of control, the fan control devices shall move to the minimum flow condition when the fan is off, and shall ramp up gradually to required flows.
   c. All building spaces shall be at a positive pressure relative to the outside. In addition, there may be requirements for pressurization of spaces relative to each other.
   d. Select one of the following modes of control:

      (1) Building Static Pressure Control: Return or relief fan volume is controlled such that the static pressure of a reference space (typical zone or zone of greatest occupancy) is maintained at a certain setpoint relative to outside air. Differential static pressure setpoint typically will be between 0.015" and 0.05" W.G. (initial setpoint, 0.02"). The location of the indoor measurement shall be remote from doors and openings to the outside, away from elevator lobbies, and shielded from air velocity effects. The outdoor measurement location should be 10 to 15 feet above the building and oriented to minimize wind effects from all directions. During warm-up mode, the building static pressure is reset to zero, and all relief and exhaust fans shall be off.
      (2) Airflow Tracking: A constant CFM or % differential is maintained between the supply and return air streams. Flow stations in the two streams, consisting of multi-point averaging pitot arrays, provide the input for this control. During warm-up mode, the return airflow is reset equal to the supply airflow, and all relief and exhaust fans shall be off.

C. Fan Enable / Optimal Start Control

1. All non-continuously operating air handling systems with heating capability (in unit and/or at terminal units) shall have this sequence.
2. The intent of this sequence is that the air handling system be started early enough that, at maximum fan speed and maximum heating output, all spaces served reach an occupied heating setpoint no more than 30 minutes prior to or 10 minutes after scheduled occupancy.
3. Air handling systems may be started under the optimal start mode no more than 3 hours prior to scheduled occupancy.
4. Air handling systems will be started as a function of outdoor air temperature, greatest negative differential between space temperature and occupied heating setpoint, calculated maximum rate of space temperature rise, and time until start of scheduled occupancy. This sequence will be locked out when the 3 hour rolling average outdoor air temperature is greater than setpoint (initial setpoint, 50˚F, adjustable).
5. The calculated rate of space temperature rise will be modified each day when the optimal start mode ends such that the next day's rate of rise is increased or decreased as a function of by how much earlier than 30 minutes prior to scheduled occupancy or later than 10 minutes after scheduled occupancy all spaces reached occupied heating setpoint.
6. The controls contractor will initialize and fine tune the optimal start algorithm as required to meet the operational intent.
7. When the system is in optimal start mode, the mixed air dampers will be in full recirculation and the supply volume (for variable volume systems) will be limited to the return volume. Mechanical cooling is disabled, except as stages

subsequent to economizer cooling if required to lower space temperature to occupied cooling setpoint.

8. When the return air temperature is greater than the occupied heating setpoint (initial setpoint, 68°F, adjustable), the optimal start mode will end and occupied mode will start.
9. In addition, a more complex sequence for optimal start of cooling equipment should be considered for buildings with significant cooling energy expenditure. Such a sequence must be “adaptive” or “anticipatory” (i.e. be self-tuning, based on previous 1 to 2 days building response), and should optimize economizer operation, mixed air temperature, and chilled water plant startup. This sequence should be locked out when the 3 hour rolling average outdoor air temperature during the scheduled unoccupied mode is less than setpoint (initial setpoint, 50°F, adjustable).
10. The building operator will be able to command start of occupancy at the operator’s terminal and at the Blanchard Building remote operator’s station (overriding the optimal start sequence) for each individual air handling system and globally for all air handling systems in the building. All points in operator priority will register as alarms.

D. Night Purge

1. This is a relatively complex control mode in which building spaces are cooled down by outside air. This sequence should be considered for buildings with large internal loads, in which a significant portion of the building mass is in thermal contact with the air stream, and in which mechanical cooling would be typically required within the first several hours of occupancy during the cooling season.
2. This mode will be enabled when the average space temperature during the unoccupied mode is above the occupied cooling setpoint, and the outside air temperature is greater than setpoint (initial setpoint, 40°F, adjustable), and the outside air temperature is at least 10 F degrees (adjustable) less than the average space temperature, and the time is within 3 hours (adjustable) of scheduled occupancy.
3. The interior space night purge setpoint (temperature to which the space will be cooled by night purge) will be adjustable, set initially to the midpoint of the heating/cooling deadband. No space shall be cooled below a temperature at which heating will be required, either in the occupied or warm-up modes.
4. When this mode is enabled, the mixed air dampers modulate to maintain the mixed air temperature at setpoint (initial setpoint, 50°F, adjustable). Heating and mechanical cooling are disabled.
5. If the fans that serve the purged spaces are equipped with VFD (or other means of volume control), the speed should be reduced in this mode to the speed that provides the optimal balance between fan electrical consumption and adequate heat transfer between the building mass and the air stream. The Designer will provide the initial setpoints for night purge fan speeds.

E. Night Low Limit

1. All non-continuously operating fan systems shall have this sequence.
2. Single zone systems: During the unoccupied mode, when the space temperature falls below the low limit (initial setpoint, 60°F, adjustable), the system supply and return fans will start, outside air and exhaust dampers will be closed, and heating will stage on as required to maintain the discharge air temperature at setpoint until the space is raised above setpoint plus differential. If heating stages are controlled as a function of discharge air temperature setpoint, the setpoint shall be reset up during this mode.

3. Multiple zone systems: During the unoccupied mode, when any space temperature falls below the low limit setpoint, the system supply and return fans will start, outside air and exhaust dampers will be closed, and heating will stage on as required to maintain the discharge air temperature at setpoint until all spaces are raised above setpoint plus differential.
4. Warming of spaces that are below setpoint may be accomplished by terminal unit or zone reheat coils instead of by a raised discharge air temperature, but the AHU discharge air temperature setpoint shall not be lower than the return air temperature during this mode. If warming of spaces that are below setpoint is to be accomplished by terminal unit reheat coils, it is preferable that the terminal unit primary air dampers be placed in reverse acting mode during night low limit operation.
5. When all spaces served by the system are above setpoint plus differential (initial setpoints, 60°F adjustable, with 5 F degree differential), the system will revert to the unoccupied mode.

F. Night High Limit

1. All non-continuously operating fan systems serving spaces whose temperatures might rise above 85°F during hours when the fans are not operating shall have this sequence.
2. Mechanical cooling is enabled as the final stage(s) of cooling during this sequence if the space temperatures are not less than the respective occupied setpoints plus differential one hour (adjustable) prior to scheduled occupancy.
3. Single zone systems: During the unoccupied mode, if the space temperature rises above the high limit (initial setpoint, 85°F, adjustable), and if the outdoor air temperature is less than the space high limit setpoint, the system supply and return fans will start, the outside air, return, and exhaust dampers will modulate to maintain the mixed air temperature at setpoint (initial setpoint, 55°F, adjustable), and mechanical cooling will stage on until the space temperature is lowered below setpoint minus differential. (See above requirements for mechanical cooling during night high limit mode.)
4. Multiple zone systems: During the unoccupied mode, when any space temperature rises above the high limit setpoint (initial setpoint, 85°F, adjustable), the system supply and return fans will start, the outside air, return, and exhaust dampers will modulate to maintain the mixed air temperature at setpoint (initial setpoint, 55°F, adjustable), and mechanical cooling will stage on until the out-of-limit space temperature(s) is lowered below setpoint minus differential. (See above requirements for mechanical cooling during night high limit mode.)
5. When all spaces served by the system are below setpoint minus differential (initial setpoints, 85°F adjustable, with 5 F degree differential), the system will revert to the unoccupied mode.

G. Economizers (Air-side)

1. All air handling units that cool by mechanical cooling shall be equipped with air-side economizers, with exceptions as allowed by the Oregon Energy Conservation Code. Economizer operation shall be integrated with mechanical cooling (i.e. able to share load with mechanical cooling) except as allowed by code.
2. Outside air dampers will remain closed when the air handling unit supply fan is off. During normal occupied operation and during night high limit operation, if there is a call for cooling from any served zone and if the outside air temperature is less than the return air temperature, the outside air, return air, and exhaust air

dampers modulate as a coordinated set to maintain the mixed air temperature at setpoint.

3. If the outside air temperature is greater than the return air temperature, the outside air damper will go to minimum position, as required for ventilation. Designer shall communicate to controls contractor required minimum position for each air handling unit, as well as minimum primary air damper position for VAV terminal units.
4. For single zone systems, the mixed air temperature setpoint will be fixed (initial setpoint, 55˚F, adjustable, or per packaged unit manufacturer).
5. For variable volume, multi-zone, dual duct, and other multiple zone systems, the mixed air temperature setpoint will be reset as a function of the highest zone cooling load. If no zone has a cooling load, and at least one zone has a heating load, the mixed air temperature setpoint will be reset up to a maximum (initial setpoint, 65°F, adjustable). The highest zone cooling load will be determined by the DDC system highest zone cooling signal, position of the most open primary air damper, position of the most open zone cooling coil valve, or similar indicator of true load. Zone temperature is not an indicator of true load, by itself.

H. Discharge Air Temperature Reset

1. A variation of this sequence will be used for all heating, cooling, or heating and cooling air handling systems that serve more than one zone.
2. Single Duct Variable Air Volume Systems:
   a. The discharge air temperature will be reset as an average of the cooling loads of representative and critical zones. The designer, controls contractor, and test and balance contractor will coordinate to identify terminal units from representative and critical (but not “wild”) building zones. For each system, at least 4 such terminal units (or all, whichever is less) should be identified.
   b. Zone cooling load will be determined by the DDC system zone cooling signal, positive deviation of space temperature above setpoint, position of the primary air damper, position of the zone cooling coil valve, or similar indicator of true load. Zone temperature is not an indicator of true load, by itself.
   c. If there are “wild” zones, i.e. zones that almost always require full primary air flow, the design and test and balance for these zones should be reconsidered.
   d. The minimum value of the discharge air temperature reset will be initially set to between 50 and 55˚F at a maximum average sample zone cooling signal (average of the selected representative / critical zones). The maximum value will be initially set to between 65 and 70˚F at a zero average sample zone cooling signal.
   e. Systems that serve zones with dissimilar cooling and heating loads, and that have terminal units with no means of zonal reheat (e.g. variable volume / variable temperature systems) are generally not acceptable.

3. **Dual Duct and Multi Zone Systems**:
   a. For chiller plants greater than 500 tons total capacity, designer will analyze whether optimization of the total of the chiller power and CHW-supplied fan system power is warranted. In general, if the fan system power is less than 25% of the chiller power, optimization sequences are not required and the following sequences will be used.
   b. The cold deck temperature will be reset as an average of the cooling loads of representative and critical zones. The designer, controls contractor, and test and balance contractor will coordinate to identify representative and critical

(but not “wild”) building zones. For each system, at least 4 such zones (or all, whichever is less) should be identified. It is also acceptable, and in some cases (where there is one or more critical zones) preferable, to use a single highest critical zone cooling load instead of an average of sample zone cooling loads.

c. Zone cooling load will be determined by the DDC system zone cooling signal, positive deviation of space temperature above setpoint, position of zone cold deck damper, or similar indicator of true load. Zone temperature is not an indicator of true load, by itself.
d. If there are “wild” zones, i.e. zones that almost always require full cold deck flow, the design and test and balance for these zones should be reconsidered.
e. The minimum value of the cold deck temperature reset will be initially set to between 50 and 55˚F at a maximum average sample zone cooling signal (average of the selected representative / critical zones). The maximum value will be initially set to between 65 and 70˚F at a zero average sample zone cooling signal.
f. The hot deck temperature will be reset as an average of the heating loads of representative and critical zones. The designer, controls contractor, and test and balance contractor will coordinate to identify representative and critical (but not “wild”) building zones. For each system, at least 4 such zones (or all, whichever is less) should be identified. It is also acceptable, and in some cases (where there is one or more critical zones) preferable, to use a single highest critical zone heating load instead of an average of sample zone heating loads.
g. The maximum value of the hot deck temperature reset will be initially set to between 95 and 110˚F at a maximum average sample zone heating signal (average of the selected representative / critical zones). The minimum value will be initially set to between 65 and 75˚F at a zero sample zone heating signal.
h. For systems with a neutral deck, the neutral deck temperature will be reset according to the economizer sequence for multiple zone systems.

4. **Humidity Control**:
   a. This section does not apply to the uncontrolled dehumidification that may result from temperature-controlled cooling.
   b. Humidification and dehumidification equipment and sequences will be applied only in cases where equipment or processes require controlled relative humidities (e.g. computer rooms, certain medical occupancies, laboratories) and in cases where internal loads may cause unsatisfactory conditions (e.g. swimming pools).
   c. Humidification will be achieved downstream of any cooling coils.
   d. If direct evaporative cooling is used, it will be controlled such that it does not result in a requirement for mechanical cooling dehumidification. Outdoor dew point temperature and space dew point temperature setpoint may be used for this control.
   e. Humidification and dehumidification should generally not be applied in systems that serve multiple zones with widely varying humidity requirements. Single zone systems or zone based humidifiers should be considered in these cases.
   f. Humidification and dehumidification equipment will be interlocked with the air handling systems supplying the respective zones.

g. Humidifier output will be modulated to maintain the zone humidistat or humidity sensor above setpoint ± differential. A duct high limit sensor will limit duct relative humidity to less than 90% (adjustable).
h. Heat recovery should be considered for systems with significant dehumidification requirements

5. **Zone Control**:
   a. Individual zone temperature conditions during occupancy will be maintained within a heating/cooling range (initial setpoints, 68˚F heating / 73˚F cooling, unless otherwise instructed by County). Zone temperature heating/cooling setpoints will incorporate a deadband of 5 F degrees, unless otherwise instructed by County. Setpoints will be easily adjustable at both the operator's terminal and at the Blanchard Building remote operator's station.

   b. Room sensors will not be adjustable by occupants and will not have temperature displays, unless the Designer is directed otherwise by the County.
   c. Each and every terminal equipment controller (TEC) shall be served by its own space temperature sensor. All TEC points shall be accessible at the space sensor via a portable terminal or notebook computer.

   d. **Single Duct VAV Systems**:
      i. Acceptable VAV terminal unit types include: throttling, series fan-powered, and parallel fan-powered. Any of the VAV terminal unit types may be supplied with or without reheat coils.
      ii. During the scheduled unoccupied mode, primary air dampers will be closed.
      iii. During warm-up, if the air handling system is equipped with a non-electric heating source and the reheat coils are electric, primary air dampers will be in reverse-action mode to maximize heating by the non-electric heating source.
      iv. During scheduled occupancy and night high or low limit operation, primary air dampers will modulate between a minimum position for no cooling to full open for a maximum cooling signal, to maintain the zone below the cooling setpoint. Upon a call for heating, the primary air dampers will modulate to the heating position and terminal unit fans and heating coils (where relevant) will sequence on to maintain the zone above the heating setpoint.
      v. Minimum primary air damper position will be determined by the designer and will be the volume required for ventilation per ASHRAE Standard 62-1989.
      vi. Reheat primary air damper position will be determined by the designer and will be no larger than the largest of: 1) 30% of the maximum position, 2) the volume required for ventilation per current ASHRAE Standard, or 3) 0.4 CFM/ft^2.

   e. **Dual Duct VAV Systems**:
      i. During scheduled occupancy and night high limit operation, if there is a cooling load the cold deck damper will modulate between a minimum position for no cooling to full open for a maximum cooling signal, to maintain the zone below the cooling setpoint. The hot deck damper will be fully closed in this condition.

ii. Upon a call for heating, the hot deck damper will modulate between a minimum position for no heating to full open for a maximum heating signal, to maintain the zone above the heating setpoint. The cold deck damper will be fully closed in this condition.

6. **Occupant Override**:
   a. The Designer shall, with input from the County, identify those zones that require HVAC occupant override due to frequent or critical after-hours occupancy. The Designer shall also define the initial override time period for each such zone.
   b. For systems that are to be provided with occupant override control, each normally occupied zone shall be equipped with an occupant override button located at the zone temperature sensor. If available, an LED on the sensor shall indicate when the system is in override mode.
   c. When the air handling unit is in the unoccupied mode, pushing the override button will place the air handling unit, and terminal units served by sensors whose overrides have been pushed, in the occupied mode for the programmed duration (initial setpoint, 60 minutes, adjustable, with a maximum setpoint limit of 4 hours). At the end of the override period, the system will revert to the scheduled mode in effect at that time.

7. **System Safeties**:
   a. **Freeze Protection**:
      i. This sequence is required for all air handling units with maximum outside air percentages greater than 25% as well as all units with hydronic coils and any provision for outside air.

ii. The freeze stat shall utilize an averaging element type sensor where any 12 inch (or less) element that senses a temperature below setpoint causes actuation of the freeze protection mode. The sensor is typically to be located downstream of the heating coil, though dual duct systems and dehumidification / reheat systems may prompt other arrangements. If there is a cooling coil upstream of a heating coil, locate the freeze stat at the cooling coil.
iii. When the air stream temperature falls below the freeze protection setpoint (initial setpoint, 38˚F, adjustable), all fans in the air handling unit will stop, the mixing dampers go to the full recirculation position, all hydronic coil valves go to full coil flow, and an alarm will be registered. The freeze stat shall require manual reset before air handling unit operation can resume.

b. **Smoke Detection**:
i. Smoke detectors will be located in the supply and return duct sections as required by code. Smoke detectors will be installed by the fire and life safety contractor.
ii. Smoke detectors will cause shutdown of their respective fans upon detection of smoke, and an alarm will be registered at the operator's terminal.
iii. The system will return to normal operation when the alarm is cleared at the operator's terminal or fire panel.

c. **High / Low Static Pressure Shutdown**:
i. All air handling units with downstream dampers (upstream dampers for return duct), including fire dampers, and capable of generating static pressures in excess of the rated duct construction allowance at zero flow will be equipped with static pressure sensors.
ii. For variable volume air handling units, when the discharge duct static pressure sensor senses a static pressure more than 1" greater than the design static pressure (or 75% of the rated duct pressure if that is less than design static plus 1"), the supply fan volume control will be overridden to limit the static pressure to the rated duct pressure. Similarly, when the return duct static pressure sensor senses a static pressure more than 1" less than the rated duct negative pressure, the return fan volume control will be overridden to limit the static pressure to the rated duct pressure.
iii. When the discharge duct or return duct static pressure exceeds the respective rated duct pressure for more than 5 seconds, the supply and return fans will be shut down, and an alarm will be registered. The high limit will require manual reset before operation can resume. The low limit (return duct) will require operator alarm acknowledgment before operation can resume.

d. **High Air Filter Pressure Drop**:
i. For all air handling units with filters and air volumes greater than 5000 CFM, a differential pressure switch located across each filter bank will register an alarm at the operator's terminal whenever the differential pressure exceeds setpoint (initial setpoint, 0.5", or as recommended by filter manufacturer, adjustable).
ii. Facilities will calibrate differential pressure switch.

iii. Alarm is reset by the operator at the terminal.

I. Chilled Water System Control:

1. **EMS interfaces**. (Note that relevant information in this interface section must be included in the specification section for chillers.)
   a. If chillers are controlled by internal controllers, then the Designer will consider, with County input, the advisability of having all internal controller inputs and outputs accessible and controllable at the DDC system operator's terminal and at the Blanchard Building remote operator's station via a gateway or similar interface. In general, such an interface will be advisable if the project has at least 100 tons of chiller capacity. Analysis shall consider energy, operation, maintenance, and installed interface equipment costs.
   b. If the Designer determines that the expense of a gateway is not warranted, each chiller shall have a terminal strip available for industry standard EMS inputs and outputs including:
      i. Chiller start/stop (EMS binary out)
      ii. Chilled water supply setpoint (AO)
      iii. Chiller failure (BI)

2. **Chiller Water System Start/Stop Control**:
   a. All chilled water system equipment shall be off during times when all served units are scheduled as unoccupied, unless any system is in the Night High Limit mode and mechanical cooling is required per the Night High Limit sequence.
   b. When any unit served by the chilled water system is on and is calling for cooling, and when the outside air temperature is above setpoint (initial setpoint, 55˚F, adjustable), a time counter is started. After 15 minutes (adjustable) of both conditions being true, the lead primary chilled water pump(s), the lead secondary chilled water pump(s) if applicable, and the lead condenser water pump(s) are started. Absence of any of these conditions for 15 minutes will cause all chilled water system pumps to be turned off.
   c. When pump flow is proven, and any 2 cooling coils are open to 50% or greater, the lead chiller is started.
   d. When the chilled water return temperature (primary, common header, as applicable) is less than the chilled water supply temperature (primary loop, common header) plus the set differential (initial setpoint, 3 F degrees, adjustable) for 5 minutes, the lead chiller is turned off. Minimum chiller run-time shall be per manufacturer's requirements.
   e. Cooling tower is enabled when the lead chiller is on. Select the lead tower optimally for the lead chiller.

3. **Chilled Water Reset**:
   a. **Primary Chilled Water Systems**:
      i. Primary chilled water supply temperature will be reset as a function of the cooling load. The designer, controls contractor, and test and balance contractor will coordinate to identify chilled water valves from representative and critical (but not "wild") building zones and fan systems. At least 4 such valves (or all chilled water valves, whichever is less) should be identified.
      ii. If there are "wild" zones, i.e. zones that almost always require full chilled water flow, the design and test and balance for these zones should be reconsidered.

iii. On startup of the chiller, the initial chilled water supply temperature setpoint will be the midpoint between the upper and lower reset limits.
iv. If none of the representative/critical valves are fully open, the chilled water supply temperature (CHWST) is reset upwards by increments with time delays between adjustments to allow for system stabilization. The increments and time delays must be tuned for the specific system, though 2 F degree increments at 10 minute intervals can be used as initial settings.
v. If one of the representative/critical valves is fully open, no resetting is done.
vi. If two or more of the representative/critical valves are fully open, the CHWST is reset downward by increments with time delays between adjustments.
vii. **Optional methods of reset**:
1. As a function of chilled water supply and return temperature differential.
2. The reset table upper and lower limits will be a function of system characteristics. The designer will recommend a reset schedule. The upper reset limit should be as high as possible, while meeting cooling loads. In general, for chilled water coils in fan systems with discharge air temperature reset, the upper reset limit should be approximately 12-15 F degrees (design differential between the coil entering chilled water temperature and the coil leaving air temperature, plus 3 to 5 F degrees) less than the lowest upper DAT reset limit of all served fan systems. Example: If the coil design is for 44°F entering CHW and 55°F leaving air temperatures (design differential of 11 F degrees), and if there are 3 fan systems with discharge air temperature reset as high as 63°F, 65°F, and 65°F respectively, then the upper reset limit for the CHW would be 63°F - 11 F degrees - 3 F degrees = 49°F. The lower reset limit would be 44°F.

b. **Primary/Secondary Chilled Water Systems**:
i. For chiller plants greater than 500 tons total capacity, designer will analyze whether optimization of the total of the chiller and secondary pump power is warranted. In general, if the secondary pump power is less than 15% of the chiller power, optimization sequences are not required.
ii. For chiller plants less than 500 tons total capacity or for any chiller plant in which the secondary pump power is less than 15% of the chiller power, the primary chilled water temperature can be reset in the same way as with primary-only chilled water systems, as a strict function of cooling load.

4. **Chiller Staging / Capacity Control**:
a. Multiple chillers, and their respective primary chilled water and condenser water pumps, will be staged on as a time function of the secondary loop flow, where applicable. (See secondary chilled water pump speed control for criteria on when secondary pumping systems are recommended. Most multiple chiller and even most single chiller systems will have variable volume secondary pumps.) In general, chillers are to be staged “ON” when the secondary loop flow exceeds 95% of the rated evaporator flow of the previously staged chiller for 5 minutes. Each chiller is to be staged off when the secondary loop flow is less than 90% of the rated evaporator flow of the previously staged chiller for 5 minutes. Minimum chiller run-time shall be per manufacturer’s requirements.

b. Control of chiller staging by power input, leaving chilled water temperature, or reverse flow in the secondary loop bypass are not acceptable.
c. For chiller plants greater than 500 tons in total capacity, designers will perform an analysis to ensure that chillers will be staged on such that, insofar as possible, chillers will run at their points of maximum efficiency. With many manufacturers, this will be at 50% load or less. Thus, it may be appropriate to stage on a second chiller when the first chiller is only operating at 50% load, then stage on a third chiller, then increase the loading on each chiller, and so forth. Differences in full load and part load efficiencies among the different chillers shall also be considered. Pump and tower energy consumption must also be considered in this analysis.

5. **Tower Staging / Capacity Control**:
   a. Tower stages (dampers, spray pumps, fan speeds, multiple towers, as applicable) will be sequentially staged on and off to maintain the common header tower leaving water temperature (ECWT) at the greater of minimum setpoint or ambient wet bulb temperature plus tower design approach.
      i. The minimum setpoint will correspond to the chiller manufacturer's minimum allowable condensing water temperature.
      ii. The ambient wet bulb temperature may be determined either with a wet bulb sensor or with a combination of dry bulb and relative humidity sensors, using software psychrometric calculations.
   b. When the lead tower is operating at minimum capacity, a tower bypass valve will modulate as required to maintain the common header tower leaving water temperature above the minimum setpoint, but below the minimum setpoint plus differential (initial setpoint, 2 F degrees, adjustable).
   c. During freezing weather, when the tower is on, the bypass valve will be operated as a two-position valve.

6. **Lead / Lag Control**:
   a. If the chiller plant includes two or more chillers of unequal operating efficiencies, the most efficient chiller for the given conditions will normally be selected as the lead.
   b. The operator can command any chiller, tower, and pumps to the lead and subsequent lag positions.
   c. Under automatic control, the DDC system will determine the lead and subsequent lag chillers and towers based on totalized run time of any unit over the setpoint number of hours (initial setpoint, 100 hours, adjustable) more than any other unit.
   d. For primary and secondary pumps, the DDC system will register an alarm at the operator's terminal when the respective lead pump has a totalized run time more than the setpoint number of hours (initial setpoint, 4000 hours, adjustable) more than the lag pump(s). Switching lead and lag pumps will be manual only.

7. **Secondary Chilled Water Pump Speed Control**:
   a. The designer shall consider secondary chilled water pumping systems for all situations where the total chiller plant capacity is greater than 50 tons, where any cooling coils are not close to the chiller, and where there is sufficient load diversity that the chiller plant can be expected to operate at less than 80% capacity more than 25% of the time.
   b. All secondary pumps shall be of identical capacity and head. Each such pump shall be controlled by an individual VFD. When 2 or more secondary pumps are running, they shall run at the same speed (within ±1% of each other).

c. With or without secondary pumps, evaporator flow shall be constant unless otherwise approved by the chiller manufacturer.
d. Static pressure sensing for secondary pump speed control will be by end-of-run differential pressure.
e. The lead secondary pump speed will be modulated between minimum speed (initial setpoint, 20%, adjustable, or minimum acceptable to motor manufacturer) and an upper staging limit (adjustable), to maintain the end-of-run differential pressure at setpoint. The upper staging limit is to be selected by the engineer for optimum system wire-to-water efficiency. Generally, this setpoint will be between 50% and 70% speed, depending on pump capacities, number of secondary pumps, system head characteristic, etc.
f. The differential pressure setpoint will be determined by the test and balance agency such that the 2-way valve serving the cooling coil with the greatest load is between 90% and 98% open at the same time that the majority of other cooling coils are under a moderate to heavy cooling load (a load roughly equal in magnitude to the design building cooling diversity).
g. If the lead pump is operating at greater than the upper staging setpoint for at least 5 minutes, and the end-of-run differential pressure is below the setpoint minus an adjustable differential (initial differential, 2 psi), then the lag pump shall be started and its speed ramped up. Both pumps will run at the same speed, as required to maintain the end-of-run differential pressure at setpoint.
h. The lag pump is turned off when the end-of-run differential pressure is above the setpoint plus an adjustable differential (initial differential, 1 psi) for more than 1 minute, and both pumps are running at less than the upper staging setpoint speed.
i. If the differential pressure is above setpoint plus 2 psi for more than 1 minute, and only the lead pump is running, and the lead pump is running at minimum speed, then the secondary loop bypass valve will modulate to maintain the differential pressure at setpoint.

J. Heating Water System Control:

1. **General**:
   a. If the boiler staging is controlled by packaged boiler controls, then all input and output signals and alarms from the packaged boiler controls shall be accessible to the DDC system. In this case, primary heating water (HW) pumps will be controlled directly by the boiler control unit or by the DDC system, as a function of the signals from the boiler control unit. The intent of this is that the boiler and primary HW pump controls be coordinated.
   b. Secondary HW pumps shall be considered for any heating water system in which the boilers are not rated by the manufacturer to accept the expected extremes of HW flow, should 2-way coil valves be used. In this application, an end-of-line bypass and control valve is required.

2. **Heating Water System Start/Stop Control**:
   a. When any equipment served by the heating water system is on and is (a) calling for heating, or (b) when the outside air temperature is below setpoint (initial setpoint, 50°F, adjustable), a time counter is started. After 10 minutes (adjustable) of either condition being true, the lead secondary heating water pump if applicable, and then the lead primary heating water pump (or boiler circulation pump) are started. When boiler flow is proven, the lead boiler is started.
   b. Absence of both of the above start conditions for 10 minutes (adjustable) will cause all heating water system pumps and boilers to be turned off.

c. When the heating water return temperature (primary, common header, as applicable) is greater than the heating water supply temperature (primary loop, common header) minus the set differential (initial setpoint, 3 F degrees, adjustable) for 5 minutes, the lead boiler is turned off. If the OSA temperature is less than setpoint at this time, the pumps remain on. If the OSA temperature is greater than setpoint, after a time delay of 5 minutes, the lead primary and secondary HW pumps are turned off.

3. **Heating Water Temperature Reset**:
   a. **General**: The leaving boiler water temperature (primary heating water supply temperature -- PHWST) will be reset as a function of the highest heating load of selected representative / critical zones. The highest heating load will be determined by the EMS highest zone heating load signal, position of the most open heating coil valve, or similar indicator of true load. Zone temperature by itself is not an indicator of true load. The minimum boiler vessel temperature will be set at 140°F for non-condensing boilers.
   b. **The designer**, controls contractor, and test and balance contractor will coordinate to identify heating water valves from representative and critical (but not “wild”) building zones and fan systems. At least 4 such valves from each of the fan systems and zonal reheat coils (or all heating water valves, whichever is less) should be identified.
   c. On startup of the boiler, the initial PHWST setpoint will be the midpoint between the upper and lower reset limits.
   d. If none of the representative/critical valves are fully open, the PHWST is reset downwards by increments with time delays between adjustments to allow for system stabilization. The increments and time delays must be tuned for the specific system, though 5 F degree increments at 10 minute intervals can be used as initial settings.
   e. If one of the representative/critical valves is fully open, no resetting is done.
   f. If two or more of the representative/critical valves are fully open, the PHWST is reset upwards by increments with time delays between adjustments.
   g. The reset table upper and lower limits will be a function of system characteristics. The designer will recommend a reset schedule. The lower reset limit should be as low as possible, while meeting heating loads, and subject to the 140°F minimum non-condensing boiler vessel temperature . The upper limit should be no higher than required for coil design loads.

4. **Boiler Staging / Capacity Control**:
   a. **Multiple boilers**, and their respective primary heating water pumps, will be staged on as a time function of the secondary loop flow, or variable primary loop flow, as applicable. (See secondary heating water pump speed control for criteria on when secondary pumping systems are recommended.) In general, boilers are to be staged on when the flow exceeds 95% of the rated maximum flow of the previously staged boiler for 5 minutes. Each boiler is to be staged off when the flow is less than 90% of the rated maximum flow of the previously staged boiler for 5 minutes.
   b. **Optional sequences** for boiler staging are to use a time function of either the differential between the heating water supply and return temperatures, or simply the differential between the return temperature and setpoint.

5. **Lead / Lag Control**:
   a. If the boiler plant includes two or more boilers of unequal operating efficiencies, the most efficient boiler for the given conditions will normally be

selected as the lead.

b. The operator can command any boiler or pump to the lead and subsequent lag positions.
c. Under automatic control, the DDC system or packaged boiler controls will determine the lead and subsequent lag boilers based on totalized run time of any unit over the setpoint number of hours (initial setpoint, 100 hours, adjustable) more than any other unit.
d. For primary and secondary pumps, the DDC system will register an alarm at the operator's terminal when the respective lead pump has a totalized run time more than the setpoint number of hours (initial setpoint, 4000 hours, adjustable) more than the lag pump(s). Switching lead and lag pumps will be manual only.

6. **Secondary Heating Water Pump (and Variable Flow Primary Pump) Speed Control**:
   a. The designer shall consider secondary heating water pumping systems for any heating water system in which the boilers are not rated by the manufacturer to accept the expected extremes of HW flow, and where the design HW flow is greater than 200 gpm.
   b. With or without secondary pumps, boiler flow shall be constant unless otherwise approved by the boiler manufacturer.
   c. All secondary pumps shall be of identical capacity and head. Each such pump shall be controlled by an individual VFD. When 2 or more secondary pumps are running, they shall run at the speed (within ±1% of each other).
   d. Static pressure sensing for pump speed control will be by end-of-run differential pressure.
   e. The lead secondary pump speed will be modulated between minimum speed (initial setpoint, 20%, adjustable, or minimum acceptable to motor manufacturer) and an upper staging limit (adjustable), to maintain the end-of-run differential pressure at setpoint. The upper staging limit is to be selected by the engineer for optimum system wire-to-water efficiency. Generally, this setpoint will be between 50% and 70% speed, depending on pump capacities, number of secondary pumps, system head characteristic, etc.
   f. The differential pressure setpoint will be determined by the test and balance agency such that the 2-way valve serving the heating coil with the greatest load is between 90% and 98% open at the same time that the majority of other heating coils are under a moderate to heavy heating load.
   g. If the lead pump is operating at greater than the upper staging setpoint for at least 5 minutes, and the end-of-run differential pressure is below the setpoint minus an adjustable differential (initial differential, 2 psi), then the lag pump shall be started and its speed ramped up. Both pumps will run at the same speed, as required to maintain the end-of-run differential pressure at setpoint.
   h. The lag pump is turned off when the end-of-run differential pressure is above the setpoint plus an adjustable differential (initial differential, 1 psi) for more than 1 minute, and both pumps are running at less than the upper staging setpoint speed.
   i. If the differential pressure is above setpoint plus 2 psi for more than 1 minute, and only the lead pump is running, and the lead pump is running at minimum speed, then the secondary loop bypass valve will modulate to maintain the differential pressure at setpoint.