Architecture & Engineering

Minimum Design Standards

MINIMUM DESIGN STANDARDS
June 15, 2013

FOREWORD

The Minimum Design Standards (MDS) provide planning, design, construction, sustainment, restoration, and modernization criteria. They apply to all projects administered by the Architecture & Engineering Division (A&E) and work for other customers where appropriate.

This document is developed based on the U.S. Department of Defense Unified Facilities Criteria (UFC) and General Service Administration, Facility Services Standards for Public Buildings, Mechanical Engineering. Any copyrighted material included in this document is identified at its point of use. Use of the copyrighted material apart from this document must have the permission of the copyright holder. UFC are distributed only in electronic media from the following source:

- Whole Building Design Guide website http://dod.wbdg.org/
- General Service Administration, Facility Services Standards for Public Buildings, Mechanical Engineering, http://www.gsa.gov/portal/category/21054

MDS are living documents and will be periodically reviewed, updated, and made available to the user. A&E is responsible for administration of the MDS system. Agencies should contact the A&E Division for document interpretation and improvements. Recommended changes with supporting rationale should be sent to A&E. MDS are effective upon issuance and are posted on the A&E website http://architecture.mt.gov with the version date on the cover. The issue date on the cover of MDS hard copies should be checked against the version date of the current document on the website.

Revisions:

March 1, 2015 Sections 2.8, 5.9, 7.1 and Appendix C reference for wood biomass energy and wood design/construction were modified pursuant to Executive Order 12-2014 to promote use of Montana wood products.

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SECTION 1 INTRODUCTION

1-1 BACKGROUND

17-7-Part 2, MCA mandates construction of new buildings, major renovation for state-owned and new leased buildings to be built and operated based on sound environmental, economic and fiscal decisions for design, construction, and operation. Specifically, it defines a High-Performance Building as one that integrates and optimizes all major high-performance building attributes, including but not limited to energy efficiency; durability; life-cycle performance; and occupant productivity. 17-7-213 MCA requires that buildings constructed as high-performance buildings continue to be maintained and operated as high-performance buildings.

1-2 PURPOSE AND SCOPE

A&E Division's goal is to build quality buildings that serve the mission of the agency, are cost effective over the life of the building, and are fiscally responsible to the citizens of Montana. This MDS provides technical guidance and outlines technical requirements for typical aspects of architectural and engineering design services. Consultants shall use the information in this document to develop plans, specifications, calculations, and construction contract documents. The information in this guide represents the minimum requirements. Project conditions may dictate the need for designs that exceed these requirements.

1-3 APPLICABILITY

This MDS applies to all projects administered by the A&E Division. Other agencies may adopt the MDS in whole or in part or may insert additional criteria. This MDS applies to all types of construction regardless of funding, including new construction, major renovations and historic properties' restoration. Certain specialized facilities, such as healthcare and laboratory facilities, carry more stringent requirements. This MDS is applicable to Design-Bid-Build projects and Alternate Delivery projects. Certain MDS requirements may not be feasible nor applicable to specific projects, particularly renovations. In these instances the project manager may waive those requirements but will apply the remaining requirements wherever practical. All waivers must be issued in writing by the project manager with a copy in the project file.

1-4 ADDITIONAL REQUIREMENTS

This document establishes MDS to be used in conjunction with the additional criteria High-Performance Building Standards (HPBS) and High-Performance Operations & Maintenance Standards (HPO&M). The initial information defines project-specific scope and expectations and is the basis of the contractual relationship with the design team.

State agencies and units of the Montana University System (MUS) may have additional design requirements and standards that provide guidance in the design and construction of buildings. Several agencies, particularly those with secure environments, have strict requirements to be followed regarding control of the contractor operations interface with their operations.

- Confirm the current applicable regulations with the Design Manager or Construction Manager.
- Confirm with the Authority Having Jurisdiction (AHJ) the pertinent local requirements.
- Confirm whether local ordinances may dictate additional requirements affecting the project.

SECTION 2 PLANNING, PROGRAMMING, AND DESIGN SERVICES

2-1 PREDESIGN, DESIGN, AND POSTDESIGN SERVICES

The contract and the project's Initial Information document delineate project specific requirements. The performance and document requirements on the A&E website, A&E Minimum Design Standards delineate expectations that apply to all A&E administered projects. Consultants may request clarification from the A&E project manager.

2-2 INTEGRATED DESIGN PRINCIPLES

Integrated design is the most important requirement in achieving a high-performance building. A design team must have strong, consistent representation from all stakeholders throughout the project phases to avoid missing opportunities to improve building performance and to fully realize increased savings potential.

A collaborative, integrated planning and design team is composed of users, A&E staff, and appropriate professionals that identify requirements and establish comprehensive performance goals and ensure these goals are are incorporated into the design, construction and operate throughout life cycle of the building. Design in response to functional, aesthetic, environmental, site, budgetary, and other factors. Evaluate local environmental factors, site, and building components to determine the extent passive and natural design strategies and features can cost effectively be incorporated into the design before the active mechanical systems are selected and sized.

2-3 EVIDENCE-BASED DESIGN

Evidence-based design is a process emphasizing the importance of the conscientious use of credible data and best evidence in order to influence the design process and in making critical decisions. Critical thinking is required by the designer and informed users to develop an appropriate solution to the design challenge. Evidence-based design also presents a definitively authoritative way to explain how design interventions will obtain a quality return on the state's investment.

2-4 DESIGN FOR FUNCTION AND LIFE CYCLE

Permanent buildings shall be energy efficient and have finishes, materials, and systems selected for low maintenance and low life-cycle cost over a life cycle of generally not less than 60 years. The projected life cycle period will be set by the A&E design manager.

Transitional Construction: Semi-permanent or temporary buildings shall be energy efficient, and have finishes, materials, and systems selected for an average degree of maintenance based on the expected life, generally between five and 25 years.

2-4.1 LIFE-CYCLE COST ANALYSIS

The consultant shall prepare a life-cycle cost effectiveness analysis (LCCA) in accordance with industry-accepted practices and based on local conditions; refer to Appendix C. Any LCCA must be calculated using accepted industry standards for equipment and components. Individual components or systems life expectancies must be reflected by inclusion of appropriate replacement and salvage values at the appropriate year of the analysis.

All analysis must be based on the actual conditions expected over the life of the facility including anticipated occupancies, scheduled hours of operation and process loads. Include realistic energy usage and efficiencies, maintenance costs, repairs and renovations. All costs or savings associated with the utilization of recovered energy, solar heat, solar photovoltaic energy, and other renewable or waste heat applications must be included. Any alternative funding such as rebates from utility companies should be appropriately credited in the LCCA.

2-5 COMMISSIONING

Employ commissioning practices appropriate to the size and complexity of the building and its system components in order to verify performance and ensure that design requirements are met.

2-6 POST-OCCUPANCY EVALUATION

A post-occupancy building evaluation enables A&E and the agency to assess the building's performance relative to occupant comfort and productivity, operational efficiency, maintainability, cost effectiveness of the investment and value of sustainable features. It creates a baseline for building performance, identifies opportunities to fine tune the building's systems and to apply lessons learned to future projects.

When new construction or major renovation projects have been occupied for 12 to 24 months, conduct a post-occupancy evaluation with the users and building operations and maintenance staff. Use the process and forms outlined in the *Facility Performance Evaluation (FPE) Guide Document for Public Facilities,* referenced in Appendix C, as modified to fit the specific project. Correct identified deficiencies to the extent reasonable and as funding allows. For projects over $5 million, include evaluation of effectiveness of features related to sustainable design and construction certification.

2-7 PERCENT FOR ART

For projects that include funding for public art, the project manager will transfer funds to the Montana Arts Council (MAC) at the initiation of the project and the design team will coordinate during preliminary design with MAC to identify location and concepts for integrating public art into the building. MAC will manage the design and placement in coordination with the design team and state project managers, and also the contractor when the installation takes place prior to substantial completion.

2-8 PROMOTE USE OF WOOD PRODUCTS

Pursuant to Executive order 12-2014 the design and construction of new buildings and additions need to consider wood for structural systems and aesthetic purposes, look for opportunities to demonstrate innovative uses of Montana wood products and incorporate wood biomass energy systems where it is viable. Cost effectiveness over the life cycle of the building needs to be considered in the selection of materials and wood energy applications.

SECTION 3 SITE AND CIVIL

3-1 MONTANA PUBLIC WORKS STANDARDS

Consultants shall comply with requirements of the latest edition of Montana Public Works Standard Specifications, compiled by the Montana Association of Contractors, for design of earthwork, paving and surfacing, and utility systems (water, storm water, sanitary sewer).

3-2 GEOTECHNICAL

Review geotechnical information provided by the agency and conduct additional geotechnical investigations or environmental assessments as necessary. Confirm that geotechnical investigations pay particular attention to previously disturbed sites and conditions abutting existing buildings. Comply with the recommendations of the reports.

3-3 SITE SURVEY

Design consultants shall review site information provided by the agency and conduct a survey as necessary to identify topography, utilities, property boundaries, easements, roads, sidewalks, structures and major vegetation. The consultant shall generally confirm information provided; the engineers shall confirm utilities including telecommunications are adequate to serve the project and include costs associated with utilities improvements in the cost of the Work.

3-4 SUSTAINABLE LOCATION AND SITE DEVELOPMENT

Sustainable site selection and site development are fundamental components of sustainable building practices. Opportunities offered by good site selection are available at the start of a project and in most cases incur no additional cost. Every opportunity shall be taken to transform state campuses into more livable, meaningful and resource-efficient communities.

3-5 SITE SELECTION

Projects shall be located proximal to users and associated functions in order to improve efficiencies, promote pedestrian and public transportation, minimize travel distance and time, and minimize private vehicle use/dependence.

When appropriate during the site-selection process, preference shall be given to sites which possess the following characteristics:

- Adaptive reuse or renovation of existing underutilized buildings (including historic buildings) that can be cost-effectively repurposed, or use of previously disturbed/developed areas;
- Building orientation shall maximize energy efficiency, passive solar, and daylighting potential of the building;
- Site projects in central business districts and rural town centers as appropriate for the specific project;
- Sites that are served by public transportation systems where available;
- Proximity to housing;
- Conform with local zoning requirements unless variations are approved through a formal public hearing process
- Avoid development of sensitive land resources;
- Parking management strategies to encourage co-use of shared parking;
- Avoid building occupied structures over contaminants, unless contaminants are mitigated to prevent detrimental impacts; and
- Minimize the need to extend utility services. Size systems with thought of future Development and as delineated by the agency’s master plan.

3-6 SITE SAFETY

Provide clear access for emergency response vehicles. To the extent feasible, separate vehicular access, including service vehicles, from pedestrian circulation.

Avoid exposed outdoor steps and stairs wherever possible. They are hazardous and a maintenance issue to shovel. Make vertical transitions inside the building or under a covered area whenever possible.

Orient building entrance to maximize safety and ease of access. Light walking surfaces for night pedestrian traffic. Layout entrances so that they are readily identifiable and evident in their purpose and relate to other buildings and campus circulation patterns.

3-7 SITE WATER MANAGEMENT

Locate projects and new buildings outside the 500-year flood plain. Buildings that need to be within the 500-year to meet their intended use must be constructed to be resilient to anticipated flood events to the extent feasible and cost-effective.

Building elevation shall be established such that surface water does not enter buildings or accumulate in associated traffic areas. Provide positive drainage away from buildings and manage roof runoff such that water is directed away from the foundation. Incorporate best management practices to minimize or eliminate sediments or pollutants from reaching surface waters and require contractors to obtain required permits before disturbing soils.

3-8 ADDITIONAL SITE PARAMETERS

Design shall provide for effective and efficient removal and piling of snow from roads, parking, and sidewalks. Design the building and site to accommodate building function with minimum disturbance of topography, soils, and vegetation.

Include in design appropriate areas for deliveries, service vehicles, trash and recycling collection. Maintain adequate turning radiuses.

3-9 LANDSCAPE

3-9.1 LANDSCAPE INTERFACE

Landscaping is a critical part of good building design and plays a vital role in blending architecture into its surroundings. Careful coordination between the landscape and building design is crucial to good design and to connect the experience of exterior environments with building interiors.

Landscape should include native plants, xeriscape, and dry-scape and promote biodiversity to create interest and reduce dependence on irrigation and the need for fertilizers and pesticides. Avoid invasive plant and noxious weed species as listed by the Montana Department of Agriculture and the Montana Center for Invasive Species Management.

Anticipate long-term root development in placing species proximal to foundations and hardscape such as sidewalks so that in the future the roots will not impact the built environment.

3-9.2 IRRIGATION

Provide an adequate buffer and design landscape irrigation systems so that systems do not spray onto the building, primary sidewalks or entry in their normal operation.

Disperse collected rainwater to vegetated areas where effective and where soil types allow.

SECTION 4 GENERAL ARCHITECTURE

4-1 SPACE PLANNING CRITERIA

Facility size shall be based on a functional analysis of activities to be accommodated. Facility planning shall be based on specific requirements for each project, to include all functional, technical, and economic considerations, instead of arbitrary allowances. To obtain the most economical and efficient use of space, facilities shall be designed based on the functional organization of adequately sized spaces. Agencies may have more detailed space requirements to be reviewed and assimilated into the program.

4-2 DESIGN FOR FLEXIBILITY

Flexibility in architectural design facilitates the change or expansion of an existing structure to accommodate changing functional requirements with minimum expenditure of resources.

From the time of construction until the end of its life, the functional requirements for buildings may change, often drastically. Except for buildings with highly specialized functions or where adaptive reuse is unrealistic, flexibility is a significant design requirement. Facilities shall be designed with consideration for anticipated program requirements to the extent feasible.

4-3 BUILDING ORIENTATION

Building siting shall be established in agreement with an agency's master plan for mission/operation. Building layout and orientation shall optimize site opportunities with regard to functional arrangement, access, exterior appearance, views, and other considerations.

Building shape, orientation, and design shall utilize the site's seasonal environmental factors to minimize annual facility energy use and to optimize daylighting. Building and glazing orientation, along with architectural shading considering seasonal solar angles and prevailing winds to enhance energy performance of the building, are all to be coordinated within the site-specific microclimate.

4-4 ACCESSIBILITY REQUIREMENTS

Comply with Title II of the 2010 The Americans with Disabilities Act (ADA) Standards for Accessible Design (ADAS). ADAS sets minimum requirements; however, the design team should strive to exceed the minimum requirements wherever readily achievable.

Review provisions of the scope to confirm the manner in which the technical provisions are to be applied. Title III may apply to select projects that are commercial facilities operated by a non-state entity. Decisions shall be documented by the design team if services are to be provided in another manner, or whether ADAS provisions do not apply to a space or building component.

At or prior to substantial completion, confirm that the construction and installation of all accessible components is within tolerance of ADAS. Exceptions may be made only after consultation with the Rocky Mountain ADA Center, Colorado Springs, CO. Construction tolerances are as follows:

- Minimum/maximum dimensions: no tolerance; must be within the specification;
- Dimensional ranges: must be within the listed range;
- Manufactured products: Must be within 1/8"±; and
- Field-installed work: Must be within specified tolerances of the specific trade. Work to be installed in a good workmanship manner; ½" ± is viewed as an absolute maximum.

4-5 ARCHITECTURAL STYLE AND CHARACTER

Facilities shall be designed to be considerate and complementing of the surrounding architecture, judiciously employing the style and character of architecturally and historically significant facilities, and consistent with campus design guidelines. Constructability, maintainability, and sustainability shall also be considered relative to architectural compatibility.

4-6 HISTORIC ARCHITECTURE AND THE STATE ANTIQUITIES ACT

Under the State Antiquities Act, repair or renovation of historic facilities or new construction near historic facilities shall be reviewed by the State Historic Preservation Office (SHPO). *Historic* refers to any property 50 or more years of age. Consultation with SHPO must begin early in design and continue as the design evolves. SHPO shall have input regarding compliance with guidelines regarding preservation and rehabilitation.

4-7 HAZARD PREVENTION

Facilities shall be designed to comply with 29 CFR Occupational Safety and Health Act and DEQ asbestos control regulations. Pay particular attention to lead and asbestos particulates, integral to the matrix or coating materials to be disturbed, or polychlorinated biphenyls (PCB) that may be part of caulking and sealant materials.

4-8 EXISTING BUILDINGS

Determine the presence, location and quantity of asbestos and PCBs in existing buildings by reviewing previous survey(s) and conduction inspections. Incorporate abatement information into construction bid package in order to remediate material in work area. Identification of lead and its management during construction is the contractor’s responsibility per 29 CFR 1926.62.

4-9 HAZARDOUS MATERIALS

Building systems and components are not allowed to contain asbestos, chlorofluorocarbons (CFC), hydro chlorofluorocarbons (HCFC), Polychlorinated biphenyl (PCB), mercury, or arsenic. Avoid use of formaldehyde, halogenated flame retardants, lead, wood treatments containing creosote on the building’s interior.

4-10 RADON

All enclosed and occupied buildings shall be designed to minimize introduction of radon gases. The Environmental Protection Agency (EPA) map of Radon Zones, 1993, predicts less than 4 pCi/L potential in Yellowstone, Wheatland, Sweet Grass, Golden Valley, Petroleum, and Treasure counties. Unless determined otherwise, projects located in these counties and renovation projects that demonstrate with detailed testing that the building does not present an exposure greater than 4pCi/L shall be exempt from this requirement.

4-11 RADON MITIGATION SYSTEM DESIGN

Passive sub-slab depressurization systems shall be provided where required. The system shall be changed to active, if needed, based on follow-up testing. Check the following EPA documents available from the EPA Radon Information Center, 703 356-5346, and online at http://www.radon.com/

- Radon Prevention in the Design and Construction of Schools and Other Large Buildings, EPA/625/R-92-016,
- Radon Measurement in Schools, EPA/402/R-92-014.

4-12 MOLD

The presence of moisture in the materials of a project can promote the growth of fungi or mold and pose a hazard to the occupants. Select materials, manage water including water vapor and condensation, and provide air movement to reduce the likelihood of mold growth. During construction, plan for moisture intrusion prevention and remove wet products subject to mold development. Refer to Appendix B for more information on design to prevent mold development.

4-13 ACOUSTICS

The facility shall be designed to provide a comfortable acoustical environment and provide comprehensive sound isolation and sound absorption measures for individual spaces as appropriate. A comprehensive acoustical design shall be developed for individual facilities as appropriate:

- Quantify sound isolation from one space to another;
- Quantify ambient noise levels and management within spaces including HVAC and equipment noise;
- Optimize use of unamplified communication where appropriate, but comply with ADA where assistive listening is required;
- Limit transmission of mechanical, reverberation, discharge air, other noise sources; and
- Design fans to operate at lower ends of fan curves.
- Mitigate impact of noise generated by building systems on occupied areas in the proximity and comply with local noise ordinances

Architectural acoustics shall be carefully coordinated with the mechanical system design. At a minimum, prevent sound from noisy spaces such as corridors, toilets, elevator, and machines from adversely affecting occupants in the vicinity. For projects where proper acoustical performance is critical to the function of the space, such as theaters and auditoria, use the services of an acoustic engineer.

4-14 STRUCTURAL

The design team shall refer to geotechnical investigation for soil bearing capacity, stability, and any other unique characteristic, and shall calculate forces and design vertical and lateral systems to be resilient to anticipated loads over the anticipated life of the building. Buildings that are critical to the operation of state government, or serve as refuge in a disaster situation, need to be able to continue operation after reasonably anticipated events.

Establish an effective uniform structural grid and then size structural components with respect to the loads imposed. Avoid long spans when supporting upper floor loads. Identify situations with low vibration and/or deflection tolerance and locate those functions in locations that are structurally stable. Consider constructability and cost effectiveness in detailing and sizing members.

4-15 MECHANICAL, ELECTRICAL & TELECOMMUNICATIONS ROOMS

Adequate area shall be designed for mechanical equipment rooms, electrical rooms, and telecommunications rooms. There shall be an adequate volume of space for all building distribution systems and provide clear access for regular service and maintenance. The design team shall plan for and provide access for removal and replacement of major system components. For mechanical equipment room sizing, the design team shall coordinate with the mechanical designer and agency maintenance personnel at the earliest stage to ensure inclusion of the required clearances for maintenance, servicing, and safety. For telecommunications rooms, the design team shall coordinate with the electrical designer and agency IT managers.

SECTION 5 SPECIFIC ARCHITECTURAL REQUIREMENTS

5-1 INTRODUCTION

The following requirements address specific design elements. Many of these requirements represent solutions to specific problems experienced on new construction and in renovation.

5-2 ABOVE-GRADE FINISHED FLOOR ELEVATION

Set finished ground floor elevations with respect to the finished grades. The finished floor shall be placed no less than 8 in. (200 mm) above the finished grade for slab-on-grade construction. Allow a minimum of 14 in. clear space above finished grade for light frame construction. The finished grade is defined as the final grade elevation adjacent to the exterior, including any planting beds.

5-3 PAINT

Paint selection shall be based on the Master Painters Institute (MPI) *Detailed Performance Standards*. Back roll or brush field-applied sprayed paint unless that is countermanded by the specific application.

Priming is not required for interior structural steel unless it is exposed to moisture or scheduled to be painted.

5-4 CONCRETE

Comply with ASTM C94 for the design of concrete and ACI 318 for placement and finishing of concrete. Specify strength, air content, and characteristics of installed work appropriate for a durable installation. Finish exposed surfaces with consideration to safety (slip hazard) and aesthetics.

- For a successful finished product, place concrete in as favorable conditions and weather as practical. Concrete installer and supplier shall coordinate to provide mix design that meets specifications and is also appropriate for the conditions at time of placement.
- Place concrete that is as close to contact surface temperature as possible, but in no instance greater than ± 40°F.
- Do not add air-entraining to concrete that is to be trowel finished.
- Concrete mix for floor slabs on grade or steel decks with non-permeable floor finishes shall be normal weight, moisture cured, with a water/cement ratio of 0.4 to 0.45; use a high range water-reducing admixture as necessary.
- Agencies are discouraged from applying deicers to exterior concrete as it is deleterious to the concrete. Any exterior concrete subject to deicers needs to be a mix design appropriate to the application and sealed to resist absorption of the chemicals.
- Space control joints to minimize uncontrolled cracking and avoid oblique sections of concrete that tend to crack and fail.

5-5 MASONRY

Comply with the Brick Industry Association Technote 7, Technote 18A, and Technote 21 for specific brick masonry recommendations and other topic-specific technotes as applicable. Coordinate with Rocky Mountain Masonry Institute for technical questions. Use masonry units that are durable and appropriate to the application. Consider large-hole units as they are lighter, use less material and use less energy to fire.

5-5.1 MASONRY CONTROL AND EXPANSION JOINTS

Non load-bearing exterior masonry walls are often thermally isolated from the building by insulation and are therefore subject to differential movement. . Masonry damage occurs most often when sufficient expansion and control joints are not provided Design a series of vertical and horizontal expansion joints to permit this differential movement. Follow the recommendations in BIA Tech Note 18A from the Brick Industry Association for movement joints in brick. Follow Tek Note 10-2C from the National Concrete Masonry Association for movement joints in concrete block.

5-5.2 EXPANSION JOINT POSITION AND LOCATION

Analyze each building to determine the potential horizontal and vertical movements, and make provisions to relieve excessive stress that might be expected to result from such movement. Place expansion and/or crack control joints in accordance with BIA Technote 18A. Indicate expansion joints on the contract drawings.

5-5.3 MASONRY WATER-REPELLENT COATINGS

Determine the source or reason for moisture problems before resorting to a breathable (silane-siloxane-based) clear masonry water-repellent on repair projects.

5-5.4 TOP OF MASONRY

Prevent water entering the top of masonry surfaces including ledges and sills by flashing, protecting or coating with a permanent nonabsorbent material. Install thru-wall flashing under caps and sills to prevent moisture intrusion. Provide ample slope and drip edge so water runs off quickly and to minimize water running down the face of walls.

5-5.5 CLEARANCE BETWEEN MASONRY AND BACKUP CONSTRUCTION

Provide a 1-in. (25-mm) minimum clear dimension from the face of cavity insulation or sheathing material to the back of the exterior wythe of masonry. Rake joint on backside as units are placed to keep cavity clear of mortar. The distance between the back face of the masonry veneer and the structural backup should be no more than 4.5". If this distance is greater, use stronger ties, more ties or specialty ties that are resistant to buckling. See ACI 530 for additional information. See BIA Technote 21 for additional guidance.

5-5.6 FLASHING AT PENETRATIONS AND PROJECTIONS

Provide flashing at all penetrations exposed into the cavity such as columns or beams, and at floor slabs, wall projections and recesses, and wall bases. All projections, recesses, and caps must be flashed and sloped away from the wall to promote drainage. Follow recommendations of BIA Tech Note 7.

5-5.7 LOCATION OF WEEP HOLES

Provide open head joint weeps at all through-wall flashing for brick masonry. Locate weeps on the same course as the flashing. Locate weeps above the level of the finished grade, including landscape mulching, to prevent the weeps from becoming clogged with foreign material. Weeps shall be designed to be open head joints with corrugated plastic inserts only. Provide masonry vents at top of walls and below continuous shelf angles. These provide better ventilation of cavity spaces to prevent buildup of warm, moist air at the tops of cavities.

5-6 EXTERIOR FINISH SYSTEMS AND EXTERIOR INSULATION AND FINISH SYSTEMS

Selection of Exterior Finish Systems (EFS) and Exterior Insulation and Finish Systems (EIFS) shall be based on a LCCA that considers maintenance requirements and frequency of recoating. In areas of severe wind select systems appropriate to the exposure. Consider self-cleaning EIFS finishes coatings and coatings resistant to fading in order to reduce maintenance costs.

Use self-draining EIFS systems unless the application does not present a concern for moisture. Do not install EFS and EIFS within 6 in (150 mm) of grade, or in areas where it will be subject to abuse by moving vehicles, equipment, or mowers. Specify high-impact resistant systems a minimum of 4 ft. above grade where subject to damage from pedestrian traffic. Construction documents shall provide specific design details for windows, trim, expansion joints, and drainage planes.

5-7 ROOFS

Roofs constitute one of the key elements in preserving the integrity of the building and protecting its contents. Maintaining the effectiveness of the water integrity of the roof is critical to avoid disruption of the agency's operation, maintain air quality and prevent damage.

- Two of the primary features of an effective roof system are its ability move water from the surface to a discharge point and to avoid ponding. Low-slope roofs should be a minimum of 3/8" per foot slope to drains and pans at primary drains should be beveled down into the insulation for proper drainage. Element that obstruct water flow need to be cricketed to direct water around the obstruction. For new construction, build primary slope into the roof deck to reduce the need for tapered insulation systems.
- Design perimeter walls and internal equipment curbs to allow for future reroofs and additional insulation without modification.
- Flash per the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) and as approved by the roof manufacturer. Detail flashing should be watertight without use of caulking wherever feasible.
- Minimize roof-mounted equipment and consolidate its location to the extent feasible. Minimize penetrations. Locate roof access within a reasonable distance of equipment requiring service, and provide walk pads to equipment. Locate equipment away from edge of roof and provide fall protection where required.
- Select systems that allow for annual inspection, and expedient detection of leaks, deterioration and required repairs.
- Provide internal roof access to buildings over one story in height.
- In areas identified by the Montana DES Hazard Mitigation Plan as prone to high winds, hail or ice storm, select systems resilient to and able to withstand such events.

5-8 GYPSUM BOARD CONSTRUCTION

Glass mat gypsum (paperless or noncellulose facing) sheathing shall be used for exterior applications, and glass mat gypsum wall board for the interior of exterior walls (prevents food source for mold). Use cementitious wall board as a tile base for wet and high-moisture areas such as showers and commercial kitchen spaces.

Conform to gypsum board construction details from the *Gypsum Construction Handbook*, USG Corporation, latest edition, and the *Gypsum Construction Guide,* National Gypsum Company.

5-9 WOOD CONSTRUCTION

Dimensional lumber for framing blocking and trusses, timbers laminated beams, finish wood and engineered wood systems produced in Montanan must be specified as being produced at a Montana mill. When approved by the project manager, these products may be specified to be milled within a certain distance not to exceed 500 miles from the site. Wood products not produced in Montana are excluded from the Montana produced requirement.

Preference is to design with and specify wood products and engineered wood systems produced in Montana. Preference should be given whenever reasonable to Montana made wood finish materials and products; see Appendix C. Certified wood shall not be specified if it limits use of Montana wood.

SECTION 6 BUILDING ENVELOPE REQUIREMENTS

6-1 INTRODUCTION

The building envelope must be designed to comply with or exceed ANSI/ASHRAE/USGBC/IES 189.1 2009 paragraph 7.4.2.1. The building envelope shall be designed to control the transfer of the following elements: heat, air, moisture, light/radiation, and noise. Design each control strategy holistically and use an integrated approach.

6-2 CONTINUITY OF BARRIERS

There are several functions that a building enclosure needs to fulfill. To do so efficiently and without problems, the most important barriers in the building enclosure shall be continuous: the rain screen or water deflection layer, the insulation or thermal barrier, the air barrier, the water drainage plane, and the waterproof barrier. Continuity of the barriers shall be traced through all details of the building enclosure without breaks.

6-3 FENESTRATION

Fenestration is the least energy-efficient component of the building enclosure. Optimize the window-to-wall ratio to reduce lighting energy when using daylighting controls, and avoid the glare and energy consumption associated with large window areas.

Select the best possible performance from a U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) for the fenestration. Optimize the emissivity coatings to control both heat gain into the building due to solar radiation and heat loss from the building. Control glare.

Select framing that includes advanced thermal breaks. Align the center of insulated glazing units with the centerline of exterior wall thermal insulation to avoid thermals shorts. Include flashings under fenestration in an appropriate manner.

Final fenestration design shall be coordinated with the mechanical and electrical engineers to comply with overall facility energy requirements.

6-4 INSULATION

The most efficient way of insulating building assemblies is to use continuous insulation layers unbroken by framing. Provide a layer of continuous insulation uninterrupted by thermal bridges except for occasional fasteners and anchors. Final assembly U-Factors shall be coordinated with the mechanical engineer to comply with overall facility energy requirements in this document and HPBS.

Protect all insulation during its service life from weather including rain, ultraviolet solar radiation, mechanical abuse, compression, or accidental or deliberate movement from its location.

6-5 MOISTURE BARRIER

A building shall be wrapped on all six sides with a moisture barrier to deflect water from its surface. Seal all penetrations of the moisture barrier.

Establish the specific functions of the membrane, its water vapor permeance value and its position relative to the other materials in the assembly determined so that its properties can be correctly selected and a “moisture balance” (more drying than increase in moisture content) will occur in the building assemblies. When necessary, consider dew point analyses to identify dew point occurrence based on materials making up the wall assembly based on anticipated interior conditions and exterior climate zone.

6-6 WATER-RESISTANT BARRIERS

Wall assemblies shall incorporate a Water-Resistant Barrier (WRB) in the backup wall behind the cladding, with flashings to direct water out. This is true for all claddings, including EIFS. All copings and sills shall receive through-wall flashing under them.

To direct moisture out of a cavity through weep holes, provide continuous flashing at the bottom of the cavity and wherever the cavity is interrupted by elements such as shelf angles, lintels, and penetrations. Penetrations such as windows and louvers in the exterior wall assemblies shall have pan flashing installed in the rough opening sill.

Counteract below-grade transfer of water through walls by damp-proofing or waterproofing on walls, depending on hydrostatic pressure and drainage capability. Drainage planes in combination with waterproofing, footing drains, and under slab drainage, shall be incorporated based on the recommendations of the geotechnical engineering report.

6-7 VAPOR RETARDERS

6-7.1 BUILDING ENVELOPE VAPOR RETARDERS

Follow vapor retarder requirements listed in the IBC Article 1405 or ASHRAE Handbook of Fundamentals (2009, Chapter 25).

6-7.2 FLOOR SLAB VAPOR RETARDERS

Floor slabs on grade with non-permeable floor finishes shall always have a vapor retarder of 0.05 perms or less, meeting the requirements of ASTM E 1745 Class A. Under slab vapor retarders shall be durable enough to withstand construction activity and shall be terminated around the perimeter and penetrations detailed according to the manufacturer’s instructions.

6-7.3 ROOF VAPOR RETARDERS

Roof assemblies over concrete slabs shall always include a vapor retarder on top of the concrete to control construction moisture in the concrete from affecting roof assemblies.

6-8 WATERPROOFING

Use waterproofing membranes to protect the interior of the building when there is hydrostatic pressure due to a high water table below grade or when there is paving, landscaping, or a vegetated roof that presents moisture intrusion potential.

6-9 AIR BARRIER REQUIREMENTS

6-9.1 NEW CONSTRUCTION

Design, construct, and test the building enclosure with a continuous air barrier to control air leakage in accordance with the requirements of ANSI/ASHRAE/USGBC/IES 189.1 – 2009 or ASTM E741. The building air leakage rate shall not exceed 0.25 cfm/ft2 (1.25 L/s-m2) when tested.

If the interface of semi-heated spaces, hangar bays, maintenance bays, or similar areas and building additions onto non-renovated structures of the interface cannot be adequately sealed for testing, omit testing, but provide the continuous air barrier. Clearly identify all air barrier components of each envelope assembly on construction documents, and detail the joints, interconnections, and penetrations of the air barrier components. Detailed inspection and testing requirements and acceptance criteria shall be included in the project specifications.

Trace a continuous plane of airtightness throughout the building envelope. Seal all penetrations of the air barrier. Unavoidable penetrations (such as electrical boxes, plumbing fixture boxes) shall be made airtight by sealing the assembly. The air barrier must be durable to last the anticipated service life of the assembly.

Provide low-leakage damper, when applicable, and control to close all ventilation or makeup air intakes and exhausts, atrium smoke exhausts and intakes, etc., when leakage can occur during inactive periods. Vents for battery charging rooms are an exception.

Provide vestibules at building entrances with high traffic. Compartmentalize spaces under negative pressure such as boiler rooms and laundry rooms, and provide make-up air for combustion.

6-9.2 RENOVATIONS

Establishing an effective air barrier for an existing building may not be practical. When a building is undergoing a major renovation of its envelope, a leak test must be conducted and foam or sealant applied to air leaks that can be effectively accessed.

SECTION 7 MECHANICAL & ELECTRICAL SYSTEMS

7-1 DESIGN CRITERIA

General Parameters Compliance with the latest versions of ASHRAE Standard 90.1 and ASHRAE Standard 62 is required for the elements of the project (architectural, mechanical, and electrical). 17-7-213 MCA requires that buildings exceed the International Energy Code by 20% or to the extent that is cost effective over the life of the building. When it is viable, coordinate with Montana DNRC Wood Biomass Energy Program to evaluate the economic and technical feasibility of installing a wood biomass energy system as primary or back-up fuel

ASHRAE Standards will be used for the calculation of Building Heating and Cooling Loads with special attention given to sizing and operating equipment for efficient part-load operation as well as full-load operation. Isolated full year cooling loads such as server rooms will be served by stand-alone cooling equipment.

Air Intake and Exhaust. The placement and location of outside air intakes is critical to the safety of the occupants inside a building and must be in compliance with the security requirements of the building, ASHRAE Standards provides a guide for minimum separation distances between ventilation air intakes and exhaust vents and other building features. Specific attention will be made to eliminate outside air pollutants from loading docks, parking lots, and other sources of pollution from entering the building through the outside air intakes. Also, outside air openings will not be accessible from ground level to the extent feasible. Exhaust Systems and Outlets will be designed to meet Local Code Acoustic Requirements and be located at a minimum of 10 ft. from any outside air opening to the building.

Outdoor Design Criteria Outdoor air design criteria shall be based on weather data tabulated in the latest edition of the *ASHRAE Handbook of Fundamentals and on thee elevtion of the specific site*. Winter design conditions shall be based on the 99.6 percent column dry bulb temperature in the *ASHRAE Fundamentals* Volume. Summer design conditions for sensible heat load calculations shall be based on the 0.4 percent dry bulb temperature with its mean coincident wet bulb temperature

Indoor Design Criteria Indoor Design Temperatures. Indoor design temperature requirements are stated for all-year, occupied spaces to be 75 F in cooling and 72F in Heating unless approved otherwise by the project manager. Room Temperature Requirements for all spaces will be defined during the programming phase and clearly delineated in the design intent document. The following spaces shall be kept under negative pressure relative to surrounding building areas: laboratories, detention cells, toilets, showers, locker rooms, custodial spaces, battery charging rooms, chemical and pesticide storage rooms, kitchens, dining areas and other similar area.

7-2 ARRANGEMENT OF MECHANICAL SPACES

Minimum Space Requirements. Mechanical Rooms will be provided in the building for air handling equipment including Heating Ventilating and Air Conditioning Equipment unless technically not feasible.

Service Access. Space shall be provided around all HVAC system equipment as recommended by the manufacturer and in compliance with local code requirements for routine maintenance. Access doors or panels should be provided in ventilation equipment, ductwork and plenums as required for in-site inspection and cleaning. Equipment access doors or panels should be readily operable and sized to allow full access. Large central equipment shall be situated to facilitate its replacement. In addition, adequate methods of access shall be included for items such as: chillers, boilers, heat exchangers, cooling towers, reheat coils, VAV boxes, pumps, hot water heaters and all devices that have maintenance service requirements. All equipment will be piped with shutoff valves for easy disconnection and service.

Vertical Clearances. Main mechanical equipment rooms generally shall have clear ceiling heights of not less than 7 feet. Work Platforms or Catwalks shall be provided for all equipment that cannot be maintained from floor level where technically feasible.

Horizontal Clearances. Mechanical rooms shall be configured with clear circulation aisles and adequate access to all equipment. The arrangement shall consider the future removal and replacement of all equipment. The mechanical rooms shall have adequate doorways or areaways and staging areas to permit the replacement and removal of equipment without the need to demolish walls or relocate other equipment. Sufficient space areas (noted by outlining manufacturer's recommendations) for maintenance and removal of coils, filters, motors, and similar devices shall be provided. Chillers shall be placed to permit pulling of tubes from all units. The clearance shall equal the length of the tubes plus 2 feet. Air-handling units require a minimum clearance of 2 feet 6 inches on all sides, except the side where filters and coils are accessed which should have a clearance on that side equal the length of the coils plus 2 feet.

Roof-Mounted Equipment. No mechanical equipment except for cooling towers, air-cooled chillers, evaporative condensers, and exhaust fans shall be permitted on the roof of the building where unless an indoor solution it is not technically feasible and approved by the project manager. Access to roof-mounted equipment shall be by stairs or ship's ladders.

Housekeeping Pads. Housekeeping pads shall be at least 6 inches wider on all sides than the equipment they support and shall be 6 inches thick.

Mechanical equipment rooms must be designed in accordance with the requirements of *ASHRAE Standard 15: Safety Code for Mechanical Refrigeration*.

Data Server Rooms. Data Rooms will be cooled by stand-alone cooling equipment.

7-3 HVAC SYSTEMS AND COMPONENTS

Air-Handling Units (AHU's). Air Handling Units will be sized using ASHRAE Guidelines to meet the heating and cooling loads of the space they are serving. Special attention will be given to design ventilation systems that operate efficiently all year through the use of Variable Air Volume Systems using Variable Frequency Drives. Psychometric analyses (complete with chart diagrams) shall be prepared for each air-handling unit application, characterizing full and part load operating conditions. Air-handling unit/coil designs shall assure that conditioned space temperatures and humidity levels are within an acceptable range, per programmed requirements, and ASHRAE Standards 55 and 62.

Supply, Return and Relief/Exhaust Air Fans. Centrifugal forward curved and airfoil fans are preferable for VAV systems. All fans shall bear the AMCA seal and performance shall be based on tests made in accordance with AMCA Standard 210. Fans should be selected on the basis of required horsepower as well as sound power level ratings at full load and at part load conditions. Fan motors shall be sized so they do not run at overload anywhere on their operating curve. Fan operating characteristics must be checked for the entire range of flow conditions, particularly for forward curved fans. Fan motors and Variable Frequency Drives will be designed to operate within their service factor and at a maximum of 60 Hertz. Fans will be sized for future growth in the building to the extent feasible.

Exhaust Fans. Exhaust Fans will be sized to meet current and future exhaust loads to the extent feasible. Exhaust Fan Systems will be designed to meet current code requirements for acoustic noise levels and also to minimize acoustic noise and vibration in the building.

Coils. Individual finned tube coils should generally be spaced to ensure that the coils can be effectively and efficiently cleaned. All hot water heating and chilled water cooling coils shall be copper tube and copper finned materials. Equipment and other obstructions in the air stream shall be located sufficiently downstream of the coil so that it will not come in contact with the water droplet carryover. Cooling coils shall be selected at or below 500 fpm to minimize moisture carryover. Heating coils shall be selected at or below 750 fpm face velocity.

Drains and Drain Pans. Drain pans shall be made of stainless steel and adequately sloped and trapped to assure drainage. Drains in draw-through configurations shall have traps with a depth and height differential between inlet and outlet equal to the design static pressure plus 1 inch minimum.

Filter Sections. Air filtration shall be provided in every air handling system. Air-handling units shall have a disposable pre-filter and a final filter. The filter media shall be rated in accordance with *ASHRAE Standard 52*. Pre-filters shall be 30 percent to 35 percent efficient. Final filters shall be filters with 85 percent efficiency capable of filtering down to 3.0 microns per *ASHRAE 52*. Filter racks shall be designed to minimize the bypass of air around the filter media with a maximum bypass leakage of 0.5 percent.

Filters shall be sized at 500 FPM maximum face velocity. Filter media shall be fabricated so that fibrous shedding does not exceed levels prescribed by *ASHRAE 52*. The filter housing and all air-handling components downstream shall not be internally lined with fibrous insulation. Double-wall construction or an externally insulated sheet metal housing is acceptable. The filter change-out pressure drop, not the initial clean filter rating, must be used in determining fan pressure requirements. Differential pressure gauges and sensors shall be placed across each filter bank to allow quick and accurate assessment of filter dust loading as reflected by air-pressure loss through the filter and sensors shall be connected to building automation system.

Access Doors. Access Doors shall be provided at air handling units downstream of each coil, upstream of each filter section and adjacent to each drain pan and fan section. Access doors shall be of sufficient size to allow personnel to enter the unit to inspect and service all portions of the equipment components.

Terminals. *VAV terminals* shall be certified under the ARI Standard 880 Certification Program and shall carry the ARI Seal. If fan-powered, the terminals shall be designed, built, and tested as a single unit including motor and fan assembly, primary air damper assembly and any accessories. VAV terminals shall be pressure-independent type units. All terminals shall be provided with factory-mounted direct digital controls compatible and suitable for operation with the Direct Digital Controls.

Air Delivery Devices. Terminal ceiling diffusers or booted-plenum slots should be specifically designed for VAV air distribution. Booted plenum slots should not exceed 4 feet in length unless more than one source of supply is provided. “Dumping” action at reduced air volume and sound power levels at maximum cfm delivery should be minimized. For VAV systems, the diffuser spacing selection should not be based on the maximum or design air volumes but rather on the air volume range where the system is expected to operate most of the time. The designer should consider the expected variation in range in the outlet air volume to ensure the air diffusion performance index (ADPI) values remain above a specified minimum. This is achieved by low temperature variation, good air mixing, and no objectionable drafts in the occupied space, typically 6 inch to 6 feet above the floor. Adequate ventilation requires that the selected diffusers effectively mix the total air in the room with the supplied conditioned air, which is assumed to contain adequate ventilation air.

7-4 BUILDING AUTOMATION SYSTEMS (BAS)

A computer-based building automation system (BAS) that monitors and automatically controls lighting, heating, ventilating and air conditioning is critical to the efficient operation of the modern state office building. The state generally encourages integration of building automation systems when it is cost effective for the size of building complexity of the system. Exceptions are the fire alarm and security systems, which shall function as stand-alone systems with a monitoring only interface to the BAS.

BAS shall be direct digital control (DDC) for providing lower operating costs and ease of operation. Microprocessor PID controllers monitor and adjust building systems to optimize their performance and the performance with other systems in order to minimize overall power and fuel consumption of the facility, BAS monitor systems such as HVAC and lighting.

The system shall consist of series of direct digital controllers interconnected by a local area network. BAS system shall be accessible through a web browser. System shall have a graphical user interface and must offer trending, scheduling, downloading memory to field devices, real-time "live" graphic programs, parameter changes of properties, set point adjustments, alarm/event information, confirmation of operators, and execution of global commands.

A BAS is not required for every project and should be evaluated based on the size of the building, number of pieces of equipment, expectation for monitoring energy use, availability of trained staff and location of building should all be considered before deciding to add a BAS. A Building Automation System will be required on all campuses which utilize a Facilities Work Station to view BAS Systems in each building.

7-5 CONTROL SYSTEMS

Direct Digital Controls will be specified in all State Buildings where technically feasible and when it is cost effective for the size of building and complexity of the system.

Automatic Temperature and Humidity Controls
A direct digital control (DDC) system with host computer controlled monitoring and control shall be provided or viewable on the building internet system where technically feasible. Control Systems shall be BACNET or LONWORKS, conforming to ASHRAE BACNET Standard 135. Any proprietary control systems including all programming will be made available through hand-held devices or programming tools or computer work station. All controllers will be provided with uninterruptible power supplies in order for programming to be stored and maintained during power outages.

Controls. Pre-programmed stand-alone single or multiple loop microprocessor PID controllers shall be used to control all HVAC and plumbing subsystems. PID loops shall be utilized. All chillers, boilers, terminal units and air handling units shall have self-contained BACNET or LONWORKS controllers, capable of communicating with the Building Automation System.

Temperature Controls. Heating and cooling energy in each zone shall be controlled by a thermostat or temperature sensor located in that zone. Independent perimeter systems must have at least one thermostat or temperature sensor for each perimeter zone. A 3.5° or less dead band shall be used between independent heating and cooling operations within the same zone. Night set-back and set-up controls must be provided for all comfort conditioned spaces, even if initial building occupancy plans are for 24-hour operation. Morning warm-up or cool-down must be part of the control system. Controls for the various operating conditions must include maintaining pressurization requirements.

Variable Frequency Drives (VFDs). All VFDs will be supplied by the temperature control supplier and will communicate to the DDC System using BACNET or LONWORKS. VFDs will be controlled through the DDC System and will be designed to protect their circuits during a power outage or an over/under voltage and to automatically restart after the power has been restored. VFDs will be designed to operate at a maximum of 60 Hertz.

Temperature Reset Controls Air Systems. Systems supplying heated or cooled air to multiple zones must include controls that automatically reset supply air temperature required by building loads or by outside air temperature.

Hydronic Systems. Systems supplying heated and/or chilled water to comfort conditioning systems must also include controls that automatically reset supply water temperatures required by temperature changes responding to changes in building loads (including return water temperature) or by outside air temperature.

7-6 MECHANICAL INSULATION

General. All insulation materials shall comply with the fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723. Accessories such as adhesives, mastics, cements and tapes shall have the same or better fire and smoke hazard ratings.

Insulation shall be provided on all cold surface mechanical systems, such as ductwork and piping, where condensation has the potential of forming and in accordance with ASHRAE Standard 90.1. Insulation that is subject to damage or reduction in thermal resistivity if wetted shall be enclosed with a vapor seal (such as a vapor barrier jacket). Insulation shall have zero permeability.

Duct Insulation. All supply air ducts must be insulated, in accordance with ASHRAE Standard 90.1. Supply air duct insulation shall have a vapor barrier jacket. The insulation shall cover the duct system with a continuous, unbroken vapor seal. Insulation shall have zero permeability.

Return air and exhaust air distribution systems shall be insulated in accordance with ASHRAE Standard 90.1. The insulation of return air and exhaust air distribution systems needs to be evaluated for each project and for each system to guard against condensation formation and heat gain/loss on a recirculating or heat recovery system. All equipment, heat exchangers, valves, tanks, and pumps shall be insulated as per ASHRAE Standard 90.1.

Piping Insulation. All piping systems must be insulated in accordance with ASHRAE Standard 90.1. Piping systems conveying fluids, those having design temperatures less than 65°F or greater than 105°F shall be insulated. All piping systems with surface temperatures below the average dew point temperature of the indoor ambient air and where condensate drip will cause damage or create a hazard shall be insulated with a vapor barrier to prevent condensation formation regardless to whether piping is concealed or exposed. Chilled water piping systems shall be insulated with non-permeable insulation (of perm rating 0.00) such as cellular glass. All exposed and concealed piping shall have PVC jacketing. Domestic water piping shall be insulated in accordance with ASHRAE 90.1.

Equipment Insulation. All equipment including air handling units, chilled and hot water pumps, and heat exchangers must be insulated in accordance with ASHRAE Standard 90.1. All pumps, valves shall have removable and reusable insulation jacketing.

Thermal Pipe Insulation for Plumbing Systems. All piping exposed in plenums or above ceiling shall be insulated to prevent condensation.

7-7 ELECTRICAL ENGINEERING

Electrical and communications systems in state buildings provide the infrastructure for an efficient work environment for the occupants. These systems must support the many types of equipment used in a modern office setting in a reliable fashion.

There are three characteristics that distinguish state buildings: long life span, changing occupancy needs, and the use of a life cycle cost approach to account for total project cost.

During the life span of a typical state building, many minor and major alterations are necessary as the missions of state agencies change. The flexibility to adjust to alterations easily must be designed into the building systems from the outset. Electrical and communications systems should provide ample capacity for increased load concentrations in the future and allow modifications to be made in one area without causing major disruptions in other areas of the facility.

It is the state's goal to build facilities equipped with the latest advances in office technology and communication. This intent should be extended to include the future evolution of automated office and telecommunications equipment as well. Making this concept a reality requires a comprehensive design for engineering systems that goes beyond the requirements of the immediate building program. It also requires a higher level of integration between architecture and engineering systems than one would usually expect in an office building

APPENDIX A: CONSULTANT SERVICES
PREDESIGN, DESIGN AND POSTDESIGN SERVICES

A-1 PREDESIGN SERVICES

This process involves meeting with the users to review the requirements for a new project and the preparation of the programming document. A&E normally completes this process in collaboration with the agency personnel. On larger or more complex projects, an Architect/Engineer may be contracted to study functional adjacencies, lead the planning process, and provide sketches and other design-related support. Often, a charrette-like process may be used to define the users' requirements.

A-2 DESIGN SERVICES

A-2.1 Architectural Review Board

Some campuses have architectural review boards. The design team shall provide adequate documentation for review including site studies, plans, elevation and material selection to provide the board a clear understanding of the design intent. Present the project as required by the campus.

A-2.2 Basis of Design

The architectural program/basis of design is a written document that describes the project at the preliminary stage and is updated at each subsequent stage. Include the following items:

- **Scope of Work** – State and summarize the architectural program or scope of work, listing the overall square footage, the function of the facility and a tabulation of rooms with square footages of each space.
- Type of Construction - Describe the type of construction selected and justify its use relative to building permanency, life cycle cost, functionality, and fire resistance.
- **Code Analysis** - Provide an analysis of the design relative to pertinent codes to include, as a minimum, the required number of exits, travel distances, egress capacity of exits, and fire area separations.
- **Gross Floor Area Calculations** - Provide complete area breakdown tabulation for gross and net areas to confirm scope.
- **Accessibility** - Describe accessibility features included in the project, and indicate how the design meets the requirements in ADAS.
- **Architectural Compatibility** - Identify the design guidelines that pertain to this project, and describe how the proposed design incorporates these guidelines.
- **Roof System Selection** - Indicate the construction of the roof, roof membrane selection, substrate, roof slope, roof drainage system.
- **Thermal Envelope** - Describe the types of insulation to be provided, and indicate specific “U” values for the wall, roof, and floor construction. Provide a moisture vapor analysis.
- **Mechanical** – Describe temperature and humidity ranges, for each space, or type of space, and its associated controls. Coordinate with building envelope and occupancy.
- **Electrical systems** - Indicate light levels including variable light levels, switching, and daylight-governed controls. Coordinate with building envelope and occupancy. Coordinate user IT requirements.
- **Sustainable Design** - Describe the sustainable design features included in the design. Provide an analysis of compliance with the Montana High-Performance Building

Standards, Green Globes Rating System, and the U.S. Green Building Council's (USGBC) "Leadership in Energy and Environmental Design" (LEED) Rating System criteria as it applies to the design of the project. Include updated information with each required design submittal.

- **Security Requirements** - Describe any physical security or hardening requirements, such as controlled access, or notification/management of threats.
- **Architectural Acoustics** – Include a statement of adherence to the applicable criteria, per SECTION 4 of this MDS.
- **Demolition or Deconstruction** – Describe the extent of any architectural demolition or deconstruction and the items to be salvaged.

A-3 CONSTRUCTION DOCUMENTS

A-3.1 BOILERPLATE

The design consultant(s) shall coordinate with the A&E design project manager and agency contact(s) in order to complete the boilerplate request form. A&E will then prepare the boilerplate and transmit it to the consultant. The consultant must confirm that his Division 1 documents coordinate with the boilerplate and may not change information without written approval of the A&E design project manager.

A-3.2 SPECIFICATIONS

Design-Bid-Build and Design-Build projects have differing specification requirements. In either case, the specifications must be as concise as possible, definitive, and free of ambiguity and omissions that may result in controversy and contractor claims for additional compensation.

A-3.3 ARCHITECTURAL DRAWINGS

Drawings must be clear, concise, accurate, and properly noted. They must be coordinated with themselves, the various disciplines and the specifications. Drawing sheets must be well laid-out, consistent and effectively use the space on each sheet. Details need to be thoughtfully and consistently laid-out and sized only as necessary to be readable and convey their information. The Architect shall internally review documents, conduct REDICHECK® review and correct issues before submitting documents for Owner review. Refer to the A&E website link http://architecture.mt.gov/forms/architectengineer.mcpx

Confirm drawing size and format requirements with the A&E design project manager prior to starting drawings.

- Draw all plans at the same scale, with the same orientation and same sheet location.
- Avoid vague notes such as see mechanical or structural; refer to specific locations.
- Verify for accuracy and complete references the details and sections.
- Show wall sections and details at relative elevations to each other.
- Provide information appropriate to the level of detail.
- Use appropriate line weights and fonts.

Final construction drawings must include, as applicable, but not be limited to the following:

- **Title and General Sheets:** List all drawings in the set, project name, agency, city, A&E project number, location and vicinity maps.
- **Floor Plans:** Completely dimension and reference other drawings. Indicate plan orientation. Draw building plans parallel to the sheet border, generally with north upward. All disciplines' drawings must be consistent in orientation. The site plan and the building plan shall be in approximately the same orientation.

- **Building Code/Life Safety Code Analysis:** Conduct a diagrammatic analysis and indicate code compliance (e.g. remoteness of exits, common path of travel, compartmentalization, fire extinguisher locations, etc.) to graphically demonstrate compliance with the Life Safety Code. Coordinate with the fire protection engineer as required.
- **Roof Plans:** Completely dimension and reference other details.
- **Reflected Ceiling Plans:** Fully coordinate with and show all disciplines.
- **Building Elevations:** For all elevations, indicate location of control joints and expansion joints. Fully coordinate with all disciplines; show vents, fixtures, louvers, meters and units.
- **Building Sections and Wall Sections:** For all different conditions. Identify air barrier, moisture barrier, and insulation barrier systems.
- **Wall Types:** Indicate all wall types on the floor plan.
- **Air Barrier:** Indicate the boundary limits of the air barrier components (pressurization area for air barrier testing) on the plan and section. Also indicate the actual area of the pressure boundary (ft.2/m2).
- **Interior Elevations:** Indicate all different conditions and coordinate with other drawings.
- **Door Schedule and Details and Window Types and Details.**
- **Room Finish Schedule and Finish Notes:** Complete for all finishes.
- **Details:** Complete for all different conditions, especially the moisture barrier system, flashing details for all wall penetrations, terminations and transitions, and roof ridge, edge, parapet, drainage, and penetration details.

A-3.3.1 DIMENSIONING

Provide floor plans with sufficient dimensions to avoid construction difficulties and so that the contractor can layout the work without multiple computations or referring to other drawings. Provide vertical dimensions on elevations and sections. Dimensioning guidelines are as follows:

Exterior Dimensions

- Provide overall building dimensions.
- Provide continuous strings of dimensions of column centerlines that extend to exterior building faces.
- Provide a continuous string of dimensions that locate all exterior building wall line breaks. Wall line breaks must also be dimensioned to column centerlines.
- Provide dimensions that show masonry and wall openings. Provide through-wall dimensions.
- Provide vertical dimensions for elevations and sections.

Interior Dimensions

- Dimensions shall be indicative of design intent (e.g. if a door is to be centered on a space, indicate dimensions as “equal-equal”).
- Indicate all statutory dimensions, such as accessibility requirements, egress, etc.
- Provide continuous strings of dimensions through the building in each direction that extend through the exterior wall.
- Dimension masonry walls and stud partitions to one side of the wall. Wall thickness may be indicated with dimensions or by wall types.
- When a dimension string passes through a space that is shown elsewhere at a larger scale, this space may be provided with an overall dimension. The large-scale plan must show additional dimensions. To ensure continuity, take dimensions from the same wall face as shown on the overall plan.

- Where a wall or partition aligns with a column, wall opening, window jamb, or other feature, ensure that all other dimensions to that wall or partition are to the same face. Additionally, if a dimension is to a particular wall or partition face, then all other dimensions to that wall must be to that face.

A-3.3.2 CALCULATION OF GROSS BUILDING AREA

Calculate the gross area of a building using the following:

- Enclosed spaces: The gross area includes the total area of all floors, including mezzanines, basements, penthouses, and other enclosed spaces as measured from the exterior faces of the exterior walls or from the centerline of walls separating joined buildings.
- One-Half Spaces: Include one-half of the gross area of paved or finished covered but not enclosed areas.
- Excluded space: attic and crawlspaces areas with ceiling height of less than 7' to underside of structure, catwalks, mechanical platforms, and uncovered exterior spaces.

APPENDIX B: BEST PRACTICES

B-1 LOCAL CONSTRUCTION METHODS, MATERIALS, AND SKILLS

Design to take advantage of economies resulting from the use of suitable local construction methods, materials, and skills that are consistent with the intent of these criteria.

B-2 BUILDING ENVELOPE

See the following resources for more information and sample design details

- Building Envelope Design Guide: http://www.wbdg.org/design/envelope.php
- WBDG Resource Webpage for Air Barrier Systems: http://www.wbdg.org/resources/airbarriers.php
- Also see USACE *Air Barrier Continuity Guide* http://www.wbdg.org/pdfs/usace_airbarriercontinuity.pdf .
- Sample Exterior Envelope Details: http://www.mass.gov/?pageID=eopsterminal&L=4&L0=Home&L1=Consumer+Protection+%26+Business+Licensing&L2=License+Type+by+Business+Area&L3=Construction+Supervisor+License&sid=Eeops&b=terminalcontent&f=dps_inf_bbrs_sample_detail&csid=Eeops

B-3 MOISTURE

Moisture in its different forms is the major cause of water intrusion, condensation, shortening of service life, and disruption of operation. Walls leak when three conditions exist simultaneously: (1) Rainwater is on a wall; (2) Openings exist through which the rainwater can pass; and (3) Forces are present to drive or draw the rainwater inward. If any of these three essential conditions is eliminated, rainwater will not penetrate the enclosure.

It is difficult and impractical to keep wind-driven rain off the exterior walls of a building. Overhangs, cornices, and solar shading can be effective in minimizing, but will not prevent, wetting of a wall. Thus, it should be expected that exterior walls will be covered by a film of water during a rain event and that this film thickens when rain flows down the building wall. It is virtually impossible to build an exterior wall without any unintentional openings or leakage paths. Such openings may be pores, cracks, incompletely filled or poorly adhered mortar joints, or moving joints between elements or different materials. A typical masonry wall contains multiple apertures of various types and sizes yielding many joints between dissimilar materials prone to movement and joint failure. One square foot of brick masonry contains 6.75 modular brick, 6 lineal ft. (1830 mm) of mortar joint and 12 lineal ft. (3660 mm) of brick-mortar joint interface. For 20,000 ft2 (1858 m2) of wall surface, this equates to 135,000 modular brick, 22.7 miles (36.5 km) of mortar joint and 45.5 miles (73.2 km) of brick-mortar joint interface. Water can penetrate openings as small as 0.005 in. (.1 mm), which is just slightly more than the thickness of a sheet of bond paper.

Even if a good seal is achieved initially; odds are that the seal will deteriorate over time under the action of temperature, water, deterioration due to ultraviolet radiation and differential movement. For these reasons, a single 4-in. (100-mm) wythe of masonry conventionally laid up in the field (or any cladding for that matter) should not by itself be expected to be watertight. It is also why sealants cannot be expected to keep water out of building enclosures. There needs to be an underlying drainage plane or WRB and flashings to lead water that penetrates building assemblies out again.

Forces acting on an exterior wall during a rain event that individually or in combination can contribute to rain penetration include the following: (1) raindrop momentum or kinetic energy, (2) capillary suction; (3) external or internal air pressure; (4) gravity, and (5) surface tension. Water hits and wets the tops of buildings first, as well as projections. Water tends to travel over and flow down reveals and channels in the façade in a concentrated manner.

When the joints are well-pointed, brick masonry tends to absorb moisture for 4 to 6 in. (100 to 150 mm) depth after a rain event, and to dry out in dry periods. All masonry mass wall must have ventilation on the interior face of the exterior wall (and parapets) to assure proper drying. Single wythe concrete block walls are undesirable because they do not manage moisture well. Wall design today should be a rain screen design; in other words cladding should have a WRB in the wall assembly behind the cladding, with flashings to lead water out. This is true for all claddings including EIFS; face-sealed assemblies are not acceptable.

B-4 LIGHT / RADIATION

Generally speaking, light is desirable while the accompanying heat (radiation) is not. They penetrate through the fenestration, which is the least energy-efficient component of the envelope. In addition to effective glazing design and shade structures, building orientation plays a large role in managing the light/heat gain balance.

B-5 MOLD

Refer to the following web site for detailed discussion of moisture management
http://www.wbdg.org/ccb/AF/AFETL/etl_04_3.pdf

B-6 ACOUSTICS

Use UFC 3-450-01, “Noise and Vibration Control” for the acoustical attenuation of the mechanical systems. The “Suggested Design Values” STC ratings in UFC 3-450-01 can also be used as a guideline for the STC ratings of different wall, floor and ceiling assemblies.

B-7 HPBS MONITORING

A&E should establish practices to evaluate its high-performance or green buildings after construction to ensure that objectives are met, performance continues to improve, and the measures required to reduce levels of energy and water use are cost-effective. Specifically, for all new construction and major renovations, A&E should measure actual performance for at least three years after initial occupancy and use the resulting information to modify its policies as needed. In addition, data for conventional A&E buildings should be gathered to establish baselines for performance measurement. A&E should retain the flexibility to modify High Performance Building Standards and the application of green building certification systems in ways that are appropriate to the department's operating environment and mission.

Using an investment approach that looks at the total cost of lifetime building ownership with the full range of benefits and expenses will also aid in decision-making about investments in A&E buildings. This approach would account for variations in geographic conditions, climate, type of building, and local prices for energy, water, and other utilities. To be effective, however, A&E will need to ensure that the data used in the analysis are accurate and reliable.

Because high-performance or green buildings incorporate integrated design practices and new technologies, facilities managers will need to be trained to understand how to operate them effectively. Implementation of DEQ training programs should help ensure that agency facilities managers are certified in the required competencies and skills.

B-8 EVIDENCE-BASED DESIGN

Evidence-based design is a process used in the planning, design, and construction of buildings that emphasizes the importance of using credible data in order to influence the design process. Decisions are made based on the thoughtful use of best information available from research, project evaluations, and from evidence gathered from the operations of the client. Critical thinking is required to develop an appropriate solution to the design problem.

The owner and design team need to work collaboratively to understand project objectives and take a balanced approach to accomplishing those objectives Evidence-based design is not static and does not mean rigid standards that limit creativity in solving design problems, but is intended to improve the quality of design decisions. Architecture has always been a blend of art and science. Strong evidence indicates that building characteristics and indoor environments significantly influence the occupant's health, worker performance and productivity.

Evidenced based designers should stay current with relevant literature, investigate completed projects and research pertinent information, and incorporate concepts based on this information. Architects and engineers have the responsibility to provide good design based on their professional knowledge and experience, and supported with credible research in human ecology, environmental considerations, financial expectations and post-construction data.

Many recent studies have examined how the physical environment can influence well-being, relieve stress, and improve productivity. Evidence-based design also presents a definitively authoritative way to explain how design interventions give clients a quality return on their investment.

B-9 SUPPLEMENTAL HIGH-PERFORMANCE & SUSTAINABLE BUILDING REQUIREMENTS

Uniform Facilities Requirements: http://www.wbdg.org/ccb/DOD/UFC/ufc_1_200_02.pdf

USGBC: http://www.usgbc.org/

B-10 BEST MANAGEMENT PRACTICES FOR CONTROLLING THE SPREAD OF NOXIOUS WEEDS

Recommendations of the Greater Yellowstone Coordinating Committee – Terrestrial Invasive Species Subcommittee for adopting a proactive approach to noxious weed control:
http://www.weedcenter.org/services/documents/GYCC_final.pdf

APPENDIX C REFERENCES

C-1 ARCHITECTURE & ENGINEERING DIVISION

The A&E web site provides information about the division, consultant selection procedures, contracting requirements, forms used in contracting and project management and high performance building standards, http://architecture.mt.gov/default.mcpx

C-2 WHOLE BUILDING DESIGN GUIDE

The Whole Building Design Guide provides additional information and discussion on architectural practice and facility design, including a holistic approach to integrated design of facilities.
Whole Building Design Guide, National Institute of Building Sciences, http://www.wbdg.org

C-3 LIFE-CYCLE COST ANALYSIS

A number of tools comparing energy system alternatives and evaluating specific conservation measures may be of benefit in performing energy conservation calculations. Additional information can be found at: http://apps1.eere.energy.gov/buildings/tools_directory/
A link to BLCC can also be found at the Department of Energy's building energy tools web site http://www1.eere.energy.gov/femp/information/

C-4 ADDITIONAL REFERENCE LINKS

2010 ADA Standards for State and Local Government Facilities Title II, http://www.ada.gov//regs2010/2010ADAStandards/2010ADAstandards.htm#pgfId-1009831

29 CFR 1910, *Occupational Safety and Health Standards,* Occupational Safety & Health Administration, http://www.osha.gov

ACI 530, *Building Code Requirements for Masonry Structures,* American Concrete Institute (ACI) International, http://www.aci-int.org

Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractors' National Association, http://www.smacna.org/

ANSI/ASHRAE/IESNA Standard 90.1 2007, *Energy Standards for Buildings Except Low Rise Residential,* American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), www.ashrae.org

ANSI/ASHRAE/USGBC/IEC 189.1 2009, Standard for the Design of High Performance Green Buildings, Except Low-Rise Residential Buildings, http://www.nrel.gov/docs/fy10osti/47906.pdf

Asbestos Control Program, Dept. of Environmental Quality, 406 444-5300, http://www.deq.mt.gov/Asbestos/default.mcpx

ASHRAE Standard 160, *Criteria for Moisture-Control Design Analysis in Buildings,* www.ashrae.org

ASTM E779, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization,* ASTM, www.astm.org

ASTM E1186, *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems,* ASTM, www.astm.org

ASTM E1745, *Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs,* ASTM, www.astm.org

ASTM E1827, *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door,* ASTM, www.astm.org

ASTM Manual 40, *Moisture Analysis and Condensation Control in Building Envelopes,* ASTM, www.astm.org

BIA Technical Note 7*Water Resistance of Brick Masonry- Design and Detailing,* Brick Industry Association, http://www.gobrick.com

BIA Technical Note 18A, *Accommodating Expansion of Brickwork,* Brick Industry Association, http://www.gobrick.com

BIA Technical Note 21, *Brick Masonry Cavity Walls,* Aug 1998, Brick Industry Association, http://www.gobrick.com

CAN/CGSB-149.15-96, *Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems*
EIFS Standards & ICC-ES Acceptance Criteria, EIFS Industry Members Association, http://www.eima.com/

Center for Invasive Species Management, Montana State University, http://www.weedcenter.org/

EPA Radon Information Center, (703) 356-5346, http://www.radon.com/

EPA/402/R-92-014, *Radon Measurement in Schools,* U.S. Environmental Protection Agency, http://www.epa.gov/radon/pubs/

EPA/625/R-92-016, *Radon Prevention in the Design and Construction of Schools and Other Large Buildings,* U.S. Environmental Protection Agency, http://www.epa.gov/radon/pubs/
http://www.deq.mt.gov/Asbestos/default.mcpx

Facility Performance Evaluation (FPE) Guide Document for Public Facilities, http://www.nasfa.net/associations/4146/files/NASFA_FPE_GuidanceDocFiNAL_110110.pdf

General Service Administration, Facility Services Standards for Public Buildings, Mechanical Engineering, http://www.gsa.gov/portal/category/21054

Gypsum Construction Guide, National Gypsum Company, http://www.nationalgypsum.com/

International Building Code, International Code Council, http://www.iccsafe.org

Montana Building Codes Bureau, Department of Labor & Industry, http://bsd.dli.mt.gov/bc/bs_index.asp

Center for Invasive Species Management, Montana State University, http://www.weedcenter.org/

Montana Multi-Hazard Mitigation Plan and Statewide Hazard Assessment, Disaster and Emergency Services, http://montanadma.org/montana-mitigation-plan

Montana Noxious Weed Program, Department of Agriculture, http://agr.mt.gov/agr/Programs/Weeds/index.html

Montana Public Works Standard Specifications, Montana Contractors Association, http://www.mtagc.org/assets/PDF/Misc/Order_Forms/Web-order-Form.pdf

Montana State Historic Preservation Office, Historic Architecture, http://mhs.mt.gov/shpo/histarch.asp

Montana Water Resources Division, Flood Plain Management, Department of Natural Resources, http://dnrc.mt.gov/wrd/water_op/floodplain/

Montana Wood Product Directory (being developed for fall 2015): http://dnrc.mt.gov/divisions/forestry/forestry-assistance/biomass

MPI *Detailed Performance Standards,* Master Painters Institute (MPI), http://www.paintinfo.com/

MPI *Architectural Painting Specification Manual,* Master Painters Institute (MPI), http://www.paintinfo.com/

Rocky Mountain ADA Center: 800-949-4232 719-444-0269 (fax), http://www.adainformation.org/

Rocky Mountain Masonry Institute, http://www.rmmi.org/

Secretary of Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings, National Park Service, http://www.nps.gov/hps/tps/tax/rhb/index.htm

Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractors' National Association, http://www.smacna.org/

The Difference Between a Vapor Barrier and an Air Barrier, 1985, R.L. Quirouette, National Research Council of Canada, Ottawa, Ontario, Canada, http://www.airbarrier.org/about/difference_e.php

Executive Order No. 12-2014 Promoting Use of Montana Wood Products , http://governor.mt.gov/Portals/16/docs/2014EOs/EO_12_2014_Wood%20Products.pdf

Wood Biomass Energy Program, Montana Department of Natural Resources and Conservation, http://dnrc.mt.gov/forestry/assistance/biomass/

reThink WOOD. Information and resources on wood performance, cost and sustainability. http://www.rethinkwood.com/

WoodWorks, Resources, education and technical support for the design and construction of *non-residential wood buildings. http://www.woodworks.org/*