2011 Manitoba Energy Code for Buildings (MECB) — PART 5, Heating, Ventilating and Air-conditioning Systems

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September 17th, 2014

Outline

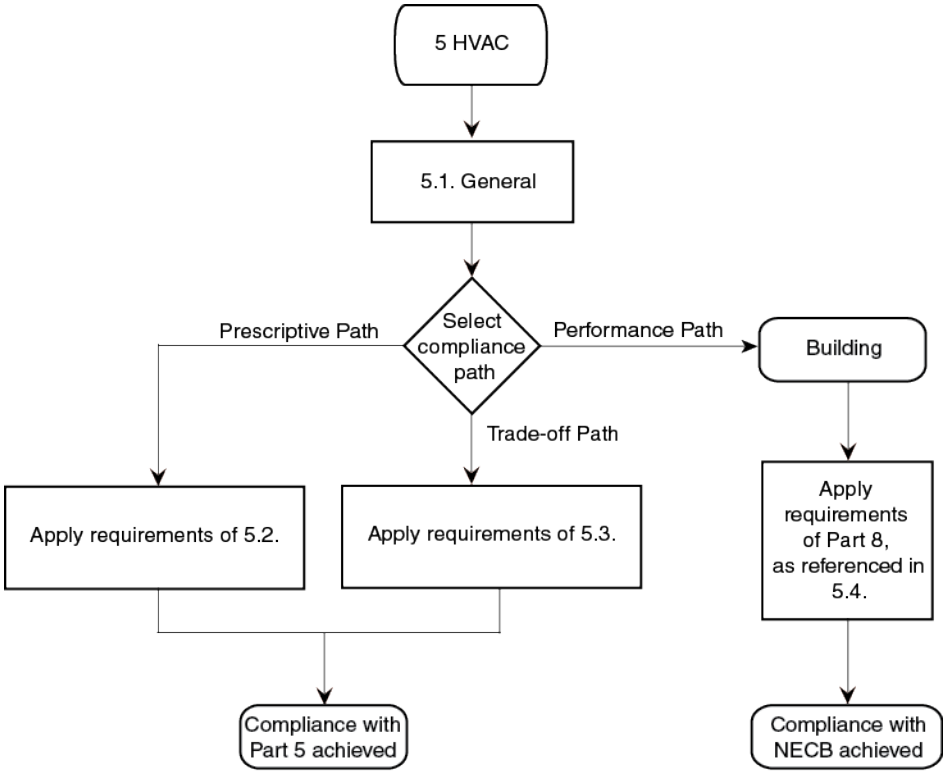
- Scope and compliance
- Prescriptive path
  - Ventilation, including heat recovery
  - Piping and pumping systems
  - Temperature control
  - Shut-off and setback controls
  - Equipment
- Trade-off path
- Performance path

Scope

- Addresses HVAC - Part 5
  - Piping and ducts forming part of the system
  - HVAC control systems
  - Air-conditioning equipment
  - Ventilating equipment
  - Heating equipment

Compliance options

- Simple prescriptive
- Trade-off
- Performance – whole building



Air distribution

- Ability to balance
- Duct Sealing
  - Constructed and installed to SMACNA (Duct Construction Standards – Metal and Flexible)
  - Sealed per static pressure classes ≤ 2”, > 2” and < 4”, ≥ 4”
  - Exemptions

Duct and plenum insulation

- Requirements based on temperature difference

Temperature Difference, °C	Min. Thermal Resistance for Ducts and Plenums, $m^2 \bullet C/W$	Min. Thermal Resistance for Run-outs, $m^2 \bullet C/W$
< 5	0	0
5 to 22	0.58	0.58
> 22	0.88	0.58

Cooling with outdoor air

- Ability to cool with outdoor air when
  - Mechanical A.C. capacity > 20 kW (5.5 tons) or
  - Air handler > 1500 L/s
  - Exception for dwelling units and hotel/motel rooms
- Direct use of outdoor air
  - Mixed air with up to 100% outside air (economizer)
  - > 20 tons = 25% capacity
  - > 6 and ≤ 20 tons = 50% capacity
- Water Economizer = provide 100% cooling

Fan systems

- Constant Volume (supply plus return)
  - 1.6 W per L/s (0.75 W per cfm)
- Variable Air Volume (supply plus return)
  - 2.65 W per L/s (1.25 W per cfm) and,
  - ≤ 55% design W at 50% design air flow when > 7.5 kW and < 25 kW

Dampers

- Locations
  - > 0.08 m^2 motorized dampers required
  - ≤ 0.08 m^2 manual on intake, back-draft on outlet
- Outside air damper leakage
  - Closed = ≤ 15 L/s per m^2 at 250 Pa (3 cfm per ft^2 at 1” w.c.)

Piping

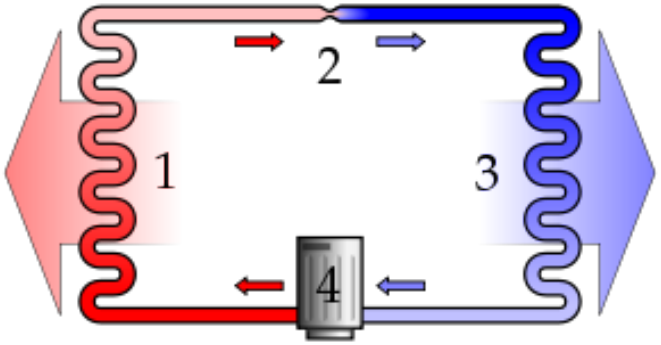
- Ability to balance all hydronic systems
- Minimum piping insulation
  - By temperature range (design) Table 5.2.5.3
  - Thermal conductivity requirements of insulation
  - Minimum insulation thickness by pipe diameter and fluid temperature
  - No longer “office” standards, will increase in future
  - Protection of insulation (subject to damage)

Pumping system

- Variable Flow Pumping
  - HVAC Pumping – control valves
    - Variable fluid flow pumps > 7.5 kW (System Total)
    - Reduce system flow ≤ 50%
    - Nameplate power rather than break power
  - Does not apply
    - Minimum flow > 50% (chiller or boilers)
    - Reset fluid supply temperature based on O.A. temp or load

Temperature controls

- Installations of thermostats
  - 1.4 – 1.5 m above floor, accurate to 1˚C
  - Exposure to sunlight or heat source
  - Away from drafts and dead air
- Heat Pump Controls
  - Prevention of supplementary heat if load can be met by heat pump alone



Space controls

- Space Temperature Controls
  - Zone specific – heating and cooling
  - Independent (de-coupled) perimeter heating or cooling systems allowed if:
    - One thermostat for each exposure
    - Heating and cooling controlled by control device in zone
  - Vestibules require a device limiting temperature to maximum 15˚C
- Dwelling units
  - At least one thermostat

Reheating and recooling controls

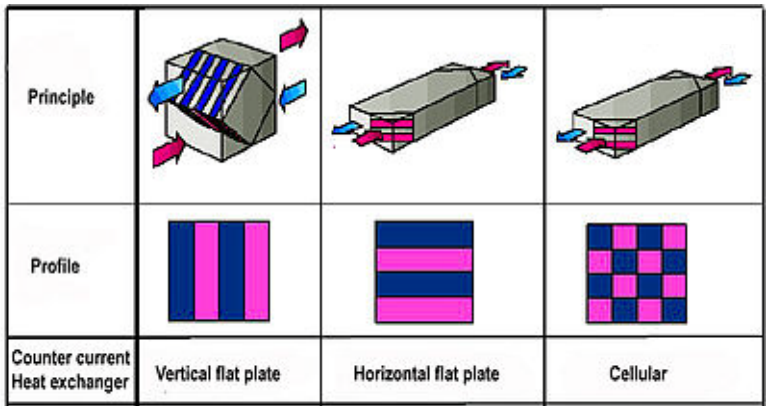
- Supply Air Handler Leaving Air Temperature
  - Controls required to achieve design supply air temperature without:
    - Heating previously cooled air
    - Cooling previously heated air
    - Heating outside air in excess of the minimum for ventilation

Reheating and recooling controls

- Control of Space Temperature by Reheating or Re-cooling
  - HVAC systems that control temperature of a space by reheating previously cooled air shall be equipped with controls that automatically adjust the temperature of the cool air supply to the highest temperature that will satisfy the zone requiring the coolest air

Heat recovery system

- Exhaust Air System Sensible Heat >150 kW
  - Shall be equipped with recovery apparatus ≥ 50% efficiency
  - Heat recovered shall be used in building system
  - Exemptions: toxic, flammable, dust or corrosive fumes



Heat recovery system

- Exhaust Air System Sensible Heat >150 kW

  Sensible Heat = 0.00123 x Q x (T_e – T_o)

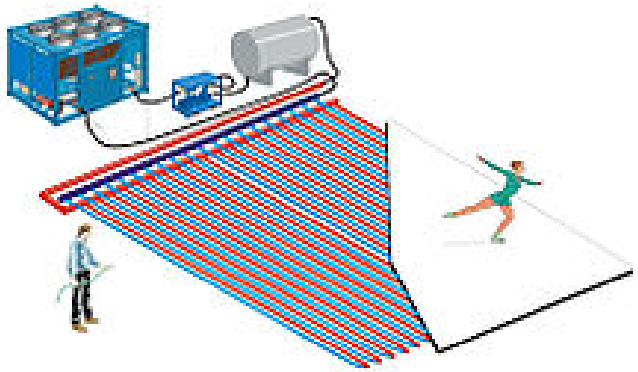
  Q = rated capacity of exhaust L/s

  T_e = temperature of exhaust ˚C before heat recovery

  T_o = outdoor 2.5% January design temperature ˚C
- 2360 L/s at 55 ˚C temperature difference

Heat recovery – pools and ice surfaces

- Swimming pools
  - 40% recovery of sensible heat from exhaust air
  - Exemption if dehumidification system provides 80% of dehumidification that would be accomplished by exhaust system
- Ice arenas
  - Required if heating load elsewhere
  - Allows use for either space or service water heating



Heat recovery – dwelling units

- Dwellings with self-contained mechanical ventilation (except in climatic zones 4, 5 and 6)
  - Principal exhaust only
  - 2.5% January design temperatures which are less than and greater than
  - <-10 C and >-30 C require 55% sensible HR efficiency
  - ≤ - 30 C require 45% sensible HR efficiency

Shut-off and setback controls

- Off-hours Controls
  - Dwelling units
  - Systems > 5 kW heating or cooling
  - Required to set back or up, or shut down
  - Reduce or shut off outside air when space not in use
  - Heat Pump – adaptive anticipation to prevent supplementary heat during recovery

Airflow control areas

- Air Flow Control Areas
  - Size > 2500 m2 shall be divided into Air Flow Control Areas
  - Or systems shall serve < 2500 m2
  - Shall have separate shut-off and set back control
  - Each AFCA limited to one storey
  - DDC controls required

Boiler controls

- Multiple Boilers
  - > 176 kW (600,000 Btuh)
    - More than one boiler or,
    - 2 stage or multi-stage firing
  - > 352 kW (1,200,000 Btuh) shall be fully modulating

Temperature Reset

- Loop Temperature Reset
  - Chilled or Hot Water Systems > 88 kW (300,000 Btuh)
  - Indoor/outdoor controller, or,
  - Represent building load using return water temperature

Equipment – minimum performance efficiency

- Efficiency with referenced standards provided for:
  - Boilers
  - Warm-air furnaces
  - Duct furnaces
  - Unit heaters
  - Packaged water chillers
  - Packaged terminal A/C
  - Computer room A/C
  - Air-cooled A/C and heat pumps
  - Water- and evaporatively cooled A/C and heat pumps
  - Condensing units
  - Ground water heat pumps

Equipment – minimum performance efficiency

- Table 5.2.12.1 HVAC Equipment Performance Requirements
  - Component groups and capacities
  - Referenced Standards and Rating Conditions
  - Minimum performance in EER, COP, IPLV, AFUE, E_c and E_t
  - Some equipment requirements set to median of current practice
  - Most aligned with EE regulations from early 2010

Equipment – minimum performance efficiency

Boilers			
Equipment	Heating Capacity kW (Btu/h)	MECB Minimum Performance	Energy Efficiency Regulations
Gas-fired	< 88 kW (300,000)	AFUE = 85%	AFUE = 82%
	≥ 88 kW and < 733 kW (2,500,000)	$E_c \geq 82.5\%$ $E_t \geq 83\%$	N/A
	≥ 733 kW	$E_c \geq 83.3\%$	
Oil-fired	< 88 kW (300,000)	AFUE ≥ 84.7%	AFUE ≥ 84%
	≥ 88 kW and < 733 kW (2,500,000)	$E_t \geq 83.4\%$	N/A
	≥ 733 kW	$E_c \geq 85.8\%$	

Equipment – minimum performance efficiency

Warm-Air Furnaces, Duct Furnaces and Unit Heaters			
Equipment	Heating Capacity kW (Btu/h)	MECB Minimum Performance	Energy Efficiency Regulations
Gas-fired furnaces	≤ 117.23 (400,000)	**AFUE ≥ 94% (Manitoba)**	≤ 66 kW ≥ 90% > 66 ≤ 117 kW, ≥ 80%
	> 117.23	$E_t \geq 81\%$	N/A
Gas duct furnaces	≤ 117.23 kW	$E_t \geq 81\%$	N/A
Gas unit heaters	≤ 117.23 kW	$E_t \geq 82\%$	$E_t \geq 80\%$
Oil-fired furnaces	≤ 66 kW (225,000)	$E_t \geq 84.5\%$	$E_t \geq 78\%$
	> 66 kW	$E_t \geq 81.3\%$	N/A

Restrictions

- Equipment performance efficiency cannot be less than required by Energy Efficiency Regulations, or provincial/territorial requirements, if more stringent
- Back-up equipment must comply with prescriptive path

Trade-off concept

- Considers energy use throughout system

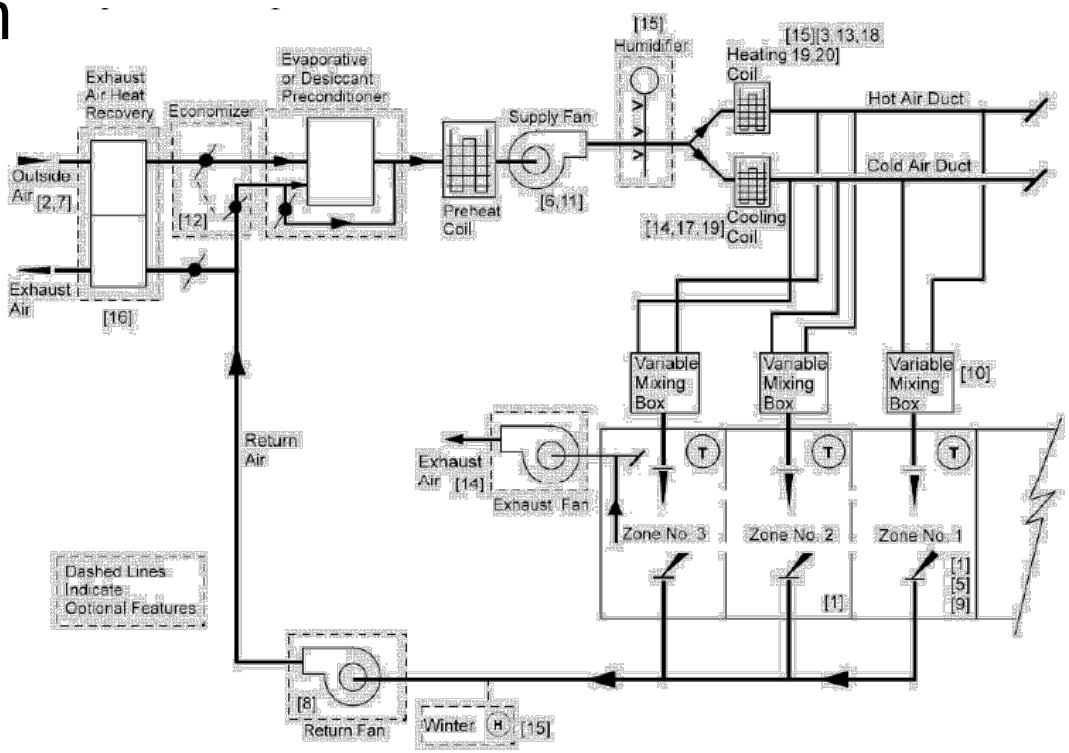
Trade-off concept

- System efficiency approach considers HVAC system as a whole
- Allows improvement in other system parts to compensate for one component not meeting a prescriptive requirement
- Intended to permit flexibility for typical design

Total **proposed** system efficiency $\geq$ Total **reference** system efficiency

Components and systems considered

- Comparison: system to same system
- 27 common system types considered
- 32 components considered



From DOE 2.2 User manual

Method

- Calculation coefficients: performance of typical system

$$HVAC_{TOI} = \sum_{i=1}^{32} \left(\alpha_i \bullet ToV_i + \beta_i \bullet ToV_i^{\,2} \right) \bullet \gamma_i$$

$$- \sum_{i=1}^{32} \left(\alpha_i \bullet BaV_i + \beta_i \bullet BaV_i^{\,2} \right) \bullet \gamma_i$$

BaVi – base prescriptive component efficiency

ToVi – component efficiency to be traded

Method

- Calculation coefficients: performance of typical system

$$HVAC_{TOI} = \sum_{i=1}^{32}\left(\alpha_i \bullet ToV_i + \beta_i \bullet ToV_i^{\,2}\right) \bullet \gamma_i - \sum_{i=1}^{32}\left(\alpha_i \bullet BaV_i + \beta_i \bullet BaV_i^{\,2}\right) \bullet \gamma_i$$

Proposed System

Prescriptive system

BaVi – base prescriptive component efficiency

ToVi – component efficiency to be traded

Coefficients

- Likely computer-program-assisted but can be completed with spreadsheet

Built-up Variable Volume

Component	XDD	α1	α2	α3	β1	β2	β3
ToV_1- Supply Fan Mechanical Efficiency	HDD	9.901E-01	-1.418E-04	5.710E-09	-5.191E-01	7.037E-05	-2.626E-09
ToV_2 -Supply Motor Efficiency	HDD	6.994E-01	-1.013E-04	4.055E-09	-2.670E-01	3.687E-05	-1.362E-09
ToV_3- Return Fan Mechanical Efficiency	HDD	6.087E-01	-5.513E-05	7.352E-10	-5.244E-01	4.324E-05	-2.153E-10
ToV_4 - Return Fan Motor Efficiency	HDD	2.916E-01	-2.712E-05	3.972E-10	-1.264E-01	1.095E-05	-8.620E-11
ToV_5 -Supply Temperature Control	HDD	-2.175E-01	1.610E-04	-1.976E-08	1.081E+00	-3.448E-04	2.887E-08
ToV_6 - Airflow Control Efficiency	TDD	1.034E-01	3.422E-05	-3.997E-09	8.110E-01	-2.076E-04	1.353E-08

Spreadsheet

$HVAC_{TOI}$		0.00
Compliance:		System is NECB Compliant
		System #1
Supply fan total static pressure	in. w.g.	2.0
Supply duct insulation	R-value	3.3
Return fan total static pressure	in. w.g.	0.6
Heating coil design temperature drop	°F	20.0
Baseboard heater design temperature drop	°F	20.0
Boiler/furnace/heat pump heating efficiency	%	83.3%
Chillers/direct expansion system/heat pump cooling efficiency	COP	1.8
Rejection fan input power ratio	W/btuh	0.004
Cooling by direct use of outdoor air (air economizer)	Selection	Dry Bulb
Outdoor airflow control	Selection	Fraction of hourly
Exhaust air heat-recovery efficiency	%	0.0%
Cooling by indirect use of outdoor air (water economizer)	%	0.0%
Piping insulation - hot water	R-value	5.0
Piping insulation - chilled water	R-value	5.0
Piping pressure losses - hot water	ft. w.g.	60.0
Piping pressure losses - chilled water	ft. w.g.	40.0
Pump mechanical efficiency - hot water	%	60.0%

Spreadsheet

$HVAC_{TOI}$		-0.02
Compliance:		System is not NECB Compliant
		System #1
Supply fan total static pressure	in. w.g.	2.0
Supply duct insulation	R-value	3.3
Return fan total static pressure	in. w.g.	0.6
Heating coil design temperature drop	°F	20.0
Baseboard heater design temperature drop	°F	20.0
Boiler/furnace/heat pump heating efficiency	%	80.0%
Chillers/direct expansion system/heat pump cooling efficiency	COP	1.8
Rejection fan input power ratio	W/btuh	0.004
Cooling by direct use of outdoor air (air economizer)	Selection	Dry Bulb
Outdoor airflow control	Selection	Fraction of hourly
Exhaust air heat-recovery efficiency	%	0.0%
Cooling by indirect use of outdoor air (water economizer)	%	0.0%
Piping insulation - hot water	R-value	5.0
Piping insulation - chilled water	R-value	5.0
Piping pressure losses - hot water	ft. w.g.	60.0

Trade-off limitations

- Energy sources used must be natural gas, propane, oil or electricity
- Back-up equipment must meet prescriptive requirements
- One of the 27 “traditional” systems

2011 Manitoba Energy Code for Buildings (MECB) — PART 6 Service Water Heating

Dieter Bartel, Manitoba Hydro

September 17th, 2014

Outline – Part 6

- Scope and compliance
- Prescriptive requirement
  - Equipment
  - Piping and storage tank insulation
  - Controls
  - Hot water discharge flow
- Trade-off path
- Performance path

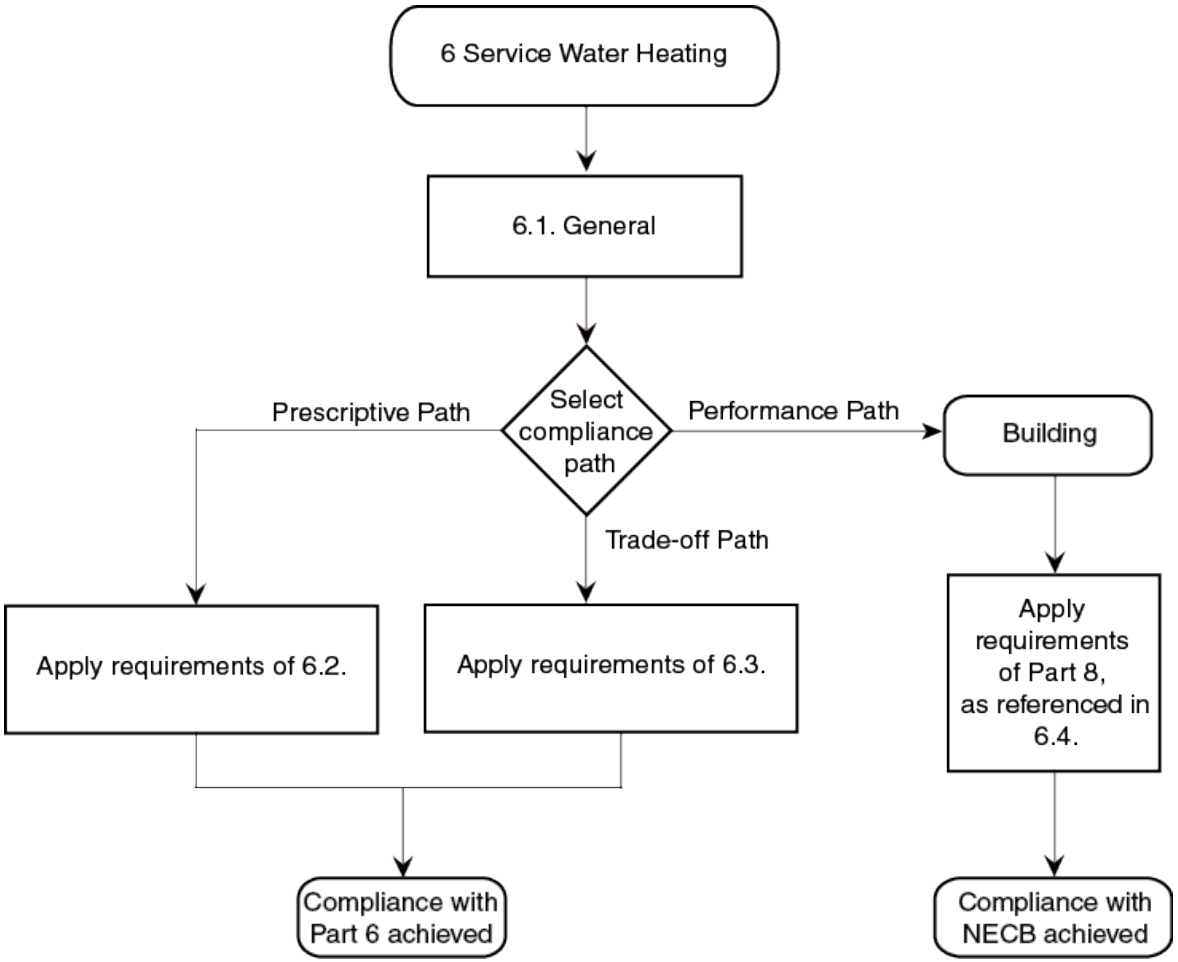
Scope

- Addresses service water heating (SWH)
  - Heating equipment
  - Piping insulation
  - Controls
  - Hot water discharge flow

"*Service water means water for plumbing services, excluding systems exclusively for space heating or cooling or for processes*"

Compliance path

- Prescriptive
- Trade-off path
- Performance path



Equipment minimum performance efficiency

- Equipment minimum efficiency performance
  - Table 6.2.2.1 SWH Equipment Performance Standards
  - Aligned with Energy Efficiency Regulations (EER) as of May 2010
  - Performance required shall not be lower than MECB, EER, or Provincial Requirements (most stringent shall apply)
  - Standby losses (SL), Thermal Efficiency (E_t), Energy Factor (EF)

Equipment minimum performance efficiency

- Manitoba Amendments

Water Heaters	Input	Performance Requirement
Gas-fired instantaneous	≥ 14.7 kW and ≤ 73.2 kW	EF ≥ 0.8
Gas-fired storage	≤ 21.98 kW	EF ≥ 0.67 – 0.0005 V
Gas- Fired storage	> 21.98 kW and ≤ 117 kW	E_t ≥ 80%

Equipment insulation

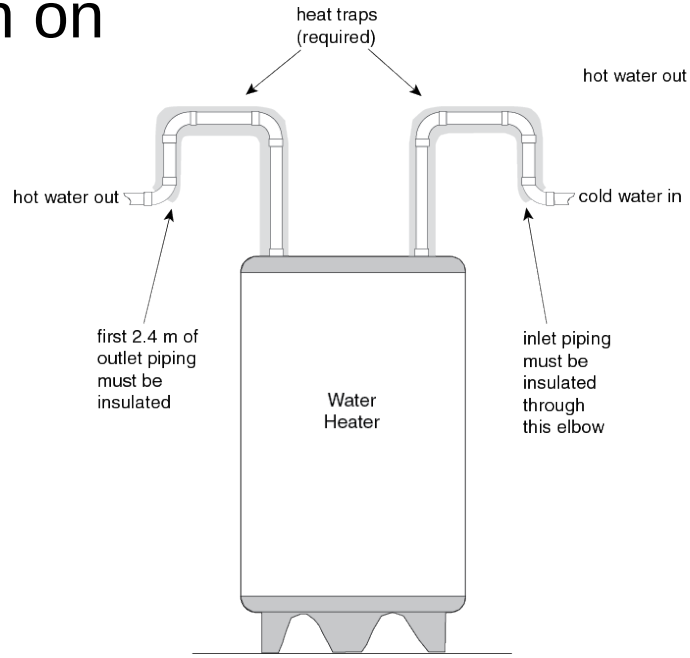
- Equipment Insulation
  - Storage Tank Insulation – maximum U-value
  - O.45 W/(m^2·K) or (0.08 Btu/h·ft^2·F)
- Combination SWH and Space Heating
  - Permitted where input to combo unit is:
  - < 22 kW (75,000 Btuh) or,
  - < twice SWH load

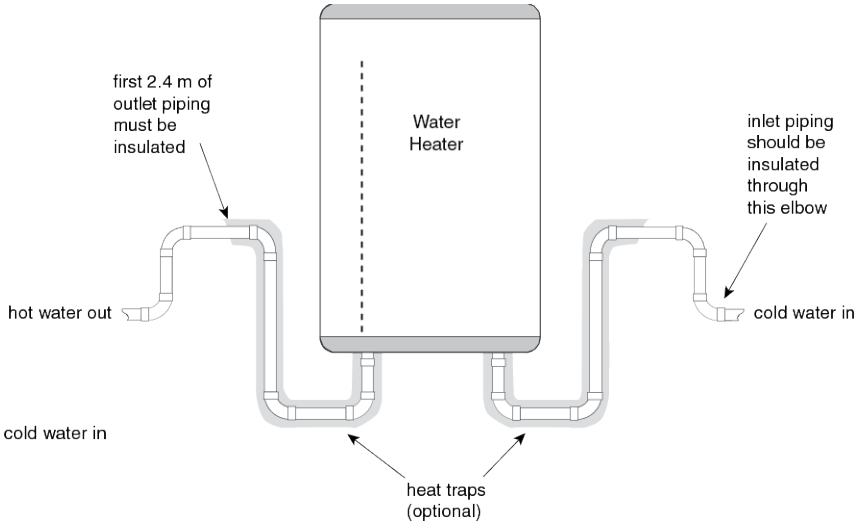
Piping insulation

- Required for
  - Hot water circulation systems
  - Hot water non-circulation systems
    - Without heat traps
    - With heating elements or heat tracing
  - Minimum thickness table for conditioned and non-conditioned spaces

Placement

- Clarification on heat traps requirements and location of insulation on runouts





Controls

- Systems with storage tanks
  - Automatic temperature control
- Controls for heat maintaining system required
- Seasonal shutdown controls required

More than one end-use temperature

- Booster Heaters required when
  - More than one end use temperature on system
  - Design discharge temperature is > 60 ˚C, and,
  - < 50% of the total design flow

Showers and lavatories

- Individual Showers (Manitoba)
  - Maximum hot water discharge 6.6 L/min (1.45 Imp gal/min)
- Lavatory Faucets (Manitoba)
  - Maximum hot water discharge 5.7 L/min (1.25 Imp gal/min)
- Automatic shut-off valves for assembly occupancies

Trade-off concept

Trade-off concept

- System efficiency approach considers SWH system as a whole
- Allows improvement in other system parts to compensate for one component not meeting a prescriptive requirement

Total **proposed** system efficiency $\geq$ Total **reference** system efficiency

Components considered

- Factors considered
  - Heat generator equipment efficiency
  - Tank insulation value
  - Piping insulation value
  - Pump motor efficiency
  - Pump efficiency
  - Heat recovery
  - Average flow of faucets and showers
  - Ratio of showers to faucets

Systems considered

- Comparison: system to same system
- Three system types:
  - Tank
  - Instantaneous
  - Originating from space heating boiler

Method

- Parameters entered into equation for system
  - Example: tank system

$$SHW - TOI = 2.813 \bullet \left\{ \frac{2.813 \bullet PDR}{\mathrm{ToV}_1} \bullet \left\{ 1 - 0.6514 \bullet \mathrm{ToV}_6 \bullet e^{-0.312 \bullet \mathrm{ToV}_6} \right\} + 0.06153 \bullet \left(\frac{A_{norm}}{\mathrm{ToV}_2} + \frac{26.180}{\mathrm{ToV}_3} \right) + \frac{0.00677}{\mathrm{ToV}_4 \bullet \mathrm{ToV}_5} \right\}^{-1} - 2.813 \bullet \left\{ \frac{2.813}{\eta_{ref}} + 0.06153 \bullet \left(\frac{A_{norm}}{12.4} + 6.807 \right) + 0.0141 \right\}^{-1}$$

- System complies if SWH-TOI > 0

Trade-off limitations

- Energy sources used must be natural gas, propane, oil or electricity
- Back-up equipment must meet prescriptive requirements
- One of the 3 “traditional” systems

Performance Path

- Equipment performance efficiency cannot be reduced below those of EE Regulations
- Back-up equipment must comply with prescriptive path

Thank you