MINNEAPOLIS
PUBLIC SCHOOLS

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ACCEPTABLE INDOOR AIR QUALITY for SCHOOL CONSTRUCTION PROJECTS

ARCHITECTURAL GUIDELINES for ACCEPTABLE INDOOR AIR QUALITY (IAQ) for SCHOOL CONSTRUCTION PROJECTS

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INTRODUCTION

The mission of the Indoor Air Quality Task Force is to create a more productive learning environment for school children through indoor air quality. Improved indoor air quality should decrease absenteeism and respiratory illness in schools. Studies have shown that:

1. Indoor air quality and relative humidity in buildings is directly linked to the health of its occupants.
2. In schools, absenteeism and the transmission of colds have been found to correlate to the relative humidity and the indoor air quality.
3. Children do not have fully developed immune systems, and are more susceptible to disease transmission, respiratory illnesses, and allergic reactions.
4. Low humidity causes dryness of the throat and mucus membrane, making one more susceptible to disease transmission.
5. Respiratory illnesses are at their peak in winter, when humidity is the lowest.
6. Molds and fungus grow when humidity is too high, which can cause allergic reactions.
7. At higher humidity, flu viruses do not spread as fast.

The following is an outline of Architectural specification recommendations developed by the task force to improve indoor air quality in school buildings, both new construction and remodeling.

*SPECIAL SCHOOL DISTRICT NO. 1
MINNEAPOLIS PUBLIC SCHOOLS
ARCHITECTURAL INDOOR AIR QUALITY TASK FORCE

SPECIFICATION RECOMMENDATIONS

DIVISION 1 - GENERAL REQUIREMENTS

A. Section 01010 - Summary of Work:

Recommendations:

1. Sequence of Work: Establish a timeline of activities: include the time periods in the construction schedule for the following issues:
   a) Off-gassing of materials: Provide schedule that includes time for material off-gassing prior to occupancy. Refer to off-gassing timeline in individual sections.
   b) On the project schedule, provide for sequencing of work to ensure appropriate environmental conditions for products to be installed under manufacturer's recommendation.
   c) Provide adequate time for concealed work to be reviewed by Architect prior to being covered (example: vapor barriers, etc.).
   d) Include time allowance for environmental testing after off-gassing periods, etc., prior to occupancy.
   e) Do not allow work which generates particulate which could be concealed by previously installed systems (example: drilling above ducts, etc.).
2. Contractor's Use of Premises
   a) Prohibit on-site smoking or use of tobacco.
   b) Isolate from construction areas locations of lunches/breaks where food cannot be left in walls, etc. Prohibit food/beverages in work areas. A designated area for consumption of food and beverages must be provided.
   c) Contractor to immediately notify Architect or Owner of wet condition and provide follow-up correction.
   d) Contractor is responsible for security of building to prevent water damage.
   e) Prohibit tools that create pollutants when site is enclosed, such as generators, etc.

f) Provide appropriate storage of hazardous materials (fuel, paints, etc.). This should be in a designated storage area, isolated in a trailer, separate from the building. Storage of fuel oils – to be in a heated trailer outside of the building.

B. Section 01040 - Coordination:

Recommendations:

1. Project Coordination
   a) Specify coordination of trades when concealing work or providing proper environmental project requirements.
   b) Specify coordination of concealed work to be reviewed by Architect: A/E team "tags" areas that have been reviewed.
2. Job Site Administration
   a) Contractor's supervisory staff to be made aware of indoor air quality concerns and project requirements.
   b) Attend IAQ training, 4 hours for job superintendent - could be a video of procedures.
   c) Require all trades attend IAQ training, 1 hour.
   d) Review IAQ issues at weekly OSHA meetings.
   e) Get rid of "not my job" philosophy at jobsite regarding IAQ
   f) Promote timely decisions from Owner and Architect regarding IAQ issues, otherwise penalties will be imposed.
   g) Post special instructions and procedures related to IAQ for products at the construction site. These posted instruction sheets would be included in the specifications appendix, and would list instructions for specific procedures for indoor air quality for a particular product.

C. Section 01045 - Cutting and Patching:

Recommendations:

1. Ensure temporary barriers are dust-free, "contain the debris"; provide dust-free openings. Provide complete enclosure of openings.
2. Employ methods for cutting to minimize dust: use water or direct vent methods. Refer to selective demolition.

D. Section 01200 - Project Meetings:

Possible Environmental Issues:

1. Pre-Construction Conference

a) Add IAQ as part of agenda, including special products, scheduling related to off-gassing, and ventilation requirements. Coordination of inspections of materials to be covered in a pre-construction meeting.

b) Have MPS health and safety representative attend regular meetings.

2. Pre-Installation Conference

a) Include indoor air quality requirements as a part of an agenda or have pre-installation conference when a product affects indoor air quality.

F. Section 01300 - Submittals & Section 01630 - Products Options and Substitutions:

Recommendations:

1. Submittal of safety data sheets for products.

a) Include MSDS.

b) Include manufacturers' written installation guidelines.

G. Section 01400 - Quality Control:

Recommendations:

1. Specify Environmental Commissioning (refer to Mechanical).

H. Section 01410 - Testing and Inspection:

Recommendations:

1. Testing and inspection related to Indoor Air Quality: Testing should be done on site prior to starting construction, after construction is complete, and periodically during construction.

2. Limits of Testing Agency Authority:
Should be able to recommend to MPS Health and Safety Representative:

a) Additional testing.

b) Correction/stop work orders.

3. Initial tests to evaluate a site include: soil and water samples, ambient air quality data and local contaminant sources.

I. Section 01500 - Temporary Facilities:

Recommendations:

1. Temporary Heat:

a) Specify that visible condensation is an unacceptable condition.

2. Temporary ventilation:
   a) Provide temporary ventilation to purge the off-gas requirements per mechanical sections at a rate of 1 cfm per sf.
   b) Provide separate temporary ventilation system if new mechanical system is installed.
   c) Painting and carpet installations are particularly crucial for adequate temporary ventilation and should be done at maximum rates.

J. Section 01569 - Construction Cleaning:

Recommendations:

1. Protect ducts and chases during construction and provide cleaning of ductwork prior to occupancy.
2. Specify periodic cleaning frequency and type of cleaning.
3. Avoid using water during clean-up.

K. Section 01700 - Contract Closeout:

Recommendations:

1. Maintenance Training: Enforce adequate training by subcontractors for systems users and building engineers to fully understand operation of all systems to maintain indoor air quality.
2. Specify thorough commissioning of mechanical systems - (see Mechanical).
3. As-builts and O & M manuals to include air quality issues.
4. Provide a close out list related to indoor air quality. Possibly include:
   a) visible condensation.
   b) was off-gassing adequate.
   c) commissioning.
   d) air balancing (see Mechanical).
   e) water damage areas.
5. Provide "special ventilation" before and during initial occupancy of all outdoor air for two hours per day.
6. Isolate construction activities from occupants after building is occupied.

DIVISION 2 - SITEWORK

A. Section 02070 - Selective Demolition:

Recommendations:

1. Methods used in demolition operations:
   Consider one or more of the following methods of containing contaminants:
   a) Water sprinkling, particularly during cutting operations (core-drilling).
   b) Eliminate, minimize or control the use of water on porous or absorbent materials to control possibility of microbial growth.
   c) Prevent ponding or entrapment of water in unreachable areas to prevent pools (standing water).
   d) Increase ventilation to control contaminant concentrations to acceptable levels.
   e) Use of special filtering.
   f) Consider carefully the removal/replacement of existing carpet due to the dust and particulate generated.
2. Maintain clean to dirty air flow between occupied and demolition areas by one of the following:
   a) Isolation, temporary enclosures or other suitable methods to limit dust and dirt.
   b) Where possible, shutdown and seal off HVAC equipment to avoid contamination and/or circulation of contaminates.
   c) Use of direct exhaust without recirculation is the preferred solution.
   d) Use of dedicated temporary exhaust systems.
3. Disposal of demolished materials to be separated due to the dust and particulate generated.
4. Identify testing for hazardous materials.
5. If mold growth was encountered use 1% - 5% chlorine solution for abatement. Use respirator during clean-up.

C. Section 02100 - Site Preparation:

Recommendations:

1. Avoid herbicides to clear vegetation.
2. Remove or seal off underground entrance paths for contaminates.

3. Prebate buildings particularly in food preparation area and waste storage areas, (Integrated Pest Plan). Use boric acid at masonry foundation walls.

D. Section 02900 - Landscaping:

Recommendations:

1. Avoid use of fertilizers and pesticides.

DIVISION 3 - CONCRETE

A. Section 03300 - Cast-in-place Concrete:

Environmental Concerns:

1. Concrete admixtures related to environmental concerns.
2. Use of liquid cure/seal compound.
3. Use of treated expansion joint fillers.
4. Location of vapor barrier beneath interior floor slabs-on-grade due to soil gases. Place vapor barrier directly below the concrete slab.

Recommendations:

1. Where there is soil behind concrete work, seal seams and cracks for soil gases. Provide continuous vapor barrier, seal all seams. Use a minimum of 10 mil. vapor barrier.
2. Take measures to reduce residual concrete dust from construction which can be an airway irritant. This may include air filtration during the mixing of concrete and vacuuming/cleaning surfaces that may accumulate concrete dust during construction. Soft cut concrete with saw while concrete is "green" (less dust). This also provides better quality control.
3. Use water-based sealants at exterior and interior concrete work.

B. Section 03350 - Concrete Finishes:

Environmental Concerns:

1. Methods and chemicals used to finish concrete which may be environmentally questionable, such as blasted concrete, exposed aggregate concrete, or acid etched concrete.

Recommendations:

1. Measures should be taken to control and remove dust produced in finishing procedures from the environment.

2. Avoid finishing surface treatments that are more likely to introduce concrete dust into the atmosphere through contact or crumbling.
3. Do not use finishing procedures or sealants that introduce chemicals with negative environmental effects (particular concern for workers and students during process).

DIVISION 4 - MASONRY

A. Section 04100 - Mortar:

Recommendations:

1. Prohibit rake joints in the interior due to dust accumulation. "V" joint or concave joints are recommended.
2. Epoxy mortar may be better in certain applications to provide a more healthy environment and a more easily maintained surface.

B. Section 04200 - Masonry:

Environmental Concerns:

1. Type of wall flashing and detailing.
2. Type of masonry cleaners used.
3. Use of insulation in wall construction - CFC free.
4. Sealant used relating to cavity wall insulation.
5. Use of foam caulking back-up material and masonry expansion and control joints.
6. Fire-safing (fibrous) insulation.

Recommendations:

1. Do not use acoustic block with fiber filler in cavities.

C. Section 04500 - Masonry Restoration and Cleaning:

Environmental Concerns:

1. Chemicals and methods used to clean masonry.

Recommendations:

1. Recommend detergent (TSP) washing in lieu of acid washing.
2. For masonry cleaning, care should be taken that chemicals are not entrained into the building HVAC system. For interior cleaning, provide adequate ventilation during and after cleaning procedures. (See temporary ventilation under temporary facilities.)

3. Control dust produced during restoration procedures - filter/ventilate to outside.
4. Control runoff of any potentially toxic cleaning chemicals.

DIVISION 5 - METALS

Recommendations:

1. Use steel framing in place of treated wood framing in areas where high moisture, termites or other pests prohibit the use of regular wood framing (to avoid VOC problems associated with treated wood members).
2. The oil coating on steel studs is potentially allergenic; however, due to the expense of removing the oil or getting the manufacturers to change products, this coating could be eliminated.

DIVISION 6 - WOOD AND PLASTICS

A. Section 06100 - Rough Carpentry:

Environmental Concerns:

1. Formaldehyde emissions of plywood and other wood products.
2. Treated woods: preservative treated, fire-retardant treated, and insect treated wood.

Recommendations for Formaldehyde Emissions:

1. Specify products using PHENOL-Formaldehyde (PF) and prohibit products using UREA-Formaldehyde (UF) since the Phenol variety has greater stability and minimal IAQ effects. Softwood plywood uses phenol formaldehyde.
2. Use exterior-grade adhesives. This is identified by the black color of the adhesive, such as seen in glue-lams.
3. Use kiln dried lumber.

Recommendations for treated lumber:

1. Specify non-treated lumber except when absolutely necessary in situations where other methods of combating decay, fire and insects are not feasible.
2. For indoor areas, enclose and seal with vapor barrier the treated framing in walls and ceiling.

B. Section 06400 - Architectural Woodwork:

Environmental Concerns:

1. Emissions from plywood and particle board used in fabrications.

Recommendations:

1. Specify phenol-formaldehyde bonded particle board and plywood instead of urea-formaldehyde varieties.
2. For hardwood panels, specify hardwood plywood panels or wood veneer particle board panels stamped with minimum HUD standards for emission limits.
3. Where UF bonded particle board must be used, specify low emitting products seal surfaces or encapsulate (such as floor underlayment).
4. Use plastic laminate and melamine, they are impervious to release.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

A. Section 07210 - Building Insulation:

For steel framed buildings, use the State energy code updated June 1, 2009 to define equivalent R-values of walls containing steel stud framing. In addition, the Architect shall use "Catalog of Thermal Bridges in Commercial and Multi-Family Construction" to identify areas of concern on each project. These areas of concern shall be noted and selected alternates identified prior to submitting documents. Building assemblies are required to maintain the thermal performance of installed insulation and the integrity of building materials against cold weather water vapor condensation and wind wash.

Environmental Concerns:

1. Fibers and/or VOC's released during installation or use of insulation systems.
2. Off-gassing of plastic foam insulation.
3. Use of adhesive and sealants in insulation systems and related off-gassing.
4. Vapor barrier installation, including anchorage and sealing.
5. Release of fibers from exposed fibrous forms of insulations.

Recommendations:

1. Keep insulation dry at all stages of installation and use to prevent growth of fungi and bacteria.
2. When using fibrous material provide adequate ventilation during and immediately after installation to alleviate problems associated with released fibers and dust.
3. Require contractors to follow protective measures recommended by the insulation manufacturer.
4. Use molded polystyrene in lieu of extruded polystyrene.
5. Use mechanical fasteners when installing insulation in lieu of adhesives.

6. Use mechanical fasteners and tape to install polyethylene film vapor barrier in lieu of adhesives and mastics.
7. Seal laps and perforations in polyethylene film vapor barriers with polyethylene tape.
8. Cover or contain fibrous forms of insulation exposed to the building environment which will restrict release of fibers into air and off-gassing of the phenol-formaldehyde binder which is often used in the manufacture of glass wool insulations.
9. Vapor Retarder:
   a) A vapor retarder must be installed on the warm side of insulated ceilings, walls and floors: minimum 6 mil. at walls, 10 mil. at concrete slabs.
   b) A vapor retarder can function as an air leakage barrier. It will need to be continuous, with all seams sealed with an approved tape as well as sealed with a caulk at the tops and bottoms of exterior walls. Adhere top in place until finishes are complete.
10. Air Leakage Barrier:
    a) A barrier must be installed to prevent the leakage of moisture laden air from the conditioned space into insulated ceilings, walls, and floors, as well as to prevent heat loss due to infiltration and exfiltration.
11. Piping and Ducts:
    a) Penetrations for piping and ducts into insulated ceilings, walls, and floors must be air sealed.
12. Framing to prevent air leakage:
    a) Framing must be installed to prevent air leakage.
13. Exterior joints:
    a) Exterior joints must be sealed around window and door frames, between wall cavities and window or door frames, at utility penetrations, between wall assemblies and their rim joists, sill plates, foundations, at exterior corners, between wall and roof/ceiling assemblies, and between separate wall panels.
14. Electrical wires and equipment:
    a) Electrical and telecommunication equipment and penetrations into insulated walls, ceilings, and floors must be sealed. The service entrance, wires, conduit, cables, panels, recessed light fixtures, electronic equipment, electrical boxes and fan housings must be sealed.
15. Performance Alternative:
    a) As an alternative to the prescriptive requirements above, buildings must have an air leakage rate of 0.35 cubic feet per minute per square foot of conditioned space or less when tested in accordance with ASTM E779-87.

16. Wind wash barrier:
    a) An air-permeable barrier must be provided at the following locations:
        i) Attic edge: A rigid or flexible baffle must be installed at the exterior edge of attic insulation to mitigate wind wash. Baffles must be resistant to wind drive moisture.
        ii) Overhangs: A wind wash barrier must be installed at cantilevered floors and bump out windows, including corners with adjoining walls above and below.
        iii) Exterior corner joints must be air sealed, including both interior and exterior corners.
17. Framing to assure air tightness and insulation coverage:
    a) Insulated ceilings with attics must have a minimum of 5 inches of vertical clearance between the wall top plate and roof sheathing.
    b) Exterior corners shall be framed so that insulation can be installed after the exterior sheathing is installed.
    c) Intersection of interior partition walls with exterior walls shall be framed to allow for insulation to be installed between the partition wall and exterior sheathing. A continuous air and vapor retarder must be installed between the interior wall and exterior wall framing.
    d) Whenever an insulated ceiling intersects a wall, the ceiling vapor retarder must be sealed to a plate or blocking in the wall. If the wall is an interior wall, the blocking must be air sealed.
    e) Prior to installing interior horizontal framing or bracing on an exterior wall, continuous polyethylene must be secured to the wall so as to provide a continuous air and vapor barrier behind the framing.
    f) Dropped ceilings and soffits shall be installed in accordance with items 'd' and 'e'. In addition, prior to installing framing on an insulated ceiling, continuous polyethylene must be secured to the ceiling so as to provide a continuous air and vapor barrier behind the framing.
    g) Rim and band joist framing must be caulked or gasketed or otherwise constructed to prevent air leakage. The sill sealer capillary break must be closed cell foam or other gasket material that will prevent air leakage.

C. <u>Section 07251 - Sprayed-on Fireproofing & Spray-applied Acoustical Materials:</u>

Environmental Concerns:

1. Release of fibers and particulate into environment.
2. Possible negative components within composition of fireproofing materials.
3. Possible introduction of moisture.

Recommendations:

1. Ventilate area and/or filter air in workspace to remove fibers/particulates.
2. Enclose sprayed-on fireproofing in walls if possible, and explore products with finished surfaces that are less inclined to introduce particulates after occupancy (through crumbling, contact, etc.).
3. Try to minimize use.
4. Review alternate methods of fire protection in lieu of sprayed on fire protection (sprinklers, etc.).

D. Section 07270 - Firestopping:

Environmental Concerns:

1. Review products used and the possibility that some manufacturers may have products which are more environmentally friendly than others.

Recommendation:

1. Use silicone-based sealants.

E. Section 07500 - Membrane and Built-up Roofing System:

Environmental Concerns:

1. Off-gassing of roofing system components.
2. The asphalt used in built-up roofing systems causes an odor which can impact workers and occupants of a building.
3. Modified bituminous roofing systems use components which off-gas, including asphalt, adhesives, primers, and coatings.
4. Both built-up roofing and modified bituminous roofing components cannot be recycled into other uses and end up having to be disposed of at the end of their life cycle.
5. Carcinogenicity of coal-tar pitch.

Recommendations:

1. A ballasted EPDM (rubber) single ply roofing system with seam tape used at joints offers fewer roofing system components which are environmentally negative. EPDM sheets can be recycled into other products at the end of the life cycle. Consider specifying 60 mil. EPDM with a 15- or 20-year total system warranty.
2. Protect existing roof during all repairs.
3. Specification should eliminate use of coal-tar pitch.

G. Section 07600 - Flashing and Sheet Metal:

Environmental Concerns:

1. Type of sealants used in sheet metal work.

Recommendation:

1. Use silicone-based sealants.

H. Section 07901 - Joint Sealants:

Environmental Concerns:

1. Off-gassing of sealants.

Recommendations:

1. For indoor use, specify sealants with low toxicity and emission rates.
2. Consider sealant curing time and application amounts with respect to off-gassing periods and levels when specifying products.
3. Provide increased ventilation when using sealants indoors.
4. Follow manufacturer precautions such as protective clothing if required.
5. Use silicone and latex sealants at interior locations and polyurethane at exterior locations.
6. Reduce the amount of caulking required due to off-gassing.
7. Use metal expansion joints.

DIVISION 8 - DOORS AND WINDOWS

A. Section 08100 - Metal Doors and Windows:

Environmental Concerns:

1. Off-gassing of foam core doors.

Recommendations:

1. Hollow metal doors to have steel reinforced or honeycomb core construction.
2. Use hollow metal steel doors in lieu of doors with particle board core if possible.

B. Section 08200 - Wood and Plastic Doors:

Environmental Concerns:

1. Off-gassing of laminating adhesive to bond veneers to core and off-gassing of particle-board core.

Recommendations:

1. Do not allow foam-core doors.
2. Seal all edges of wood doors.
3. Verify with wood door manufacturers if particle board core could be available with phenol-formaldehyde particle board in lieu of urea-formaldehyde.
4. Specify adhesive used to laminate face veneers to be free of formaldehyde.
5. Specify all edges which expose core construction to be sealed by factory in such a way which restricts off-gassing of core construction.
6. Factory finish wood veneer doors in lieu of field finish doors.

C. Section 08400, 8500, 8600 - Windows:

Environmental Concerns:

1. Due to the humidity levels required for indoor air quality, control of air infiltration and condensation at exterior windows is critical. Excessive condensation can lead to moisture problems (mold, mildew).

Recommendations:

1. Specify air infiltration to not exceed .10 cfm per s.f. of opening when tested with ASTM E783-02 (2010) at a uniform pressure of 6.24 PSF. Examples: H-window, Alpana 1150 Awning or Wausau 3250T Awning.
2. Specify historical performance on air infiltration -- 10 years.
3. Specify condensation resistance factors (CRF). Example: H-window : CRF: 67.
4. Specify thermal breaks in aluminum framing systems and establish a high CRF requirement. CRF of 35 is a minimum for thermally-broken systems. Also, for aluminum framing, allow water vapor that enters the frame to escape to the exterior, and collect condensation that does occur and drain to the exterior. However, due to aluminum's low resistance to thermal transmission, aluminum framed windows should be avoided in lieu of wood window systems which generally have higher CRF (in the range of 59 typically).
5. Specify prefinished wood windows. This allows for the factory finishing of the windows off-site, to avoid the off-gassing process of the treated wood on site.
6. Minimize use of operable windows due to conflict with mechanical systems, or provide a system interlock for the windows. This system interlocks the opening window with the mechanical system. When windows are open, the mechanical system can compensate for pressure changes.

D. Section 08800 - Glazing:

Environmental Concerns:

1. Possible off-gassing of glazing products, including sealants.

Recommendations:

1. Specify insulated glass as a minimum; consider triple glazing if budget allows.
2. Specify solar films, tinted glass, or low E coated glass, or argon-filled glass to reduce heat gain. This reduces heating of interior materials which increase VOC emissions.

DIVISION 9 - FINISHES

A. Section 09200 - Lath and Plaster:

Environmental Concerns:

1. Use of acrylic liquids, bonding agents, and other additives used in plaster work.

Recommendations:

1. Specify plasters with no VOC-emitting additives.
2. Avoid the use of adhesives when installing lathing board and specify only VOC-emitting adhesives.
3. Specify mixing of plaster materials to be done in a manner to minimize airborne dust, especially if silica sand is used for texture.
4. Provide dust proof work enclosures in remodeling work to avoid dust getting in carpet, ductwork, or other places that may allow dust to become airborne in occupied spaces.

B. Section 09215 - Veneer Plaster:
(On gypsum board base).

Recommendations:

1. Use plasters with no VOC-emitting additives (typically to affect drying time, etc.).
2. Specify only low emission surface applications/finishes to dried plaster.
3. Specify mixing of plaster materials to be done in a manner to minimize airborne dust, especially if silica sand is used for texture.
4. Provide dust proof work enclosures in remodeling work to avoid dust getting in carpet, ductwork or other places that may allow dust to become airborne in occupied spaces.

C. Section 09250 - Gypsum Board:

Recommendations:

1. Provide for off-gassing of joint compound.
2. Use mechanical fastening systems in lieu of adhesives wherever possible.
3. Use paper joint tape instead of glass-fiber joint tape.
4. Use low VOC-emitting joint compounds.
5. Reduce dust and particulates by finishing taped seams with a wet sponge instead of sanding.
6. Heat and ventilate the area during curing to accelerate the drying process and removal of VOC's.
7. Paint/seal surfaces to reduce both VOC-emissions from the assembly and absorption of VOC's from other materials.
8. Provide dust proof work enclosures in remodeling work to avoid dust getting in carpet, ductwork, or other places that may allow it to become airborne in occupied spaces.
9. Specify that acoustic batt insulation be covered by gypsum board in all locations (this is often left exposed above ceilings).
10. Require removal and replacement of any gypsum board which becomes wet during construction to avoid mildew growth in wall cavity.
11. Gypsum board work should not begin until building is enclosed.
12. Hold gypsum board 1/2" off floor.
13. Provide weeps at bottom of metal wall to allow water to weep out that may develop in the cavity.
14. Green board should be used in wet areas as a minimum. Durarock "Cementitious". is preferred.

D. Section 09400 - Terrazzo:

Environmental Concerns:

1. Type of sealer used on terrazzo.

Recommendations:

1. Allow for adequate curing/off-gassing time (72 hours).
2. Use low VOC bonding agents.
3. Limit use of epoxy or polyacrylic terrazzo, which emit higher VOC's during installation and curing.

E. Section 09510 - Acoustical Ceilings:

Environmental Concerns:

1. Use of ceiling panels which may introduce fibers or particulate into air.
2. Sink capacity of acoustic ceiling tiles - although their own emissions are minimal in most cases, they have the capacity to absorb/desorb VOC's at rates higher than other materials such as carpet.
3. If painted, they should use low emission / toxin paints.

Recommendations:

1. Explore the potential for painting or sealing the surface of the tiles to reduce its sink capacity. Check the implications of such action on the tile's acoustical performance with the manufacturer.
2. Timing: Installation after other products are off-gassed. Ceiling tile should follow installation of carpet due to sink effect of carpet. Carpet needs to be protected during installation of ceiling tile.
3. Specify factory-applied antimicrobial treatment (available on limited styles at this time). Example: Armstrong Intersept (limited to some products).
4. Specify washable finishes with minimum Relative Humidity 90 value in restrooms, food service areas, locker rooms and wet areas.
5. In schools without air-conditioning or where high humidity is anticipated, specify acoustical ceilings with minimum. RH90 value to prevent warping. Because of the additional cost involved, this could be listed as an add alternate.

F. Section 09521 - Acoustical Wall Panel:

Environmental Concerns:

1. Use of panels which may introduce fibers or particulate into air.
2. Use of mechanical methods of anchorage in lieu of adhesives.

Recommendations:

1. Specify mechanical mounting methods in lieu of adhesives.
2. In applicable areas (cafeteria, gymnasium, specify washable finishes such as perforated vinyl wall covering in lieu of fabric to reduce "sink effect."
3. See Section 099050- wall covering.

G. Section 09650 - Resilient Flooring:

Recommendations:

1. In existing building, old vinyl flooring products may contain asbestos. These materials should be handled or removed only by a trained professional.

2. Strongly consider asbestos abatement in lieu of covering over existing asbestos containing tile with new finishes.
3. Specify low or no VOC-emitting adhesives.
4. Specify flooring products which offer a system of "environmentally-friendly" maintenance products (no phosphates, ammonia-free, low solvent).
5. Specify that products be removed from packaging and allowed to "breathe" for 24 hours prior to installation.
6. Do not install over uncured or below-grade concrete slabs.
7. Increase ventilation during installation. Allow a minimum of 72 hours (after completed installation) before occupying building.
8. Strongly consider flooring products such as linoleum, which are made of natural materials and require very little chemical maintenance (ceramic, porcelain, etc.).

H. Section 09678 - Resilient Wall Base and Accessories:

See "Resilient Flooring" above.

I. Section 09680 - Carpet:

Recommendations:

1. Specify products which contain no latex in the backing system (latex contains 4-PC's). Examples: Lees carpets with "Unibond" backing, or Mohawk's " Nova II" with "PLB" backing.
2. Specify low or no VOC-emitting adhesives.
3. Consider tackless strip installations (such as 3M's "Tac Fast" system), which avoid adhesives completely.
4. Do not specify double glue down.
5. Specify that carpet products be removed from packaging, unrolled and allowed to "breathe" off-site for 24 hours prior to installation.
6. Specify carpets with built-in (not surface-applied) antimicrobial treatments.
7. Allow a minimum of 72 hours to ventilate after completed installation before occupying building.
8. Specify that manufacturer's recommendations are strictly followed in developing a scheduled maintenance program to include recommended cleaning products and procedures. Use HEPA or high efficiency vacuum cleaners/bags.

9. Provide a means to accelerate drying of carpets such as fans in case of spills, etc. during construction: Dry cleaning of carpet is preferred.

10. Specify carpets which have been tested and certified under CRI's "green label" program.

J. Section 09900 - Painting:

Environmental Concerns:

1. VOC-emissions

Recommendations:

1. Consider low-emitting alternative paints (natural, hypo-allergenic, low-biocide etc.) for chemically sensitive clients. Characteristics and handling procedures may vary from conventional paints.
2. For renovations/demolitions consult a professional for proper lead abatement procedures when lead-based paint is present.
3. Even where lead-based paint is not present, increase ventilation for any removal or sanding of existing paint to reduce dust and particulates.
4. Increase ventilation for at least 72 hours following paint application to minimize residual vapors in the air.
5. Store paints and solvents in a designated space away from the work area, preferably its own trailer outdoors, where they cannot contribute to the further build-up of VOC's in the finish space.
6. Water-based and organic solvent-based high solids paints and stains should be preferred for their low emissions and significantly shorter off-gassing period (as little as 48 hours).
7. Specify formaldehyde-free finishes for woodwork.
8. Specify wood stains, varnishes and paint thinners which contain no methylene chloride.
9. Seal exposed edges and faces of plywood panels.
10. Requirements for biocides in water-based products: Biocides introduced by coating manufacture into formulation by water-based products to meet following requirements:
    a) Control bacteria, fungi, yeast and algae.
    b) Provide low hazard potential for manufacturing personnel, end-user, and environment.
    c) Have Environmental Protection Agency (EPA) registration covering applications specified within this section.
    d) Have Food and Drug Administration (FDA) acceptance.

e) Shall not contain:
- Mercury, tin, barium, arsenic, or other heavy metals.
- Formaldehyde or generate formaldehyde.
- Phenols or substituted phenols.

f) Shall not require:
- Detoxification prior to disposal.
- Fish or wildlife warning label.

g) Shall not contribute odor to end products.
Coating manufacturer to submit written certification that biocides introduced into water-based formulations meet specified requirements for biocides.

11. When staining and varnishing of interior wood is required (excluding wood athletic flooring), use a water-based wood stain and varnish similar to Hirshfield's Paint Manufacturing No. 8410 stain and No. 9410 acrylic varnish.

12. When coating metal surfaces, consider using "direct to metal;" 100 percent acrylic coating system or 100 percent solid epoxy coating systems. Epoxy will be affected by UV light and should not be used where exposed to exterior or UV light within interior spaces.

K. Section 099050 - Wall Covering:

Environmental Concerns:

1. Adhesives used in application of wall covering.
2. Off-gassing of materials used in manufacture of wall coverings.
3. Use of fibrous or carpet types of wall coverings.

Recommendations:

1. Specify solvent-free, low VOC-emitting adhesives.
2. Specify wall coverings which use solvent-free inks.
3. Specify wall coverings which use cadmium-free dyes.
4. Specify wall coverings which are non-fibrous to reduce "sink effect" of bacteria, dust, etc.
5. Increase ventilation for 72 hours after installation.
6. Do not use wall covering on exterior walls of buildings.

DIVISION 10 - SPECIALTIES

A. Section 10100 - Visual Display Boards:

Recommendations for Porcelain Enamel Chalkboards:

1. Gypsum board is the "safest" core material. Adhesive fumes used in laminating materials together are minimized when sandwiched between the 28 gauge steel face sheet and on aluminum foil panel backing on the back side of gypsum core.

Recommendations for Porcelain Enamel Marker boards:

1. A potential problem with dry marker boards is the felt tip marking devices and cleaners used. Some markers emit solvent fumes strong enough to permeate every part of a classroom. Cleaners for dry erase surfaces can be equally as bad or worse.
2. Due to the concerns associated with markers and cleaners, not using or minimally using marker boards may be considered.
3. If marker boards are used, the owner should use water-based dry ` markers or low-odor markers.

Recommendations for Tackboard:

1. Natural cork boards have fewer additives in composition, but may not stand up as well as sealed composition cork not have the aesthetic appeal. The resinous, vinyl finished, sealed composition cork tackboards possibly do not contribute significantly to the level of indoor contaminants.
2. Safest choice in backing for tackboards would be foil backed exterior grade plywood or hardboard.

Recommendations for Mounting:

1. Mount chalkboards, marker boards, and tackboards to walls using mechanical fasteners in lieu of adhesives.

DIVISION 12 - FURNISHINGS

A. Section 12300 - Manufactured Casework:

Environmental Concerns:

1. Off-gassing of particleboard (see Division 6).

Recommendations:

1. Use particle board with a phenol-formaldehyde binder in lieu of a urea-formaldehyde binder. Verify with casework manufacturers, the availability of product and economic implications.

2. All surfaces of the plywoods, fiber boards, and particle boards used in casework should be laminated. This includes all surfaces that will be unexposed once casework is installed, such as backs, bottoms and cut edges.
3. Open holes drilled for adjustable shelving reduce the effectiveness of the laminate encapsulating the particle board core, this should be avoided unless plastic plugs are used to fill unused holes. Consider using surface mounted metal brackets and metal clips for adjustable shelving. Do not rout standards into cabinet sides exposing particle board core.
4. Cut edges from sink and electrical cutouts should be sealed with an appropriate sealant.

B. Section 12710 - Fixed Auditorium Seating:

Environmental Concerns:

1. Glued-up woods, polyurethane foam padding, treated fabrics, and adhesives are common materials in most auditorium seating. All have a negative impact on indoor air quality, especially in an auditorium where the exposure is significant.

Recommendations:

1. Use hardwood plywood with polyvinyl acetate (PVA) adhesive rather than formaldehyde resin adhesive.
2. Use adhesives which are latex based if possible.
3. Use solid wood, molded plastic or metal components where possible.

C. Section 12775 - Lecture Room Tables and Seating:

Environmental Concerns:

1. Off-gassing of materials used in manufacturing.

Recommendations:

1. Cover all surfaces of tables with laminate and edges with 3 mil. PVC edge banding so particle board core is completely encapsulated. PVC edge banding allows corners to be rounded.
2. Table core to be plywood with PVA glue or phenol resin formaldehyde glue with all surfaces covered with plastic laminate and edges covered with PVC edge banding.

PRE-DESIGN, PROGRAMMING AND DESIGN

1. Pre-Design:
   a) Additional time allowed for each phase of design to incorporate indoor air quality issues and for option evaluation: according to size and complexity of project.
      i) Schematic Design.
      ii) Design Development.
      iii) Contract Documents.
   b) Additional time allowed for review at each phase.
   c) Additional time allowed for construction.
   d) Additional budget must be allowed for indoor air quality systems, etc.
      i) Establish criteria for level of indoor air quality to be attained vs. cost; set "tiers" of quality level.
   e) Site Selection:
      i) Include testing of existing site air quality
      ii) Analyze soil, air, and water for contaminants
2. Program:
   a) Adequate space allowed for maximum building occupancy
      i) Student/Occupancy requirements: -- (1 person/20 square feet for classrooms, typically). This must be accurate to insure the systems are not over or under-designed. Electronic occupancy sensors (CO_2) are a method to control air volume as needed.
   b) Adequate mechanical space programmed for ease of service access (not in net/gross factor).
3. Design:
   a) Floor to floor/roof heights adequate for additional mechanical ductwork and equipment.
   b) Location of fresh air intake relative to:
      i) Site related pollutant sources.
      ii) Likely locations for smokers.
      iii) Plan vehicular circulation and parking away from air intakes.
   c) Location/relationship of 'occupied' spaces to sources or odors, irritants, etc.
   d) Location of entrances relative to pollutant sources, such as service drives, buses, dumpsters, etc.
   e) Selection of materials:
      i) Include long-term maintenance as factor: i.e. use of cleaners, solvents, etc.
      ii) High-quality vapor barrier, evaluate the number of "perms," and careful attention to location of vapor barrier. Control of humidity levels is critical.
      iii) Windows: operable vs. inoperable, tightness relative to humidity.

f) Pollutant generating areas, such as science labs, locker rooms, art rooms, and food preparation areas should be isolated from the adjacent interior spaces. These areas should be adequately ventilated: with adequate exhaust without recirculation.

g) Avoid dead zones in the design of HVAC systems.

h) Orientation of building to increase natural lighting/energy efficiency.

i) Evaluate "stack-effect" of a design.

j) Commissioning of mechanical system, perhaps a separate agency to perform this function.

k) Include installation in specifications: single-source quality control.

l) Dehumidification in basements.

MINNEAPOLIS
PUBLIC SCHOOLS

Urban Education. Global Citizens.

MECHANICAL SYSTEMS GUIDELINES
for
ACCEPTABLE INDOOR AIR QUALITY (IAQ)
for
SCHOOL CONSTRUCTION PROJECTS

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I. INTRODUCTION

The following mechanical systems guidelines are provided as a minimum set of criteria that need to be included in school construction projects to establish and maintain acceptable indoor air quality (IAQ). These guidelines are typically written for new construction projects. Remodeling construction projects will need to be examined on an individual basis to determine how many of these guidelines can be incorporated considering the extent of the remodeling efforts.

II. DESIGN

A. GENERAL:

1. DOCUMENTATION:

a. The design criterion that was used to design the air handling unit system shall be included in the construction documents.

1) Applicable building codes

2) Outdoor design conditions

3) Indoor design conditions

4) People load

5) Equipment load

6) Lighting load

7) Other loads

8) Design ventilation rates

9) Minimum outdoor air ventilation rates (including the method to calculate)

10) Method of control to maintain constant minimum outdoor air intake

11) Air filtration

12) Other air filtration (such as gas-phase air cleaners)

13) Special exhaust systems

14) Narrative describing modes of control for the air handling unit system(s)

2. PREFERRED SYSTEM DESIGN:

a. Central Station Air Handling Unit:

Central station air handling unit system design is preferred over terminal unit air conditioning system design (such as under-window unit ventilators) for several reasons, some of which are as follows. Terminal unit air conditioning system design should be avoided.

1) Outside air intakes for terminal units that provide outdoor air ventilation are typically located close to grade level whereas intakes for central station units have more flexibility of location which can be important with regard to outdoor air quality conditions.

2) Central station units are easier to maintain than terminal units because there are fewer central station units and they usually have better access than do terminal units.

3) Higher efficiencies of air filtration can be provided for central station units than can be provided for terminal units.

4) The fan and motor noise from terminal units can be destructive to the classroom environment.

5) People sitting directly in front of a terminal unit can become too cold or too hot depending upon the time of year operation.

6) Summer season relative humidity is not directly controlled with terminal units, but is a by-product of space temperature control.

b. Indoor Mechanical Equipment Room:

Air handling unit equipment located inside indoor mechanical equipment rooms is preferred over package rooftop air handling units for ease and frequency of maintenance. Package rooftop air handling unit design should be avoided.

c. Energy Recovery:

Where practical, energy recovery should be incorporated into the air handling unit system design to reduce the dependence on "new energy" for heating and cooling. For example, it may be possible to recover energy from the exhaust/relief air streams and use it to temper the intake outdoor air stream.

1) It may be possible to use desiccant heat wheel technology to transfer both sensible and latent energy loads from the exhaust/relief air streams to the intake outdoor air stream. It is important to select a desiccant material that is designed to transfer heat energy and water vapor only without transferring airborne contaminants.

B. AIR HANDLING UNIT:

1. OUTDOOR AIR QUALITY:

   a. At the beginning of the design process, the proposed building site shall be surveyed to determine the quality of the outdoor air. The purpose of this effort is to determine if any special gas-phase air cleaners (such as activated carbon absorption filters, etc.) need to be included in the air handling unit system(s) design.

   b. The method by which this survey can be completed is left up to the Design Engineer. If outdoor air quality problems are suspected, it may be possible to hire a testing firm to complete actual field testing of the air quality. The results of these field tests can then be compared with national air quality and emissions trends as published by the Environmental Protection Agency. The problem with this method is that the air quality may vary from hour to hour and from day to day. Accurate field test results may require hourly/daily testing for a period of weeks or months which may not be practical.

   c. However, after the quality of the outdoor air is evaluated, the Design Engineer shall work closely with the Owner to determine the necessity/desirability of special gas-phase air cleaning filters.

2. LOCATION OF OUTDOOR AIR INTAKE LOUVERS AND/OR OTHER TYPES OF INTAKE DEVICES:

   a. At the beginning of the design process, it is very important that the Design Engineer coordinate closely with the Architect to establish the location/configuration of mechanical equipment rooms and the consequent location/configuration of the outdoor air intake louvers. The location/arrangement of architectural building elements can greatly affect the performance/effectiveness of outdoor air intake louvers.

   b. The location of outdoor air intakes shall be at least 25 feet from any contaminated and/or odorous exhaust air outlets. It is recommended that greater distances be used especially when considering the effects of wind patterns and physical/architectural obstructions.

      1) Examples of contaminated exhaust outlets include:

Boiler/incinerator combustion stacks
Combustion stacks
Laboratory/hood exhaust outlets
Plumbing vent stacks
Paint Hood exhaust outlets
Emergency generator
Kitchen Hood exhaust outlets
Industrial Arts exhaust outlets
Welding Hood exhaust outlets

c. The location of outdoor air intakes shall be at least 30 feet minimum from any evaporative cooling towers. It is recommended that greater distances be used especially when considering the effects of wind patterns and physical/architectural obstructions.

d. The location of the bottom of outdoor air intakes shall be at least 3 feet above ground level.

   1) Special consideration shall be given to maintain an adequate horizontal distance between outdoor air intakes and objects that project above grade level so as not to restrict air flow to the intake as well as to prevent snow drifting in front of the intake.

e. The location of the bottom of outdoor air intakes shall be at least 3 feet above roof level.

   1) Special consideration shall be given to maintain an adequate horizontal distance between outdoor air intakes and objects that project above roof level (such as roof parapets) so as not to restrict air flow to the intake as well as to prevent snow drifting in front of the intake.

f. In addition to the above requirements, special consideration shall be given to keep outdoor air intakes away from vehicular traffic areas. It may be necessary to increase the horizontal distance between outdoor air intakes and vehicular traffic areas to be greater than the minimum distance of 25 feet. It may also be necessary to increase the vertical distance above ground level for outdoor air intakes to be greater than the minimum distance of 3 feet.

   1) Examples of vehicular traffic areas include:
      Bus loading/drop-off areas
      Truck loading dock areas
      Vehicle parking areas
      Heavily traveled roadways/intersections

g. The prevailing wind conditions and building architectural elements shall be evaluated with regard to the location of outdoor air intakes. If outdoor air intakes are located down-wind of any contaminated sources/outlets, then the above minimum separation distances may need to be increased.

3. DESIGN OF OUTDOOR AIR INTAKE LOUVERS AND/OR OTHER TYPES OF INTAKE DEVICES:

   a. Outdoor air intake louvers (and other types of intake devices) shall be designed at a maximum face velocity of 500 feet per minute through the "Free Area" of the louver. This will minimize the intake of moisture in the outdoor air stream in the form of rain and snow.

1) It is important that the Design Engineer accurately calculate the "Free Area" of the louver to be used. In many cases, the top fin and the bottom fin of the louver cannot be included in the "Free Area" because they are sealed to the louver frame and do not permit any air flow.

b. Intake louvers should be designed/oriented so as to prohibit the intake of driving rain and blowing snow.

c. Where the intake of rain and snow cannot be totally prevented in the design of the outdoor air intake louvers, a plenum with a floor drain shall be provided inside the building, adjacent to the intake louver to permit any entrained rain or snow to drain away from the air handling unit system intake section.

1) The plenum floor drain shall be connected to the required building waste system using an air-gap, indirect waste connection.

d. Bird screens shall be provided on intake louvers and other intake devices in the proper configuration to prohibit nesting inside the intake louver.

1) This may require the bird screen to be applied on the exterior face of the louver instead of the interior face of the louver.

4. OUTDOOR AIR INTAKE CONTROL:

a. For all variable air volume (VAV) air handling unit systems other than those supplying 100% outdoor air at all times:

1) The outdoor air intake volume shall be measured and automatic control shall be provided to ensure that the minimum required amount of outdoor ventilation air is maintained at all times during the building occupied period of operation of the air handling unit system.

5. AIR FILTRATION:

a. Two (2) filters shall be provided for each air handling unit system. The first filter shall be a pre-filter with the minimum MERV rating of 8 when tested in accordance with ASHRAE Standard 52.2. The second filter shall be a final filter with the minimum MERV rating of 11 when tested in accordance with ASHRAE Standard 52.2. The pre-filter shall be located upstream of any air handling unit components. The final filter shall be located downstream of the pre-filter.

1) The air filters shall mount inside the air handling unit using compression clips and gasketed frames to minimize air bypass between the filter units.
2) The air flow pressure drop for each filter shall be monitored by the temperature control system and shall signal an alarm when it is time to change the air filters. The pressure drop value that is used to signal the alarm shall be obtained from the filter manufacturer.

6. HUMIDIFIER CONFIGURATION:

   a. For duct mounted humidifiers, a discharge duct section sized in length to a minimum of five (5) equivalent duct diameters shall be provided downstream of the humidifier location for absorption purposes. The discharge duct section shall be constructed of stainless steel and shall be provided with a cross-broken, sloped, stainless steel drain pan.

   b. For air handling unit mounted humidifiers, a discharge plenum section sized in length to a minimum of one and one half (1-1/2) equivalent unit cross-section diameters shall be provided downstream of the humidifier location for absorption purposes. The discharge plenum section shall be lined with stainless steel and shall be provided with a cross-broken, sloped, stainless steel drain pan.

   c. Humidifiers shall be located downstream of air filters.

7. COOLING COIL DRAIN PANS:

   a. All cooling coil drain pans shall be constructed of stainless steel with a cross-broken, sloped bottom (drain outlet at the lowest point) and trapped and connected to the required building waste system using an air-gap, indirect waste connection. The traps shall be designed to maintain water level in the trap regardless of the positive or negative static pressure condition that exists at the location of the cooling coil during system operation.

   b. It may be possible to use desiccant energy recovery technology to eliminate latent cooling loads from the air handling unit cooling coils. Under this scenario, the air handling unit cooling coils would provide sensible cooling only and operate as dry coils (there would be no dehumidification condensate drainage from the cooling coils). If this scenario is used, cooling coil drain pans shall be provided in the air handling units as a precautionary measure.

8. AIR BLENDERS:

   a. Air blenders designed to eliminate stratification and provide thorough mixing of return and outside air streams shall be provided on all air handling unit systems other than those supplying 100% outside air at all times. The air blenders shall be located upstream of all air handling unit components.

      1) The air blenders shall consist of fixed mixing vanes and be constructed of heavy gauge welded aluminum.

9. ACCESS SECTIONS:

   a. Each air handling unit shall be designed with access sections located in between all air handling unit components. This means that each individual air handling unit component shall have an access section

directly adjacent to it on each side of the component. Each access section shall contain a removable access panel or hinged door and be sized to permit the access by maintenance personnel for inspection/cleaning purposes (hinged doors are preferred and should be used whenever available, removable panels should only be used on small units where hinged doors are not available).

1) Discretion is left to the Design Engineer on how to implement this requirement because of different air handling unit sizes. Small size air handling units will have smaller size access available than large air handling units. In any case, as much as possible, access should be provided on each side of all individual components of each air handling unit system.

10. INTERNAL INSULATION:

a. Exposed internal insulation inside air handling units shall not be allowed. All air handling units shall contain double wall construction with insulation in between the two walls.

11. AIR HANDLING UNIT CONSTRUCTION:

a. All air handling units shall be constructed of sheet metal and gasketed and sealed to minimize air leakage.

12. AIR HANDLING UNIT ACCESS:

a. Air handling units shall be located so as to permit adequate access for maintenance personnel to inspect, clean and remove/replace all individual components of the air handling unit. This applies to units located inside mechanical equipment rooms or units mounted outdoors.

1) Adequate access shall be provided without requiring the removal of permanently installed building elements and/or other permanently installed equipment elements.

C. <u>OCCUPIED SPACE:</u>

1. ROOM TEMPERATURE:

a. The heating, ventilating and air conditioning systems shall be designed to achieve the following room temperature conditions in all occupied spaces:
1) Summer: 72 deg. F at 50% Relative Humidity (RH)

2) Winter: 75 deg. F (see below for Relative Humidity)

NOTE: The Energy Code for the State Of Minnesota states: "Indoor design temperature shall be 72 deg. F. for heating and 78 deg. F. for cooling." This means that according to the Energy Code, regardless of how the equipment is designed, it cannot be operated during "normal occupancy hours" to achieve indoor conditions below 78 deg. F. during the cooling season and above 72 deg. F. during the heating season. The Energy Code does permit oversizing of equipment for the purposes of design safety factor and pre-occupancy building warm-up and cool-down operation.

2. ROOM HUMIDIFICATION:

   a. Room humidification in all occupied spaces shall be designed to achieve the levels as set forth in the following reset schedule:

Outdoor Air Temperature	Humidity Level
-30 deg. F.	15% RH
-20 deg. F.	20% RH
-10 deg. F.	25% RH
0 deg. F.	30% RH
>0 deg. F.	30% RH

   b. Clean steam should be used as the source of humidification. Evaporative humidification should be avoided due to potential problems with standing water and microbial growth.

   c. This shall require that the building have a continuous vapor barrier in all exterior walls on the warm side of the insulation. This shall also require that all windows in the building have the minimum requirements of double pane construction with 1/2 inch air space and 100% thermally broken mullions (coordinate these requirements with the Architect).

3. ROOM MINIMUM OUTDOOR AIR VENTILATION RATE:

   a. The minimum outdoor air ventilation rates shall be designed and calculated according to the currently adopted version of ASHRAE Standard 62: Ventilation For Acceptable Indoor Air Quality.

      1) It is important to note that ASHRAE Standard 62 specifies minimum acceptable outdoor ventilation rates for building spaces. Depending upon the individual building/space situation, it may be necessary to provide more outdoor air ventilation than required by ASHRAE Standard 62 in order to provide acceptable indoor air quality.

   b. Consideration should be given to designing all outdoor air ventilation rates to be 10% higher than current occupancy density for future growth in occupancy density.

4. NON-OCCUPIED SPACES:

   a. Consideration should be given to designing air handling unit/ductwork systems and room air change rates for all non-occupied rooms for future use as occupied rooms. For example, all storage rooms should be designed to be converted to future use as offices.

5. NOISE CRITERIA:

   a. Classroom spaces shall be designed to a maximum Noise Criteria Level of NC-35.

      1) The maximum permissible sound pressure level (in dB re 20 mPa) for each octave band center frequency for a Noise Criteria Level of NC-35 is as follows:

Octave Band Center Frequency	Sound Pressure Level
63	60
125	52
250	45
500	40
1000	36
2000	34
4000	33
8000	32

   b. Mechanical and electrical equipment shall be designed and located so as to minimize vibration and sound transmission into occupied spaces.

   c. Internal duct lining shall not be used as a method to control fan generated noise, VAV box generated noise, or duct velocity generated noise.

6. SUPPLY AND RETURN DIFFUSER LOCATIONS:

   a. Supply and return diffuser locations shall be designed to prevent "short-circuiting" of the supply air flow. Short circuiting occurs when the supply air flow is removed from the room/space before it has a chance to mix with the room air volume.

   b. For rooms/spaces with ceiling heights of 12 feet or greater, supply air shall be introduced into the space at or near the ceiling and return air shall be removed from the space near the floor level.

      1) Depending upon the individual space situation, it may be necessary to introduce supply air into the space at or near the floor level and remove the return air at or near the ceiling. In any case, with high ceiling spaces, supply and return diffusers should not be installed at the same elevation.

7. ROOMS CONTAINING CONTAMINATED SOURCES:

a. Rooms/spaces containing contaminated sources shall be balanced to maintain a negative air flow condition with respect to adjacent rooms/spaces.

1) Examples of contaminated source rooms are as follows:

Chemistry labs	Biology labs
Industrial arts shops	Locker rooms
Swimming pools	Copier rooms
Toilet rooms	Trash rooms

b. Rooms/spaces containing contaminated sources shall be designed to be 100% exhausted and prevent air recirculation to adjacent spaces unless the room/space containing the contaminated source is provided with its own dedicated air handling unit system or the contaminated source within the room/space is contained within a local exhaust system (such as a fume hood).

c. All exhaust systems shall be fully ducted from occupied space to exterior of the building. All ducted exhaust systems installed within building occupied spaces or within ceiling plenums shall be under a negative pressure in accordance with the State Building Code. Use of ceiling plenum space or mechanical room space for all or part of the exhaust air path shall not be allowed.

D. <u>DISTRIBUTION DUCTWORK:</u>

1. DUCTWORK CONSTRUCTION:

a. Ductwork shall be constructed of sheet metal and sealed to minimize air leakage.

2. DUCTWORK INSULATION:

a. All supply ductwork shall be insulated with externally applied insulation.

1) All variable air volume boxes shall be internally insulated with a cover over the internal insulation. The cover can be made of sheet metal or a poly-type sheet material.

b. All ductwork (supply, return, exhaust) shall be externally insulated if the ductwork is installed inside unconditioned spaces.

c. All ductwork (supply, return, exhaust) installed outdoors shall consist of double wall construction with insulation in between the two walls. The exterior surface exposed to the elements shall be sealed and made weatherproof.

3. EXPOSED INTERNAL DUCT INSULATION:

   a. Exposed internal duct insulation shall not be allowed in pressurized ductwork systems.

      1) Internal duct insulation shall only be allowed in non-pressurized air transfer ducts for the purposes of sound transmission mitigation. The internal insulation shall utilize an antimicrobial material.

4. SOUND ATTENUATORS:

   a. Sound attenuators should be of the baffle-design type without any fibrous sound absorbing material.

   b. If a sound attenuator with fibrous sound absorbing material is used, then the fibrous material shall be covered with a poly-type sheet material to prevent exposure of the fibrous material to the ventilation air stream.

5. DUCT ACCESS PANELS:

   a. Access panels shall be provided on each side of all duct mounted equipment.

III. CONSTRUCTION/COMMISSIONING

A. CONSTRUCTION TECHNIQUES:

1. USE OF VOLATILE ORGANIC COMPOUNDS (VOC's):

   a. The use of volatile organic compounds (VOC's) in construction materials and methods shall be minimized as much as possible. If VOC's are used in a particular area of the construction project, then the following procedure shall be used as part of the construction process:

      1) Consult with the manufacturer of the material/product containing VOC's to determine the period of time during which significant off-gassing will occur.

      2) After the installation of the material/product containing VOC's is complete and prior to occupancy, provide purging ventilation to that area by supplying and exhausting 100% of the design maximum air flow rate for that area.

         a) It may be possible to accomplish this process by using the air handling unit system for that area and operating it in a 100% outdoor air economizer mode during the purging period.

      3) The purging ventilation process shall operate continuously for a period of time equal to the period of significant VOC's off-gassing plus 48 hours.

2. CONSTRUCTION FILTERS:

   a. If the air handling unit systems are operated during the construction process, then all return and/or exhaust air openings shall be provided with cartridge filters with a minimum MERV rating of 8 in accordance with ASHRAE Standard 52.2.

      1) The filters shall be attached to the return/exhaust air openings with compression clips and gasketed frames.

   b. A set of filters for the air handling unit shall be installed if the air handling unit is operated during the construction process. These filters shall be the same as specified for the air handling unit. These filters shall be removed at the end of the construction process (prior to system air balancing work efforts) and replaced with new filters prior to occupancy.

3. PROTECTION OF MATERIALS:

   a. All construction materials shall be protected from dirt, debris, and moisture while being stored on the construction site. Any materials that become water-damaged shall be discarded and replaced with new materials.

      1) Extra care shall be taken to protect materials during any construction process that requires the use of water as part of the process. A good example of this situation is the grinding of terrazzo floors. If it is impossible to prevent the wall board adjacent to the terrazzo floors from becoming wet, then the wall board should be installed after the grinding process is finished.

      2) It is important for the construction process to be organized in a manner that will protect materials from damage. Materials should be delivered to the construction site close to the time of installation so that they are not stored for long periods of time at the site. Materials should be installed according to a time sequence that will permit the building to protect itself. For example, interior drywall should not be installed before the roof, walls and windows are completely installed and the building is sealed against rain/snow damage.

4. REMODELING CONSTRUCTION; ISOLATION OF MAJOR CONSTRUCTION AREAS:

   a. Remodeling construction within existing buildings or new addition projects that are connected to existing buildings shall be isolated from the occupied existing buildings using temporary walls, plastic sheeting, or other vapor retarding barriers. These temporary barriers shall be designed and installed to prevent the migration of construction dust, debris, fumes, and other indoor air contaminants from the construction areas to the occupied areas.

b. The construction areas shall be maintained at a negative pressure with regard to the adjacent occupied areas. This can be done by pressurizing the adjacent occupied areas or exhausting the construction areas.

c. In situations where a single air handling unit system serves both occupied areas and construction areas, the return air openings in the construction area shall be temporarily capped and sealed to prevent the spread of contaminates. Where dust, dirt, and debris particles are the only contaminates of concern, it may be possible to cover the construction area return air openings with temporary filters during the construction process as discussed above. This will allow the air handling unit system to continue to operate and serve the occupied areas during the construction process.

B. COMMISSIONING PROCESS:

1. GENERAL: **Refer to MPS Commissioning Plan** dated September, 1999

   a. In as much as possible, all of the following commissioning activities shall be completed after substantial completion of the construction process and prior to occupancy.

2. DRAINS/DRAIN PAN TESTING:

   a. Drain pans and connecting drain lines under cooling coils, humidifiers, outdoor air intake plenums, etc. shall be tested to ensure proper slope and drainage to prevent water stagnation which could result in microbial growth.

      1) Plug the drain pan and fill it with water. Remove the plug and observe the drainage (it should drain completely in less than 5 minutes without leaving any puddles larger than 2 inches in diameter).

   b. Check the drain pan trap to make sure that the water seal is maintained with the supply air fan operating and shut off.

   c. If the drain pan does not drain properly, it shall be reconfigured or removed and replaced with a correctly designed drain pan.

3. VISUAL INSPECTION OF AIR HANDLING UNIT SYSTEMS:

   a. The inside of all air handling unit systems shall be visually inspected for dirt, debris, and damaged components/equipment. Dirt and debris shall be removed and damaged components/equipment shall be repaired or replaced prior to occupancy.

4. AIR HANDLING UNIT/DUCTWORK SYSTEM CLEANING:

   a. After substantial completion of construction (not before all sheetrock work is completed) and prior to occupancy, the inside of all air handling units, return fans and ductwork systems shall be cleaned to remove all surface dust and debris inside those systems.

5. TEMPERATURE CONTROL SYSTEMS TESTING:

   a. The temperature control systems shall be tested prior to occupancy to determine that they are operating as specified. The Design Engineer working with the Temperature Control Contractor shall activate all control systems one-at-a-time to observe them in action.

   b. Control algorithms shall be activated to determine if the proper control signals are being relayed throughout the control systems. The physical action of control dampers, control valves, fans, pumps, etc. shall be observed to determine if the action corresponds to the control algorithms as specified. Alarm reporting, record keeping, signal interfaces with other building control systems shall also be tested and verified.

6. AIR BALANCING:

   a. Air balancing devices such as dampers, grilles, registers, and diffusers shall be installed so as to permit adequate access for air balancing purposes. Air balancing devises not readily accessible shall be removed and reinstalled at the Contractor's expense so as to permit access.

   b. All ventilation systems (supply, return, exhaust, and outside air) in a building construction project shall be balanced by an independent, certified air balance contractor selected by the Owner to deliver the required air flow rates as specified in the construction documents.

   c. Air balancing shall be completed in accordance with ASHRAE Standard 111-2008 or other approved standard.

   d. Air balancing shall be completed if the use of the building changes from its original use as defined in the design criteria established by the Owner.

7. BUILDING VENTILATION PURGING:

   a. After substantial completion of construction and prior to occupancy, provide purging ventilation to the construction area by supplying and exhausting 100% of the design maximum air flow rate for that area.

      1) It may be possible to accomplish this process by using the air handling unit system for that area and operating it in a 100% outdoor air economizer mode during the purging period.

      2) It is important to limit relative humidity levels to a maximum of 60% during the purging process. This may require mechanical cooling of the purging air source. It is acceptable to reduce the purging ventilation air flow rate below 100% of the design maximum air flow rates in order to limit the relative humidity level.

b. The purging ventilation process shall operate continuously for a minimum period of seven (7) days.

1) It may be necessary to modify the purging period if VOC's were present in construction materials (see above).

8. SYSTEMS DOCUMENTATION:

a. The following information shall be provided to the Owner upon completion of the construction project:

1) Design Criteria/Design Assumptions used to design the systems

2) Operating & Maintenance Manuals (prepared according to ASHRAE Guideline 4-2008)

3) Mechanical Shop Drawings for all systems and equipment

4) Final, complete Air Balance Report

5) Record Construction Drawings showing field changes

IV. OPERATION & MAINTENANCE

A. GENERAL:

1. DOCUMENTATION OF PERCEIVED INDOOR AIR QUALITY PROBLEMS:

a. All complaints of perceived indoor air quality problems shall be documented by location, time, date, type of complaint, person registering complaint and types of remedial action taken to resolve the complaint.

2. STAFF TRAINING:

a. Prior to active operation and maintenance duty, all staff shall be thoroughly trained in the acceptable means and methods for operating and maintaining all of the various systems. This is a key aspect to maintaining acceptable indoor air quality for the life of the building.

B. OPERATION:

1. VENTILATION SYSTEM START/STOP:

a. The ventilation systems shall be started at least one half (1/2) hour prior to the beginning of "normal occupancy hours" and stopped at least one half (1/2) hour after the end of "normal occupancy hours".

1) The start times may need to be lengthened if warm-up and cool-down operation sequences are used.

2. AFTER "NORMAL HOURS" OCCUPANCY:

   a. Provisions shall be made to operate the ventilation systems as needed for periods of time outside the "normal occupancy hours" during which the building will be occupied. The building should not be occupied with the ventilation systems shut off.

C. MAINTENANCE:

1. DOCUMENTATION:

   a. The following documentation shall be readily available to the maintenance personnel:

      1) Design Criteria/Design Assumptions used to design the systems from the original construction project

      2) Operating & Maintenance Manuals from the original construction project

      3) Mechanical Shop Drawings for all systems and equipment from the original construction project

      4) Air Balance Report from the original construction project

      5) Record Construction Drawings from the original construction project

      6) Changes to operating procedures

      7) Re-testing, re-balancing, re-commissioning of systems

      8) Renovation, retrofit of systems

      9) On-going maintenance logs, reports, work orders, etc. documenting all maintenance activities

2. DRAIN PAN CLEANING:

   a. All drain pans shall be thoroughly cleaned at the end of each cooling season. Any organic or inorganic films or material build-up shall be physically removed from both the drain pan and connecting drain line.

   b. All drain pans shall be visually inspected at least once per month during the cooling season to observe that drainage is occurring.

3. COOLING TOWER WATER TREATMENT:

   a. A documented water treatment program shall be put in place for each cooling tower to control corrosion, sediment, and biological growth.

b. The cooling tower water shall be tested at least once each week during the cooling season.

4. AIR FILTER CHANGE-OUT:

a. All air filters shall be replaced with new filters when the temperature control system signals an alarm that the pressure drop across the filters has reached the maximum allowable according to the filter manufacturer.

b. All air filters shall be visually inspected at least once every month for damage, etc.

5. OUTDOOR AIR INTAKE LOUVERS:

a. All outdoor air intake louvers shall be visually inspected at least once every six (6) months for damage, dirt and debris and cleaned as necessary.

6. TEMPERATURE CONTROL SYSTEM RECALIBRATION:

a. The temperature control systems shall be checked and recalibrated as required at least once every two (2) years.

b. Certain types of control systems may require more frequent recalibration.

1) Carbon monoxide or carbon dioxide sensors shall be recalibrated at least once every six (6) months.

7. AIR BALANCING RECALIBRATION:

a. The ventilation systems air balancing shall be checked and recalibrated at least once every two (2) years.

1) The required air flow rates may have changed since the original construction project due to remodeling. It is important to use the current required air flow rates that result from any past remodeling projects.

2) The required design outdoor air quantities need to be checked to make sure the ventilation systems are delivering the required minimum outdoor air quantities.

b. Air balancing shall be completed if the use of the building changes from its original use as defined in the design criteria established by the Owner.

8. PERIODIC AIR HANDLING UNIT SYSTEM/DUCTWORK CLEANING:

a. All air handling unit systems and ductwork systems shall be checked at least once every five (5) years and cleaned as needed.

1) All air handling unit coils need to be checked.

2) Supply, return and exhaust grilles and diffusers need to be cleaned.

END OF GUIDELINES

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