

23 01 00 OPERATION AND MAINTENANCE OF HVAC SYSTEM**23 01 01 GENERAL REQUIREMENTS**

General System Design

1. Use air systems in combination with perimeter radiation. Perimeter radiation shall be capable of being operated independent of the air system.
1. Avoid all air systems.
2. Zone mechanical systems by intended occupancy, separate interior and exterior zones.
3. Provide re-heat coils in each interior zone.
4. All air handling units shall have heating or preheat coils even if building load indicate that one is not required.
5. Proposed fan volume control schemes, based on building static pressure, must have prior approval from FMGT.
6. Do not specify variable pitch in motion fans.
7. Design all air handling units with minimum 15% spare volumetric and static pressure capacity.
8. Buildings with no mechanical cooling (typical) shall have cooling circulation air increased by minimum of 25% or have sufficient volume to meet WCB requirements with respect to maximum space temperature, whichever is greater. Consider additional costs of construction and compare to cost of adding and operating mechanical cooling.
9. Radiant heating panels shall not face windows.
10. Provide separate exhaust to all photocopier rooms or areas. Exhaust to outdoors.
11. Ensure sufficient air mixing within the occupied space on VAV systems under all operating conditions.
12. VAV systems shall have reheat coils.
13. Window mounted air conditions and exhaust fans are not acceptable.
14. All exhaust ductwork within the building shall be under negative pressure.
15. Specify separate ventilation and heat recovery systems for mechanical and electrical rooms.
16. Do not specify sidewall supply registers for classroom applications.
17. Laboratory design shall meet best practices of applicable ASHRAE design standards, and/or the equivalent CSA standard recognized by the B.C. Building Code.
18. Return and supply fans requiring volumetric tracking shall have same type devices for volume control (i.e. inlet dampers must be only used with inlet dampers, VFD's with VFD's, etc.).

19. If fume hood exhaust systems are located in mechanical penthouses they shall be located in separate self-contained areas within the mechanical penthouse.
20. Where fume hood fans are contained within mechanical penthouses, pressurize the penthouse with supply air from the building from a safe outside source to avoid the possibility of recirculation exhaust air into the service space and to provide flushing of contaminants if a minor duct leak occurs. Fumes from industrial lab process shall be removed from spaces by the use of dedicated exhaust systems (not recirculation permitted).
21. Ventilation systems shall be designed to limit bio-contamination. Spaces containing "like-risks" can share ventilation systems, while bio and chemical ventilation systems shall be separated to avoid cross contamination.
22. Humidification shall be applied to each specific zone which requires local control. Avoid upstream humidification and downstream dehumidification.

Piped Systems Cleaning

1. For the campus heating mains, process water lines or chilled water lines, retain the services of a professional cleaning agency to supervise the chemical cleaning and flushing of the new piping. FMGT Mechanical Shop will provide the subsequent chemical treatment.

23 01 30 OPERATION AND MAINTENANCE OF HVAC AIR DISTRIBUTION

Cleaning Exhaust Systems – General Requirements

1. All new ventilations systems, or those affected by the project shall be cleaned by a professional cleaning Trade Contractor with appropriate equipment and trained personnel.
2. The following air systems shall be cleaned as specified by the Mechanical Consultant:
 - i. Supply, return, relief, and exhaust.
 - ii. Air conditioning.
3. All components within each new or affected system shall be thoroughly cleaned to the Consultants satisfaction.
4. On new construction, renovation, or retrofit project, the ductwork shall be cleaned before the air systems are balanced or calibrated.
5. All damper positions shall be marked before cleaning and returned to their original position unless the system is to be balanced.
6. Cleaning shall generally include high capacity power vacuum, compressed air or wire brushing. Solvent cleaning is to be avoided.

Filters

1. The Cleaning Contractor shall replace any temporary or existing filters and supply and install new filters as specified by the Consultant after the air system is cleaned.

23 07 19 HVAC PIPING INSULATION

1. Insulation shall be installed by qualified insulation fitters.
2. Insulation shall be installed in accordance with the requirements and recommendation of B.C. Insulation Contractors Association Manual.

Campus Heating Mains

1. This system may operate with up to 116°C (241°F) water.
2. Provide minimum 50mm (2") thick, mineral fibre insulation on piping (not drains) with vapour barrier jacket and where trenches or manholes provide a generous coating of water-proofing sealer.
3. Mains valves 65mm (NPS 2-1/2) and larger shall have bonnets insulated with removable insulation jackets.

Refrigeration Piping (Including Chilled Water)

1. Where installed outdoors, provide a continuous aluminum jacket finish (to prevent birds removing the insulation).
2. Provide closed-cell insulation and best industry practice to seal surface at all locations including hangers and exposed fittings.

Insulation Finish

1. Provide aluminum jacket over all outdoor insulation.
2. Provide an all service jacket and pre-fitted PVC jacketed elbows and fittings for all indoor insulated pipes with the exception of:
 - i. Provide a "Thermocanvas" type finish and pre-fitted PVC jacketed fittings on all piping in mechanical rooms and where exposed to occupant view.

23 10 00 FACILITY FUEL SYSTEMS

23 11 00 FACILITY FUEL PIPING

Campus Heating Mains

1. All piping shall be Schedule 40 steel to ASTM A53 Grade B.
2. All piping shall be welded except manual air vent and drain valves may be screwed and piping downstream of them may be screwed.
3. Manual air vent and drain valves shall be ball valves with wing-type (not lever-type) handles.
4. There shall be no high or low point in the piping between heating mains manholes. If this cannot be avoided then air vents/drains must be provided at the high/low point.
5. Valves (other than air vent and drain valves) shall be class 150 ball valves. 150psig/400°F. $\geq 1\ 1/2$ " must be equipped with gear driven operator to slow speed to open valve. ≥ 4 " to have 3/4" gate bypass for warmup.
6. For the most part these mains run underground. Where underground they shall run in a concrete trench typical in design and construction to the existing which are designed for water-tightness and to have removable lids.
7. Mains valves, drain valves, and vents shall be in accessible manholes or in building mechanical rooms.
8. Where possible arrange take-offs for a building to be valved such that future shutdown of a section of the mains will not interrupt service to the building.

Building Heating, Heat Recovery, and Chilled Water Piping and Valves

1. Piping may be steel to ASTM A53 Grade B or type L copper, to ASTM B88M-86.
2. Connections for steel pipe shall be welded and flanged on pipe NPS 2-1/2 (65mm) diameter and larger shall be screwed on pipe NPS 2 (50mm) diameter and smaller.
3. Connections for copper pipe shall be brazed with silver base brazing alloy, 538°C (1000°F) melting point but with soldered to screwed cast bronze fittings (to ANSI B16.18) or wrought copper fittings (to ANSI B16.22).
4. Grooved mechanical couplings are not acceptable.
5. Press-fit type couplings are not acceptable.
6. Valves NPS 2-1/2 (65mm) and larger shall be flanged. Valves NPS 2-1/2 (65mm) and smaller shall be soldered or screwed.
7. Butterfly valves may only be used on heat recovery systems or chilled water systems or heating water systems where the maximum design temperature does not exceed 180°F (82°C).

8. Balance valves shall be multiple-turn, memory stop, positive shut-off with inlet and outlet pressure connections, calibrated for flow measuring. Acceptable products: Armstrong CBV, Tour & Andersen STA.

23 20 00 HVAC PIPING AND PUMPS

23 21 23 HYDRONIC PUMPS

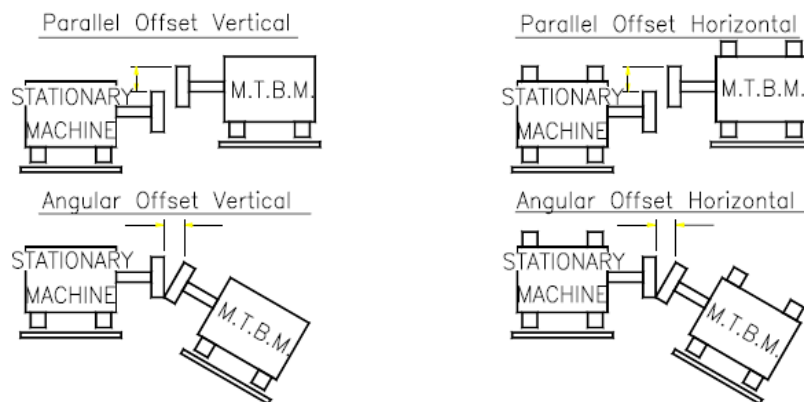
Tolerances for Shaft Alignment

- When aligning pump shafts use the table below to determine the required tolerances. Record alignment values and submit as part of close out submittals, a template form can be provided by FMGT. Have FMGT operations representative witness and approve final alignment.

Parallel Offset		
RPM	Excellent (mils)	Acceptable (mils)
600	0.005	0.009
900	0.003	0.006
1200	0.0025	0.004
1800	0.002	0.003
3600	0.001	0.0015
7200	0.0005	0.001
Angular Offset		
RPM	Excellent (mils)	Acceptable (mils)
600	0.001	0.0015
900	0.0007	0.001
1200	0.0005	0.0008
1800	0.0003	0.0005
3600	0.0002	0.0003
7200	0.0001	0.0002

Notes:

- Values are expressed in thousands of an inch (mils)
- These suggested tolerances are the maximum allowable from zero or a targeted offset in each of the four parameters of misalignment illustrated below:



23 30 00 HVAC AIR DISTRIBUTION

23 31 13 METAL DUCTS

Ductwork

1. All ductwork shall be metal, typically galvanized steel. Flexible ductwork is not acceptable.
2. Fume hood duct shall normally be 18 gauge, 316 stainless steel, continuously welded. Exceptionally corrosive situations may require more corrosion resistant materials.
3. Flexible duct of 300mm maximum length is acceptable only on a horizontal branch duct to an individual diffuser to allow alignment with the ceiling grid. It may provide a maximum of 15 degrees change in direction. No flexible duct shall be used for diffuser necks.
4. Ductwork shall be to SMACNA Standards excluding beaded, crimp joints and snaplock seams. Adjustable elbows must be the same gauge as the adjoining duct and only used if all sectional joints are sealed and secured in the installed position.
5. Ducts shall be sealed to SMACNA Seal Classification A or B as appropriate for the rated working pressure.
6. Specify access panel each side of heating coils.
7. Specify filter protection of heat recovery coils.
8. Motorized control dampers are strongly preferred over backdraft dampers.
9. Balance dampers of same material as the ductwork and shall have bushing-type bearings and a quadrant operator capable of locking the damper in a fixed position.
10. Avoid ductwork acoustical liners. Employ other methods acceptable to FMGT.

23 36 16 VARIABLE-AIR-VOLUME UNITS

1. Monitor supply air temperature downstream of every VAV box with a heating coil.

23 37 00 AIR OUTLETS AND INLETS

1. Do not specify balancing dampers at the face of air outlets and inlets. Locate balancing dampers sufficient distance into the ductwork to maintain acceptable sound level within the conditioned space (NC 3035 or less).
2. Coordinate with architectural discipline.

Outside Air Intake Louvers

1. Locate outside air intake louvers as far away as practical from all sources of contamination; avoid locating intakes at loading docks, fume hood exhausts, and generator exhausts. Outside air intake louvers are not to be located on roof tops where fume hood exhausts are located.
2. Locate outside air intake louvers as high as possible above grade and shall not be at grade level.

3. Where below grade intakes are unavoidable install bird/debris screen on outside of the louvers.
4. Where roof top parapets or screening hinder effective cross ventilation exhaust discharges, plumbing stacks and other contaminated discharges shall be elevated above air intakes at a minimum distance proscribed by code/regulation and/or good engineering practices.

Painting

1. Specify corrosion resistant primer paint to ferrous supports and site fabricated work (pewter gray).

Salvage

1. UVic does not have extensive storage facilities for salvaged material. Air conditioners, motors, and variable frequency drives in good condition have previously been considered for salvage. Occasionally a small fan or fume hood in good condition has been salvaged.
2. On renovation projects the Consultant shall submit a list of items to be considered for salvage to FMGT at the start of the design stage. The Consultant shall coordinate with FMGT to determine all materials to be salvaged which shall then be clearly specified.
3. The Mechanical Shop prefers the Contractor to remove the materials and move them to a designated storage place on campus.
4. All materials to be salvaged shall be carefully removed and handled to prevent damage and the Contractor shall obtain a signed receipt from the Mechanical Shop for all salvaged materials.

Photocopier Exhaust

1. Provide exhaust air from photocopier rooms, areas with large photocopiers (larger than a typical office copier) and areas for regular large copy production.

23 40 00 CENTRAL HEATING EQUIPMENT

23 41 00 PARTICULATE AIR FILTRATION

Indoor Air Quality – Filters

1. Filters for service rooms, protection of heat recovery coils or for small air handling units (less than 500 l/s) shall be minimum MERV 8. Standard of acceptance is 50 mm thick AAF AM-AIR 300. Acceptable product is Farr 30/30.
2. Filters for air handling systems over 500 l/s shall be a combination of a MERV 8 pre-filter and a MERV 13 final filter unless user requirements stipulate a higher value. Pre-filter standard of acceptance: 100mm thick AAF AM-AIR 300. Acceptable product is Farr 30/30. Final filter standard of acceptance, 100mm thick AAF AM-AIR Varicell II. Acceptable product is Farr Econocell.
3. Preference for pre-filter bank to be slide-in type. Final filter bank shall be built up from gasketed, individual filter frames with spring clips.
4. Separate filter gauge for each filter bank. Standard of acceptance: Dwyer Series 2000.
5. Design for suitable access for changing filters.

23 50 00 CENTRAL HEATING EQUIPMENT

23 52 00 HEATING BOILERS

1. Main Campus Loop – Industrial type, minimum boiler efficiency of 85%; gas fired.
2. Off Campus Loop – Condensing boiler (if supply water temperature demands permit); minimum life span – 20 years.
3. Minimum life span to exceed 25 years (industrial grade) for greater than 250,000 btu/hr burner rating (input).

23 57 00 HEAT EXCHANGERS FOR HVAC

1. Heat exchangers using campus heating water or any service over 82°C (180°F) shall be brazed plate type (not gasketed, plate-and-frame type).
2. Heat exchangers for domestic hot water heating shall be double-wall brazed plate type.
3. Heat exchangers for hydronic systems with water temperature 80°C (180°F) or below may be plate and frame or brazed plate type.
4. Heat exchangers anticipated to be in year-round service shall be installed as a pair each having 60% of design capacity and each with valves and unions so as to be removable without interfering with the operation of the other. This allows removal for replacement or cleaning. Duplex heat exchangers for domestic water heating shall only be considered where interruption of domestic hot water would be very disruptive (e.g. laboratory use, food services use).
5. Provide a two-way control valve on the campus mains return from the heat exchanger. Provide a 20mm (NPS 3/4) heat exchanger by-pass between the campus mains supply and return with a modulating control valve (c_v between 1.5 and 2.0), a throttling valve and isolation valves.
6. The building heating water pumps shall be designed either with duplex pumps or with valves and piping that can provide back-up in the event of failure of any one pump.
7. The heating coils should be on a separate heating water circuit from radiation to allow for different scheduled temperature control.
8. Provide flexible piping connectors on all piping connections. Standard of acceptance is Flextech Style FB26-TF.
9. Provide isolating valve, pressure gauge, thermometer, temperature sensor on each pipe connection.
10. Standard of acceptance is Alpha Laval Brazed Plate – Model CB200.

23 60 00 CENTRAL COOLING EQUIPMENT

23 61 00 REFRIGERANT COMPRESSORS

Mechanical Cooling

1. Some spaces require mechanical cooling because of equipment heat gain or process driven requirements.
2. Air cooled split systems or evaporating type condensers (closed or open) using treated water for make-up may be used. Systems using municipal water or other portable water (pass through cooling) are not acceptable.
3. Packaged roof-top equipment is generally not acceptable.
4. Unit with modulating cooling capacity are preferred (e.g. Mitsubishi variable refrigerant flow, inverter compressors).
5. Consider heat pump units instead of cooling only. Multi-zone heat pump systems must have master controls that communicate with the BAS.
6. For a new builder consider a centralized cooling system with chilled water if numerous spaces (present or future) are anticipated to require cooling.
7. Refrigerants shall not be CFC or HCFC type. R134a, R407c, and R410a refrigerants are acceptable. For low temperature refrigeration R507 is acceptable.

23 70 00 CENTRAL HVAC EQUIPMENT

23 74 00 PACKAGED OUTDOOR HVAC EQUIPMENT

Outdoor Air Handling Units

1. Select for long-life, weather tightness, and good quality.
2. Standard of acceptance: Haakon, Scott Springfield or equal.
3. On large units include a service corridor or mechanical (non-plenum) room for controls.
4. Include over-head lifting point for motors 7.5 hp and larger.
5. Variable frequency drives are required where variable volume control is required.
6. Pilot lights on plenum light switches.
7. Quality plenum door hardware.
8. Exterior doors lockable and keyed to suit appropriate UVic mechanical access key.
9. Weather louvres preferred to exterior hoods.
10. Electrical power and controls wiring in EMT conduit.
11. Typically locate air handlers in mechanical rooms. When necessary locate outdoors. Coordinate access to equipment with Architect. Typically full stairway access is required to mechanical rooms and to roof top equipment with paver walkways across roof and around equipment to protect roofing. Coordinate railings/fall protection with Architect.

Centrifugal Fans

1. Bearings: Heavy duty pillow-block, grease lubricated ball or roller self-aligning type, minimum life of AFBMA L-10 80k or AFBMA L50 400k.
2. Extend grease nipples to exterior of guards.
3. Sound power levels to AMCA 311.
4. Statically and dynamically balanced, constructed in conformity with AMCA 99.
5. Ratings: based on tests performed in accordance with AMCA 211, and ASHRAE 51. Units shall bear AMCA certified rating seals.