Hennepin County Principles of Safe Design

In response to societal demands for safer products and workplaces, governments, businesses, designers and other decision makers are seeking greater consideration of safety issues in design. This document introduces the concept of safe design.

Hennepin County is committed to protecting human health and the environment through best design practices.

This document provides information and advice on eliminating hazards and controlling risks at the design stage to persons involved in the design or modification of products (including buildings, structures, equipment and vehicles) and processes used for work. Please refer to the Hennepin County Internet site for the current version of this document.

Safe Design has two primary purposes. One is to reduce injuries at the site, for example, slips and trips, which reduces cost. The other is to reduce the life cycle cost of the facility or equipment by improving employee & vendor access to equipment and by reducing the cost of regulatory compliance.

Quick Links

What is Safe Design?

Safe design is a process defined as the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimize the risks of injury throughout the life of the product being designed. It encompasses facilities, hardware, systems, equipment, tooling, materials, energy controls, layout, and configuration.

A safe design approach begins in the conceptual and planning phases with an emphasis on making choices about design, materials used and methods of manufacture or construction to enhance the safety of the finished product. The designer needs to consider how safety can best be achieved in each of the lifecycle phases, for example:

- Specify systems and equipment that eliminate fall hazards. Where a fall hazard cannot be eliminated, specify the installation of fall protection anchors.
- Specify sufficient space for safe access to mechanical equipment.
- Specify lighting systems that can be maintained safely and efficiently.
- Specify disconnects located in close proximity to equipment.
- Specify equipment and systems that reduce or eliminate the need to enter confined spaces or other hazardous areas (e.g., by using automatic valves, valve extensions).
- Specify holes in roof perimeters for the placement of temporary guard rails.
- Specify walkways and equipment to minimize slipping and tripping hazards.
- Design parking areas and walkways to minimize ice accumulation.
- Specify indoor building materials and furnishings with low volatile organic compound content for good indoor air quality.
- Design spaces with physical security in mind for occupants from human caused threats or criminal behavior.

Safe design will always be part of a wider set of design objectives, including practicability, aesthetics, cost and the functionality of the product. Safe design is the process of successfully achieving a balance of these sometimes competing objectives without compromising the health and safety of those potentially affected by the product over its life.

The design function is influenced by a range of parties at varying stages of the design process, as well as during the lifecycle of the product. They include:

Design professionals such as architects, engineers, industrial designers, software developers.

- Other groups who make design decisions, such as clients, developers, builders, owners.
- Insurers, project managers, purchasers, safety professionals and ergonomics practitioners.
- Suppliers, constructors, installers and trades/maintenance personnel and code officials.

What are the Principles of Safe Design?

The key elements that impact on achieving a safe design are:

Persons with Control – persons who make decisions affecting the design of products, facilities or processes are able to promote health and safety at the source.
Product Lifecycle – safe design applies to every stage in the lifecycle from conception through to disposal. It involves eliminating hazards or minimizing risks as early in the lifecycle as possible.
Systematic Risk Management – the application of hazard identification, risk assessment and risk control processes to achieve safe design.
Safe Design Knowledge and Capability – should be either demonstrated or acquired by persons with control over design.
Information Transfer – effective communication and documentation of design and risk control information between all persons involved in the phases of the lifecycle is essential for the safe design approach.

Ergonomics and Safe Design

Safe design also incorporates ergonomics principles. Ergonomics is a user centered discipline which plays a major role in design but it is also a philosophy and way of thinking. An ergonomic approach ensures that the design process takes into account a wide range of human factors, abilities and limitations affecting end users. Ergonomics considers the physical and psychological characteristics of people, as well as their needs in doing their tasks – how they see, hear, understand, make decisions and take action. User safety, efficiency, productivity and comfort are indicators of how effective the design is in fulfilling its purpose.

Ergonomics Principles

When analyzing the need for a designed product or space, an ergonomic approach will address five main elements.

- **The user** – their characteristics, including the physical, psychological and behavioral capacities, skills, knowledge and abilities.
- **Job and task characteristics** – what the user is required to do or actually does.
- This includes task demands, capacity to make decisions, work organization and time

requirements.

- **The work environment** – the work area and space, lighting, noise and thermal comfort.
- **Equipment design and the interface with the user** – including the 'hardware' needed to perform the work and including electronic and mobile equipment, protective clothing, furniture and tools.
- **Work organization** – including the patterns of work, fluctuations in work load, timing of work and the need to communicate and interact with others, as well as broader industry or economic influences.

Indoor Air Quality Considerations

Indoor air quality refers to the health and comfort of building occupants with the design of effective ventilation systems that maintain temperature, humidity, fresh air exchange and filtration of particulates and limit air pollutants within the indoor environment.

ASHRAE has provided technical guidance for HVAC design, construction and commissioning within its published 2009 Indoor Air Quality Guide.

Interior design furnishings are a source of indoor air pollutants within buildings. Carpets and furniture contain volatile organic compounds (VOCs) that off-gas chemicals with low odor thresholds for humans. Many VOCs are known carcinogens and can have short term and long term health impacts. Selection of products and materials with low VOC content improves indoor air quality by limiting odor and chemicals that occupants breathe. The Carpet and Rug Institute (CRI) is a trade association of manufacturers and suppliers that tests and certifies products to meet industry standards and regulations for low VOC content. It is recommended that Green Label Plus certified carpets, cushion and adhesive products be selected for projects because they meet the highest standards of industry certification and meet or exceed governmental regulation for VOC content.

Health effects from poor indoor air quality can be immediate and long term. Single exposures to indoor air pollutants cause irritation to the eyes, nose and throat and long term exposures contribute to respiratory diseases, heart disease and cancer.

Physical Security Considerations

Crime Prevention Through Environmental Design (CPTED) is a multi-disciplinary approach to deterring criminal behavior through design principles and strategies with the least inconvenience to end users. Target hardening is the concept of making it more difficult and less desirable for a crime to be committed such that a perpetrator will choose a more vulnerable target.

- **Natural surveillance** increases visibility into shared spaces to increase social ownership and general awareness of surroundings. Criminal behavior is deterred by increased risk of being noticed or caught in the act.
- **Natural Access Control** separates public and private spaces by designing traffic flow, points of entry and providing social indicators of appropriate use of space.
- **Natural Territorial Reinforcement** defines space such that occupants inherit a sense of ownership and intruders easily stand out. Activity and signage give the impression that areas are controlled.
- **Maintenance** expresses pride of ownership and positive reinforcement of social value. Perpetrators are more likely to target areas of deterioration or neglect for vandalism than a well maintained structure.

The Benefits of Safe Design

The opportunities to create safer workplaces are most cost effective when captured in the earliest phases of the lifecycle of designed products and structures. The most effective risk control measure – eliminating the hazard – is often cheaper and more practical to achieve at the design or planning stage, rather than making changes later in the lifecycle when the hazards become real risks to clients, users, employees and businesses. The direct costs associated with unsafe design can be significant.

Since these costs impact more on parties downstream in the lifecycle who purchase and use the product, the incentive for these parties to influence and benefit from safe design is also greater.

A safe design approach results in many benefits, including:

- Prevention of injury
- Improved usability of products, systems and facilities
- Improved productivity
- Reduced costs over the lifecycle of a product
- Compliance with safety and environmental legislation

The Safety Design Challenge

Hennepin County challenges our contracted planners, architects, designers, engineers, suppliers and others, in helping us achieve our commitment to best safety and environment practices in design.

Coordination with County Departments

The A/E shall coordinate with the Facilities Management and Workplace Safety & Environmental Divisions in the Property Services department.

The architect shall work with the mechanical engineer to ensure that the equipment installation meets the architectural requirements of the building. It can be assumed that a 50-year building shall have (with the exception of cooling towers and rooftop HVAC units) mechanical equipment located inside of the building.

Safe Design Essentials

The following design elements shall be included in the project unless 1) they are not applicable, or 2) the Property Services Design & Construction Manager and EHS Manager provide a written exemption.

Access to Equipment

Access to equipment means efficient, economical access to equipment where there is a routine inspection or maintenance requirement. Specifications in this section include access ways sufficient to readily enter and perform work; protection from falls > four feet; fixed stairs or ladders rather than portable ladders; steps or ladders at abrupt changes in elevation greater than 19 inches; and work platforms for equipment that must be serviced at height.

- Location of equipment shall be determined by its service need, so it can be easily maintained. When the equipment service points are located 4 feet or higher above the ground, a service platform shall be provided that complies with OSHA requirements for

service and maintainability. The A/E shall include section drawings throughout mechanical rooms. The mechanical engineer shall meet with zone personnel to discuss and ensure adequate accessibility early in the design phase.

- The A/E shall coordinate the mechanical design with other disciplines to provide adequately sized and properly located access panels.
- Where equipment is entered for maintenance, doors and hatches shall be sufficient to allow ease of passage of a large male worker (anthropometric U.S. 95th percentile male).
- Roof access shall be by permanent stairs (preferred), ship's ladders, or vertical ladders.
- Equipment shall be located at least 10' from an abrupt change in elevation > 4'.
- Specify ladders, catwalks, mezzanines, etc., as necessary to allow safe maintenance of equipment.
- Design access points to confined spaces as large as possible and when feasible, provide remote operation of devices located inside the space.

Fall Protection

OSHA requires maintenance worker protection from falls > four feet. In practice, this suggests the use of guardrails. Guardrails can be avoided in some cases by keeping equipment 10 feet laterally from fall hazards. Where personal fall protection is deemed appropriate, dedicated rated, labeled anchors must be provided. Additionally, were swing stage use is anticipated, rated, labeled anchors shall be provided.

- Workers shall be protected from falls where elevation to lower level > 4'. Note: It will typically be most cost-effective to use guardrails. Where guardrails are not used or are not feasible and work is > 4', tie-off anchors for personal fall protection shall be provided. Gantry or continuous wire rope anchors are preferred to single point anchors for most applications. Anchors shall be rated, labeled and certified – with paperwork being turned over the County as part of O&Ms
- Equipment shall be located 15 feet from the unprotected edges whenever possible. By giving extra distance from the fall hazard for employees or vendors to work on equipment (5 foot buffer distance in addition to the code requirement) it eliminates the fall hazard and the requirement for fall protection systems.
- For access doors through floors, use doors which immediately provide guarded entry around the opening when the door is open.
- For tower type structures, specify a permanent vertical fall protection system.
- Lighting systems and other equipment located at or near ceilings shall have a means of safe access for inspection and maintenance. Where safe access is deemed impractical from below, alternate safe access systems shall be provided. This may necessitate the specification of rated fall protection anchors.
- Provide suitable certified rated anchors for suspended work activities such as window washing. See MNOSHA window washing standard for details.
- Provide handholds at 30" – 42" high for hatches (e.g., roof hatches).
- When designing an atrium in a building, specify permanent guardrails, anchor points, gantries or other effective and efficient fall protection mechanisms.

Mechanical Equipment – General

Mechanical equipment must have adequate guards. Guards, however, should be designed for ease of access at equipment service points. Equipment must be labeled so as to clearly indicate function and hazard (e.g., LOW PRESSURE STEAM). Valves and disconnects shall be specified such that they can be easily locked and tagged to conform to the OSHA Lockout / Tagout Standard.

- Equipment with moving parts shall be guarded or enclosed to prevent injury during normal operation.
- Nip and pinch points shall be guarded. Include interlocks where appropriate.
- Control valves shall be located such that they can be easily reached and operated.
- Valves and switches controlling hazardous energy shall be capable of being easily locked and tagged without the use of specialized devices.
- Valves, switches and disconnects controlling a hazardous material (e.g., piping) or energy source shall be uniquely identified (numbered) with a unique, permanent tag, label or sign.
- Equipment (pumps, fans, boilers, electrical panels, etc.) shall be identified with a unique, descriptive label.
- Emergency controls and displays shall be clearly marked.
- Pressure relief devices shall be directed away from passageways and work areas.
- Where steam cannot be shut off during maintenance (e.g., 24/7 operations), specify steam line design to allow double block and bleed for maintenance, as necessary, to protect workers.
- Mechanical rooms shall allow safe removal and replacement of equipment.
- Specify vertical clearance in mechanical rooms and access ways to avoid head injury, or provide padding and warnings to alert persons to the hazard.
- Specify conditioned space for major mechanical equipment.
- Equipment and related hardware shall be mounted on a pad above the finished floor.
- Locate lifting eyes, hoist, or crane above the equipment to aid in the installation and maintenance of the equipment.
- The air intake location must consider the relative position of other air emission sources such as emergency generator stacks and loading docks.
- Equipment rooms shall be heated and ventilated with at least four air changes per hour.
- Mechanical equipment shall be located, sized and arranged in a space that provides easy access for maintenance, repair and future replacement. The equipment shall be enclosed and separate from other building functions.
- Where heat-generating equipment is situated adjacent to or above occupied spaces, the equipment shall be ventilated.
- Adequate provisions shall be made in mechanical space to support equipment, piping and ductwork.
- Equipment, piping and ductwork in such rooms shall be mounted or suspended in a manner that will isolate it from the system and from the structure to prevent noise and vibrations in adjacent spaces.
- No piping shall run into or through fresh air plenums and/or air ducts.
- Complete temperature control drawings shall be mounted in a conspicuous location on or immediately adjacent to major equipment such as air handlers and converters.
- Specifications shall clearly define the responsibilities of contractors and manufacturers to provide instruction to designated County personnel for the proper operation and maintenance of mechanical equipment. The schedule for the training shall be coordinated with the owner's representative and/or the commissioning agent as appropriate.
- Equipment on roof shall be properly anchored and shall rest on properly drained roof curb.
- Equipment and penetrations that require multiple curbs in close proximity to each other shall be incorporated into one larger curb to minimize the difficulty in roofing activities.
- PROHIBITED: Interior thermal insulation of air ducts.
- Sound attenuation for each individual project must be reviewed and is subject to approval before design is completed.
- Thickness of supply air duct and plenum insulation shall be selected to prevent condensation on the surface of insulation when the ambient relative humidity is 90 percent at the maximum difference between the ambient air temperature and the supply air

temperature. Fresh air intake ducts shall be insulated with fiberglass board insulation 2 inches thick, mechanically fastened, and shall have a finish suitable to the location and surrounding conditions.

- Fastenings shall not penetrate the inside of ducts.

Pipes & valves

Pipes must be labeled with contents, flow direction, pressure, etc. in order to allow workers to assess the chemical and physical hazards associated with piping. Workers must able to easily protect themselves from the unexpected release of energy as described in the OSHA Lockout / Tagout standard. Designers and installers shall specify systems that allow workers to simply and effectively control hazardous energy. Systems such as double block and bleed may be necessary in some environments (e.g., 24/7 operations).

- Valves associated with piping containing chemical or physical hazards shall be capable of being easily locked and tagged without the use of specialized devices.
- All systems such as potable water, heating systems and cooling systems must have a minimum of one isolation valve per building level or as the County representative requires.
- Specify the placement of a brightly colored warning tape approximately one foot above newly installed underground lines.
- Specify the placement of a metal locator line with non-metallic piping.
- Route pipes so as to avoid trip hazards.
- Route piping drains and overflow outlets to trench drains so the drainage material does not become a slip hazard.
- Locate drains to avoid slippery floor conditions.
- Do not locate piping in rooms containing high voltage equipment, bare wires, or bus bars (>50v).
- All piping shall be labeled every 20 feet and at every change of direction as to type of service and direction of flow. Markers can be Seton or of equal plastic kind, secured by approved plastic banding. A black arrow on the markers shall indicate the direction of flow. Letters shall have a minimum height of 1 inch.
- Valve tag numbers shall correspond to valve numbers on drawings and control diagrams and sequence of operation.
- PROHIBITED: Installing piping joints on disturbed soil in the backfill outside the building wall unless a structural beam anchored in the wall is constructed under the pipe.
- Insulate the following piping:
    a) Steam lines
    b) Domestic hot and recirculating water lines
    c) Steam condensate lines
    d) Chilled water lines, except for buried lines
    e) Refrigerant lines, where necessary
    f) Cold water lines
    g) Fuel oil lines, where necessary or exposed to low temperature
    h) Roof drain bodies and horizontal rain leaders
    i) Heating water lines
    j) Other piping systems above and below ambient temperature
- New insulation covering shall be colored to indicate non-asbestos material, or as specified by the County. Insulate fittings, flanges, unions and valves. Insulation covers shall be either prefabricated or fabricated of pipe insulation. Insulation efficiency shall not be less than that of the adjoining piping. Specify that insulation vapor barrier be installed continuous and unbroken.
- Branch steam mains shall have valves at the main.
- Flanges or unions shall be provided, and valves arranged so removable equipment may be

easily dismantled for maintenance without disruption of service.

Plumbing

The primary concerns related to plumbing are allowing access for maintenance, avoiding ruptures due to freezing, and keeping lead in potable water to a minimum.

- Attempt to avoid installing pipes in cold spaces. All plumbing installed in cold spaces shall be protected from freezing. All water mains, branches and risers shall have drain and isolation valves to facilitate drainage and minimize disruption to occupants.
- Locate isolation valves in restrooms in an easily accessible location for maintenance.
- Specify wall-hung, lead-free, electric water coolers. Water coolers used at universal access installations shall be of two-tier design, and be ADA-compliant.

Refrigerants

The primary concern with refrigerants is the potential for asphyxiation due to oxygen displacement.

- All comfort cooling refrigeration equipment shall be charged with a nonflammable, low toxicity, hydro chlorofluorocarbon (HCFC) or hydrofluorocarbon (HFC), having an ozone depletion factor (ODF) of 0.05 or less. Acceptable refrigerants for centrifugal chiller as of July 15, 1998: R-22, R-123 and R-134A (or others that can be appropriately documented).
- Refrigerant piping arrangement, equipment room and purge system ventilation shall consider the allowable exposure limit for the refrigerant specified. Provide a corresponding complete purge system.
- Mechanical spaces that have the potential for hazardous release of CFC shall meet the requirements of the latest edition of ASHRAE 15, and be equipped with the following:
  A multi-port CFC monitoring system.
  A direct readout device located outside the entrance to the mechanical room and/or each entrance of the mechanical room. The device shall be equipped with a yellow alarm light at 30 ppm and a red alarm light and audio alarm at 500 ppm. Recommended manufacturers of the CFC monitor include Trane, TruSense MGRMWE infrared photoacoustic refrigerant, Chillgard RT or County-approved equal. The monitoring system shall be connected to the BAS.
- The A/E shall specify a sequence of operation as follows to signal refrigerant release, ventilate the space and shut down equipment as needed to protect workers from eminent danger.
- All contractors shall carry appropriate EPA certification for their on-site technicians and shall provide copies of these certifications as requested by the owner's representative. Contractors and their subcontractors shall follow requirements as defined in 40 CFR 82, which includes using EPA approved recovery equipment.

Rooftop Air Conditioners

When rooftop air conditioners are specified, safe access and work platforms shall be provided as necessary to protect workers.

- Rooftop equipment may be considered only when other viable options are not available.
- The A/E shall select the rooftop unit and location to minimize noise impact in occupied areas and on neighbors.
- The A/E shall submit to the County for review what noise criteria level will be used for the selection of rooftop equipment.

- When required by application, condensing equipment shall be capable of starting and operating at low ambient temperatures.

Air Handlers

The primary concerns regarding air handlers ease of access for inspection and maintenance and for air filtration appropriate to the local environment and occupant needs.

- Filter racks shall be specified to minimize air bypass.
- Filter efficiency (MERV Rating) shall be based on local environmental conditions (e.g., higher filtration efficiency in core urban areas) and in consultation with County mechanical engineers.
- Filter sections shall allow for complete and total access for replacement of all filters.
- Equipment rooms with refrigeration equipment shall comply with ASHRAE Standard 15.
- Provide adequate ventilation for equipment rooms, including a filtered outdoor air and exhaust system, complete with thermostatic control. The temperature in equipment rooms shall not exceed 100 degrees on a design day.
- PROHIBITED: Activated carbon filters to protect poorly located outside air intakes.
- The A/E shall be responsible for locating the outside air intake away from sources of exhaust fumes. Examples include loading docks, parking areas, heavy traffic areas, cooling towers, nuisance odors, plumbing vents, emergency generator exhausts and engine-driven fire pump exhausts.
- Intakes shall be at least 24 inches above the roof and at least 30 feet above grade. Exceptions to be approved by County. Each intake shall be sized based on the manufacturer's criteria for eliminating rain and snow penetration or carry over into the air-handling system.
- The A/E is responsible for locating building exhausts away from air intakes.
- Provide a minimum 24-inch by 24-inch, insulated access panel with a gasket at all exhaust and relief valves and intakes for cleaning and maintenance.
- Outside air intake chambers, relief hoods and power roof ventilators shall be furnished with watertight drain pans that have a minimum depth of 2 inches. An open waste drain line shall be designed to carry rain or melting snow to a nearby floor drain. Install an access door large enough to service the drain. Metal pans shall be stainless steel.
- At duct humidifiers, solder ductwork watertight, 5 feet upstream and 25 feet downstream of the ductwork. Pitch ductwork to a drain located at the humidifier.
- All ducts exposed to weather shall be watertight.
- Fan Identification: All fan units shall be permanently marked to clearly identify the equipment number and area served.

Fans, Fan Drives and Motors

The primary concerns in this section are worker protection from moving parts, ability to easily lock out and tag equipment, and to locate disconnects close enough to equipment (as is feasible) so as to preclude a need for lockout procedures.

- Drive belt guards shall be made with expanded metal and have hinged access so the belts can be easily examined.
- Provide shaft guards per OSHA standards.
- Fan Access Panels shall have gaskets and be airtight.
- Isolate fans to meet the specified vibration requirements of the project.
- Provide a minimum 1/16-inch-thick flexible connection between ducts and inlets and outlets of all supply and exhaust fans and units. Joints shall be lapped and airtight, and not be located at corners of ducts. Provide a minimum separation of two inches between joints on flexible canvas connections with a minimum overlap of two inches.

- Fans must meet Air Movement and Control Association (AMCA) 204, Balance Quality and Vibration Levels for Fans.
- Lights: Air-handling units with more than 5,000 cfm shall be provided with interior service and inspection lighting.
- The trap for cooling coil drain pans shall be designed to handle the maximum static pressure of the system. The water shall flow out of the pan at the specified maximum static pressure without the pan overflowing.
- Specify that all motors be mounted so that the nameplate can be read without removing the motor from its mounting.
- Specify that bearings that require lubrication have readily accessible, approved grease fittings for easy service without entering the fan chamber.

Air Distribution

The primary intent of this section is to maintain air quality via good supply air mixing and the avoidance of mold growth related to wet air distribution materials.

- Design supply and return air systems to minimize short-circuiting supply air to the return air system. The A/E shall include a schedule of ventilation efficiency on the contract documents for rooms occupied by more than five people.
- Ventilation efficiency shall be no less than 75 percent. Ventilation efficiency shall be calculated in accordance with the most recent edition of ASHRAE 62.1.
- PROHIBITED: Fiberglass ductwork.
- PROHIBITED: Pipe or any other type of obstruction passing through a duct.
- Provide a minimum of three duct diameters from fan inlet or discharge before transition or elbows.
- Specify and show all dampers required for proper balance of air on drawings.

Smoke and Fire Dampers

The primary intent of this section is life safety and maintenance of air distribution systems related to actuated dampers (damper reset).

- Smoke dampers or combination smoke/fire dampers shall be actuated digitally and meet current UL requirements (e.g., UL555 / UL555S).
- Damper operation shall be a controlled-closure type that closes in no less than seven seconds and no more than 15 seconds.
- All smoke and fire dampers shall be designed with access panels adjacent to the dampers. The dampers shall be sized to allow damper reset through the access panels.
- Access doors with 1/4-inch wire glass panels shall be installed at each fire damper so that the damper position can be inspected from the floor.
- The A/E shall require field-testing of all smoke and fire damper installations in the presence of the contractor.
- Install access doors on mechanical and electrical devices such as coils, motorized and manual dampers, and humidifiers.
- Access doors shall be installed in sides or bottom of duct. The minimum size for access doors shall be 18 inches by 16 inches. For smaller ducts, door width shall be 2 inches narrower than the ducts by 16 inches long.

Carbon Dioxide Demand Control Ventilation

The primary intent of this section is to ensure that carbon dioxide demand controlled ventilation systems are fully functional and that materials and information necessary for maintenance are provided.

- If demand control ventilation will be used, assume 400 ppm as the outside ambient level.
- Carbon dioxide sensors shall be calibrated following manufacturer instructions. A calibration kit with manufacturer instructions shall be provided. The contractor shall provide training in sensor calibration to County personnel. Complete written instructions shall be included in the O&M manuals.
- Building automation systems and equipment tied to carbon dioxide sensors shall be commissioned.
- The sequence of operation will position the outside air damper minimum position to equal code required cfm/person based upon maximum design occupancy. As the carbon dioxide decreases below 900 ppm (adjustable), the damper minimum position

  will be proportionately reset down to an occupied minimum position of approximately 10 percent. (15 cfm/person equals a differential of 700 ppm; 20 cfm/person equals a differential of 500 ppm.) This bottom end minimum position ensures that there is adequate ventilation for odor control when there are few people present.

Carbon Monoxide Sensors and Controllers

The primary intent of this section is to ensure that carbon monoxide sensors and controllers are fully functional and that materials and information necessary for maintenance are provided.

- Carbon monoxide sensors shall be calibrated following manufacturer instructions. A calibration kit with manufacturer instructions shall be provided. The contractor shall provide training in sensor calibration to County personnel. Complete written instructions shall be included in the O&M manuals.
- Building automation systems and equipment tied to carbon monoxide sensors shall be commissioned.
- In spaces where low CO exposures are anticipated (public ramps), solid state sensors should be installed due to their low maintenance requirements. In spaces where high CO concentrations and/or longer exposures are anticipated (vehicle maintenance shops) electrochemical sensors should be installed due to higher accuracy.
- Sensors and controllers may require two, three or four-wire connections. To allow for any wire requirement in the future, a minimum of four control wires shall be installed in new construction.

Testing and Commissioning

The HVAC and control systems shall be commissioned in accordance with the ASHRAE Guideline (current edition). The temperature controls contractor shall provide assistance, staff and materials to support the commissioning activities.

In addition, the temperature controls contractor shall assist the balancing contractor as needed with necessary software, hardware and training while balancing the HVAC systems.

Electrical Equipment > 50 volts

The primary intent of this section is the protection of workers from electrical shock and arc flash energy with regard to OSHA standards and NFPA70E.

- Electrical equipment shall be designed to allow an “electrically safe work condition” as defined in NFPA70E.
- Electrical equipment (panelboards, motor control centers, etc.) shall be marked with nominal voltage and amperage.
- Equipment with potential incident arc flash energy at or greater than 1.2cal/cm2 at 18” shall be marked with the incident energy and hazard category per NFPA70E.

- Fingersafe electrical devices shall be installed when available (e.g., light ballasts).
- Equipment (e.g., fan motors) shall have disconnects at the service point.
- Electrical single line drawings will be provided for the facility or project.
- Electrical equipment shall readily accept locks and tags where an electrically safe condition is required by OSHA or NFPA70E.
- Place a brightly-colored warning tape along underground lines approximately 12 inches above the lines.
- Provide electrical design, construction documents and record documents adequate for operations and future modifications.
- Demolition and construction drawings shall be depicted on separate sheets.
- Show conduit sizes and routings, along with number and sizes of conductors for feeders and home runs and complicated circuitry. State that any modifications to the number, size and type of wires or conduits from those indicated is prohibited.
- Show circuit lighting and power outlets on the drawings and identify the panel terminal point for each circuit. Identify load locations and/or room numbers on panelboard schedules.

Automatic Transfer Equipment

- Provide a minimum of two sets of auxiliary form C contacts for normal and emergency transfer switch positions.

Demonstration of Electrical Systems

- The contractor shall test and supervise the initial operation of all equipment and special systems. The contractor shall demonstrate the equipment and special systems to County personnel, and instruct County personnel in operation and maintenance.

Electric Utility Commissioning

- All switching, protective devices, and metering on main distribution switchboards shall be identified with black-white-black laminated 1/8-inch thick plastic plates. Plastic plates shall be attached to the equipment with screws or rivets.
- Identification plates are required for all electrical distribution equipment from the service through branch circuit panelboards and motor control centers. Labels shall identify the equipment designation, operating voltage, and the source supplying the equipment.
- The A/E shall specify numbering and wording of identification plates.
- Motor and associated equipment numbers shall be the same.

Electrical Equipment Locations

- PROHIBITED: Installing electrical distribution equipment in stairwells, corridors or other occupied space of a building.
- PROHIBITED: Locating plumbing facilities above the electric vault or switchboard room.
- Locate electrical distribution equipment in dedicated electrical closets, electrical rooms or mechanical equipment rooms.
- Exclude piping, ductwork and other systems that are not compatible with the electrical installation from the entire interior of electrical closets and electrical rooms.
- Equipment and raceways in such rooms shall be mounted or suspended in a manner that will prevent excessive noise and vibrations in adjacent spaces.
- Exclude raceways and electrical equipment from ducts, plenums, areaways and tunnels unless required by their function to be located there.

Batteries

- Clearly specify the type and required life expectancy of batteries. Require a straight pro-rated replacement agreement or better from the battery manufacturer. The design shall

address the environmental requirements for batteries.

- If wet cell batteries are specified, provide a separate battery room with appropriate ventilation and safety features. Require a clear case for wet cell batteries.
- Batteries on racks or in cabinets shall be accessible for testing and verifying torque for individual cells or unit terminals. Vertical access above batteries shall be a minimum of 6 inches for dry batteries and a minimum of 18 inches for wet batteries.
- Each cell or unit shall be numbered for maintenance records.

Electrical System Studies

- Short circuit calculations and the protective device coordination study for electrical service equipment shall be performed during the design phase. Specification of equipment short circuit current interrupting and withstand ratings, and proper over- current protection for all elements of the electrical service shall be submitted to Hennepin County Property Services for review at least two weeks before the project is advertised.
- The A/E's responsibility for these studies shall not be delegated to the contractor within the contract documents. Contract documents may require the contractor to submit supplemental electrical system studies based on the specific equipment furnished to confirm the A/E's selection of equipment ratings and protective devices.
- Submit results of electrical system studies in accordance with IEEE Standard 242 - Protection and Coordination of Industrial and Commercial Power Systems and IEEE Standard 399 - Power System Analysis.

Electric Vaults & Utilities

For the purpose this document, the term "electric vaults" is defined as transformer rooms and/or electrical equipment rooms that contain medium-voltage service equipment of more than 600 volts.

- PROHIBITED: Equipment such as ventilation fans, distribution panelboards and drain lines in electric vaults.
- PROHIBITED: Telecommunications equipment, phone panels, standby generators, transfer switches and related equipment, small secondary transformers and related panelboards, and fire alarm boards in electric vaults.
- PROHIBITED: Foreign piping, clean-outs and/or ductwork in electric vaults. An entire electric vault shall be defined as an “electric vault” to exclude foreign piping and ductwork.
- PROHIBITED: Fire protection sprinkler systems in electric vaults. The A/E shall design an electric vault room and equipment therein so that a fire protection sprinkler system is not required by NFPA 13-5-13.11 exception, 1999 edition and/or any other applicable codes.
- Provide outside access and egress for equipment. The A/E shall identify the route on the drawings. Electric service areas shall be adjacent to an outside wall or vent shaft that can easily accommodate rigging equipment.
- Provide a minimum of two means of personnel access and egress within the working space to each electric vault.
- To provide safe operating space for hot stick operation, a minimum of 6 feet of clearance is required in front of all doors. In addition, a minimum of 6 feet of clearance is required in front of any removable panels where grounding clusters may be applied or an exposed live part may exist.
- Provide a minimum of 30 inches in front of any removable panel or ventilation space.
- Provide detail on the working and ventilation space for equipment in electric vaults on the drawings.

Panelboards and Cabinets

- Furnish each electrical panel with a clear, plastic-covered, typed-circuit schedule mounted in a metal cardholder. The schedule shall identify circuits by room number using final numbers that the County furnishes. Verify room numbers with the County.
- Provide a number designation on each circuit protective device. Odd numbers shall be used in sequence down the left side and even numbers in sequence down the right side.
- Provide cross breaker connectors and bus for breakers in the future. Indicate the designated space in panelboard schedules for panelboards to accept maximum capacity.
- Identify the panelboard ID and power origin on each panelboard on the outside or inside door.
- Schedules: Show the schedule for panelboards and cabinets on the drawings, preferably on the same sheet as the power riser diagram. Include the following information as a minimum:
    a) Voltage, phase and wire
    b) Main bus rating
    c) Main breaker rating
    d) Short circuit rating
    e) Circuit numbers
    f) Branch breaker current rating and number of poles
    g) Load description
    h) Connected loads
- Sound levels of transformers shall be consistent with the use of the building areas adjacent to the transformer. Sound levels shall not exceed ANSI standards.
- In areas of very low ambient noise level such as libraries and reading rooms, use transformers with lower sound levels.

Walking and Working Surfaces

The primary intent of this section is to minimize injuries to workers and the public due to slips & falls as well as to comply with OSHA standards.

- Where an abrupt change in elevation occurs >19", permanent stairs or ladders shall be installed.
- Water shall not be directed over pedestrian walkways or surfaces.
- Walkways and work areas shall be free of tripping hazards.
- Elevated walkways shall include toe boards where materials falling to a lower level would present a hazard to persons below.
- Provide permanent guardrails around floor & roof openings.
- Design the finished floor around mechanical equipment to be at one level.
- Design the covers over sumps, outlet boxes, drains, etc. to be flush with the finished floor to eliminate these features as tripping hazards.
- Reduce trip hazards by providing a non-slip walking surface on walkways and platforms adjacent to open water or exposed to the weather.
- Use serrated grating, instead of checkered steel plate, for walking surfaces on steel structures to prevent slipping hazards.
- As is feasible, provide a covering, or extend the roof line over exterior stairs, ramps, and walkways to reduce the buildup of moss or the accumulation of ice in winter.
- PROHIBITED: Surface water runoff from a roof that discharges on the ground and flows over a sidewalk, parking area, or into a street or roadway.

Illumination

- Where recurring maintenance or inspection work is anticipated, a minimum illumination of 30 foot-candles shall be provided (50 – 100fc preferred).

Hazardous Materials

- PROHIBITED: Insulation containing asbestos.
- In locations where radon is prevalent, design coarse granular fill and drain pipe(s) under the slab such that the arrangement allows radon to be diverted to the ambient air rather than through the slab and into the structure.
- Provide emergency eye-wash stations with tempered water in areas where personnel might come in contact with highly toxic or corrosive materials. Provide clear signage for eye-wash basins.

Miscellaneous

- Design for compliance with Minnesota building code.
- Ventilation shall comply with ASHRAE 62.1, current edition.
- Temperature and humidification systems shall be capable of meeting conditions specified in ASHRAE 55, current edition.
- Facilities and equipment shall be designed such that maintenance can be readily and economically accomplished in accordance with OSHA rules for worker protection.

Library AMHs

- Nip and pinch points shall be guarded. Include interlocks where appropriate.
- Preferred: Include an anteroom with fire suppression and cold weather barrier inside the main AMH room.

Contractor Qualifications

Fire protection contractors must meet qualification criteria.

- The licensed fire protection contractor shall be responsible for the design, layout and hydraulic calculations for wet and dry sprinkler, pre-action and deluge systems.
- A professional engineer who is competent in the field of fire protection or a NICET Level 4 designer shall certify the fire protection contractor's design.
- The A/E shall specify that the acceptance of the fire-protection system be based upon completion of the necessary testing as outlined in the state and national fire codes. All testing must be documented on certificate forms.
- The fire protection contractor is responsible for maintaining the equipment in service after the acceptance test, as well as minimizing impairments to the system for the remainder of the project. During remodeling or after Certificate of Occupancy or Substantial Completion, coordinate impairments with the owner's representative.
- Provide permanent signs to identify drains, test connections, control valves, risers supplying hydraulically designed sprinkler systems, and each alarm. Label valves normally open (NO) or normally closed (NC).

Safety & Health During Construction

Site safety and health during construction is enhanced when designers and contractors anticipate hazards and implement mitigation strategies.

- Design fall protection and scaffolding tie-off points into exterior walls of buildings for construction purposes as is useful and feasible.
- Run continuous reinforcing steel through all floor openings in elevated slabs (the rebar can be cut after work on elevated slab is complete).
- On larger masonry blocks, provide cast-in handles or handholds for easy lifting.

- HVAC equipment and ductwork shall be kept free of dust, debris and fluids prior to installation.
- **Dust Control**
- The A/E shall specify measures to contain construction-related dust, contaminates and odors within the construction limits including HEPA ventilation, HEPA vacuums, and site cleaning schedules. Construction-related dust, contaminates and odors shall not interfere with normal County operations.

Weather Protection

- To protect facilities during remodeling or new construction from damage due to weather, the A/E shall specify the following. This language is required whenever roofs, walls or windows are disturbed as part of a remodeling project, or when exterior work may impact existing drainage systems.
    a) Provide necessary measures to protect temporary and final work, existing and adjacent buildings, material and equipment from weather damage. This includes groundwater, rainwater, wind, ice, snow and the backing up of sewers and drains.
    b) Provide temporary weather-tight enclosures, pumps, equipment, grading, bailing or other work necessary to ensure this protection.
    c) Provide temporary insulated weather-tight enclosures of all openings in exterior walls and roofs.
    d) Provide temporary enclosures to withstand gale force wind.
    e) The contractor shall inspect, protect, maintain and ensure constant operation of existing roof drains.
    f) The contractor shall protect areas of partial demolition until area is enclosed and weather-tight.
    g) The contractor shall inspect, protect, maintain and ensure intended operation of existing interior building floor drains in the construction area.
    h) The contractor shall inspect, protect, maintain and ensure intended operation of existing site drainage, exterior catch basins and areaway drains within the construction site so water does not pond.

Hazardous Waste Management

- General: Evaluation, on-site storage, transportation, disposal and other aspects of Hazardous Waste Management shall comply with Pollution Control Agency Hazardous Waste Rules, Chapter 7045.
- Hazardous Waste from Construction Activities: The contractor is responsible for the proper management of hazardous waste generated by his or her construction activities. Such waste is considered excess or unwanted hazardous construction- related materials, including, but not limited to, aerosols, paints, activators, adhesives and caulks. In no case shall such construction hazardous waste be co-mingled with demolition hazardous waste. In no case shall such construction hazardous waste be co-mingled with non-hazardous construction or demolition waste.
- Manage construction and demolition waste through reuse, recycling and reduction methods. Typical designated waste streams are land clearing debris, concrete and masonry, metals, dimensional wood and lumber, wooden pallets, gypsum wallboard, paper and cardboard. Depending upon the project, other large volume wastes may be included such as bricks, asphalt and carpeting. A specified percentage of the waste shall be collected, segregated and sent for recycling or reuse. Documented waste reduction strategies shall be credited toward the percentage of waste goal.
- Demolition waste shall be recycled as is feasible.
- **PROHIBITED**: Concrete truck washout and other construction generated wastes being discharged into storm sewers.

Site Access

- The contractor shall enclose the construction site limits, including the staging area, with a 2-inch and 6-foot-high mesh chain link fence with a top rail and lockable gates. Anchor steel posts, and space them not more than 10 feet on center. To avoid cutting or damaging pavement, sidewalks or waterproof plaza membranes, use portable base posts where appropriate.
- The contractor shall close and lock gates at times when construction personnel are not present. Remove fencing and restore the staging area to original condition before final completion.

Fire Safety Precautions

- The A/E shall include the following or similar statement in the specifications with regard to protective measures for the contractor during grinding, cutting, brazing, sweating or welding operations.
- All grinding, cutting, brazing, sweating or welding operations carried on in the vicinity of, or accessible to combustible material, shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
- When it is necessary to do grinding, cutting, brazing, sweating or welding close to wood construction in pipe shafts or other locations where combustible materials cannot be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. A helper shall be stationed nearby to guard against sparks and fire.
- Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations or spatter from electric arc, a fireguard shall be kept at the place of the work for at least one hour after completion to make sure that smoldering fires do not start.
- When welding or cutting in a vertical pipe shaft or floor opening, a fireguard shall examine all floors below the welding or cutting operation.
- The fireguard shall be kept on duty for at least one hour after completion of work to guard against fires.

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