
Dieter Bartel, Manitoba Hydro
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

<table>
<thead>
<tr>
<th>Temperature Difference, °C</th>
<th>Min. Thermal Resistance for Ducts and Plenums, m²°C/W</th>
<th>Min. Thermal Resistance for Run-outs, m²°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 to 22</td>
<td>0.58</td>
<td>0.58</td>
</tr>
<tr>
<td>&gt; 22</td>
<td>0.88</td>
<td>0.58</td>
</tr>
</tbody>
</table>
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 m² motorized dampers required
  • ≤ 0.08 m² manual on intake, back-draft on outlet

• Outside air damper leakage
  • Closed = ≤ 15 L/s per m² at 250 Pa (3 cfm per ft² 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 \times Q \times (T_e - T_o)
  \[ Q = \text{rated capacity of exhaust L/s} \]
  \[ T_e = \text{temperature of exhaust °C before heat recovery} \]
  \[ T_o = \text{outdoor 2.5% January design temperature °C} \]

• 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
  • $<-10 \, ^\circ\text{C}$ and $>-30 \, ^\circ\text{C}$ require 55% sensible HR efficiency
  • $\leq -30 \, ^\circ\text{C}$ 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
• 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

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Heating Capacity kW (Btu/h)</th>
<th>MECB Minimum Performance</th>
<th>Energy Efficiency Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas-fired</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 88 kW (300,000)</td>
<td>AFUE = 85%</td>
<td>AFUE = 82%</td>
<td></td>
</tr>
<tr>
<td>≥ 88 kW and &lt; 733 kW (2,500,000)</td>
<td>Ec ≥ 82.5% \ Et ≥ 83%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>≥ 733 kW</td>
<td>Ec ≥ 83.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oil-fired</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 88 kW (300,000)</td>
<td>AFUE ≥ 84.7%</td>
<td>AFUE ≥ 84%</td>
<td></td>
</tr>
<tr>
<td>≥ 88 kW and &lt; 733 kW (2,500,000)</td>
<td>Et ≥ 83.4%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>≥ 733 kW</td>
<td>Ec ≥ 85.8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Equipment – minimum performance efficiency

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Heating Capacity kW (Btu/h)</th>
<th>MECB Minimum Performance</th>
<th>Energy Efficiency Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-fired furnaces</td>
<td>( \leq 117.23 ) (400,000)</td>
<td>AFUE ( \geq 94% ) (Manitoba)</td>
<td>( \leq 66 \text{ kW} \geq 90% )</td>
</tr>
<tr>
<td></td>
<td>&gt; 117.23</td>
<td>Et ( \geq 81% )</td>
<td>&gt; 66 \leq 117 \text{ kW}, \geq 80%</td>
</tr>
<tr>
<td>Gas duct furnaces</td>
<td>\leq 117.23 kW</td>
<td>Et ( \geq 81% )</td>
<td>N/A</td>
</tr>
<tr>
<td>Gas unit heaters</td>
<td>\leq 117.23 kW</td>
<td>Et ( \geq 82% )</td>
<td>Et ( \geq 80% )</td>
</tr>
<tr>
<td>Oil-fired furnaces</td>
<td>\leq 66 kW (225,000)</td>
<td>Et ( \geq 84.5% )</td>
<td>Et ( \geq 78% )</td>
</tr>
<tr>
<td></td>
<td>&gt; 66 kW</td>
<td>Et ( \geq 81.3% )</td>
<td>N/A</td>
</tr>
</tbody>
</table>
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

\[
\text{Total proposed system efficiency} \quad \triangleright \quad \text{Total reference system efficiency}
\]
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

\[
HVAC_{TOI} = \sum_{i=1}^{32} \left( \alpha_i \cdot ToV_i + \beta_i \cdot ToV_i^2 \right) \cdot \gamma_i
\]

\[
- \sum_{i=1}^{32} \left( \alpha_i \cdot BaV_i + \beta_i \cdot BaV_i^2 \right) \cdot \gamma_i
\]

BaVi – base prescriptive component efficiency
ToVi – component efficiency to be traded
Method

• Calculation coefficients: performance of typical system

\[
HVAC_{TOI} = \sum_{i=1}^{32} \left( \alpha_i \cdot ToV_i + \beta_i \cdot ToV_i^2 \right) \cdot \gamma_i
\]

\[
- \sum_{i=1}^{32} \left( \alpha_i \cdot BaV_i + \beta_i \cdot BaV_i^2 \right) \cdot \gamma_i
\]

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

<table>
<thead>
<tr>
<th>Component</th>
<th>XDD</th>
<th>α1</th>
<th>α2</th>
<th>α3</th>
<th>β1</th>
<th>β2</th>
<th>β3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ToV₁ - Supply Fan Mechanical Efficiency</td>
<td>HDD</td>
<td>9.901E-01</td>
<td>-1.418E-04</td>
<td>5.710E-09</td>
<td>-5.191E-01</td>
<td>7.037E-05</td>
<td>-2.626E-09</td>
</tr>
<tr>
<td>ToV₄ - Return Fan Motor Efficiency</td>
<td>HDD</td>
<td>2.916E-01</td>
<td>-2.712E-05</td>
<td>3.972E-10</td>
<td>-1.264E-01</td>
<td>1.095E-05</td>
<td>-8.620E-11</td>
</tr>
<tr>
<td>ToV₅ - Supply Temperature Control</td>
<td>HDD</td>
<td>-2.175E-01</td>
<td>1.610E-04</td>
<td>-1.976E-08</td>
<td>1.081E+00</td>
<td>-3.448E-04</td>
<td>2.887E-08</td>
</tr>
<tr>
<td>ToV₆ - Airflow Control Efficiency</td>
<td>TDD</td>
<td>1.034E-01</td>
<td>3.422E-05</td>
<td>-3.997E-09</td>
<td>8.110E-01</td>
<td>-2.076E-04</td>
<td>1.353E-08</td>
</tr>
<tr>
<td>Compliance:</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVAC_Toi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply fan total static pressure</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply duct insulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return fan total static pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating coil design temperature drop</td>
<td>20.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseboard heater design temperature drop</td>
<td>20.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler/furnace/heat pump heating efficiency</td>
<td>83.3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chillers/direct expansion system/heat pump cooling efficiency</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rejection fan input power ratio</td>
<td>0.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling by direct use of outdoor air (air economizer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor airflow control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust air heat-recovery efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling by indirect use of outdoor air (water economizer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping insulation - hot water</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping insulation - chilled water</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping pressure losses - hot water</td>
<td>60.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping pressure losses - chilled water</td>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump mechanical efficiency - hot water</td>
<td>60.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### HVAC TOI

**Compliance:**

<table>
<thead>
<tr>
<th>System #1</th>
<th>Supply fan total static pressure</th>
<th>in. w.g.</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supply duct insulation</td>
<td>R-value</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Return fan total static pressure</td>
<td>in. w.g.</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Heating coil design temperature drop</td>
<td>F</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Baseboard heater design temperature drop</td>
<td>°F</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Boiler/furnace/heat pump heating efficiency</td>
<td>%</td>
<td>80.0%</td>
</tr>
<tr>
<td></td>
<td>Chillers/direct expansion system/heat pump cooling efficiency</td>
<td>COP</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Rejection fan input power ratio</td>
<td>W/btuh</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Cooling by direct use of outdoor air (air economizer)</td>
<td>Selection</td>
<td>Dry Bulb</td>
</tr>
<tr>
<td></td>
<td>Outdoor airflow control</td>
<td>Selection</td>
<td>Fraction of hourly</td>
</tr>
<tr>
<td></td>
<td>Exhaust air heat-recovery efficiency</td>
<td>%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>Cooling by indirect use of outdoor air (water economizer)</td>
<td>%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>Piping insulation - hot water</td>
<td>R-value</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Piping insulation - chilled water</td>
<td>R-value</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Piping pressure losses - hot water</td>
<td>ft. w.g.</td>
<td>60.0</td>
</tr>
</tbody>
</table>

*System is not NECB Compliant*
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

Diagram:

- 6 Service Water Heating
  - 6.1. General
    - Prescriptive Path
      - Apply requirements of 6.2.
      - Compliance with Part 6 achieved
    - Trade-off Path
      - Apply requirements of 6.3.
    - Performance Path
      - Building
        - Apply requirements of Part 8, as referenced in 6.4.
        - Compliance with NECB achieved
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

<table>
<thead>
<tr>
<th>Water Heaters</th>
<th>Input</th>
<th>Performance Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-fired instantaneous</td>
<td>$\geq 14.7 \text{ kW}$ and $\leq 73.2 \text{ kW}$</td>
<td>$\text{EF} \geq 0.8$</td>
</tr>
<tr>
<td>Gas-fired storage</td>
<td>$\leq 21.98 \text{ kW}$</td>
<td>$\text{EF} \geq 0.67 - 0.0005 \text{ V}$</td>
</tr>
<tr>
<td>Gas- Fired storage</td>
<td>$&gt; 21.98 \text{ kW}$ and $\leq 117 \text{ kW}$</td>
<td>$E_t \geq 80%$</td>
</tr>
</tbody>
</table>
Equipment insulation

- Equipment Insulation
  - Storage Tank Insulation – maximum U-value
  - 0.45 W/(m²·K) or (0.08 Btu/h·ft²·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

\[
\text{Total } \text{proposed} \quad \text{system efficiency} \quad \geq \quad \text{Total } \text{reference} \quad \text{system efficiency}
\]
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

\[
SHW - TOI = 2.813 \left\{ \frac{2.813 \cdot PDR}{ToV_1} \cdot \left\{ 1 - 0.6514 \cdot ToV_6 \cdot e^{-0.312 \cdot ToV_6} \right\} \\
+ 0.06153 \cdot \left( \frac{A_{\text{norm}}}{ToV_2} + \frac{26.180}{ToV_3} \right) + \frac{0.00677}{ToV_4 \cdot ToV_5} \right\}^{-1}
\]

\[
-2.813 \cdot \left\{ \frac{2.813}{\eta_{\text{ref}}} + 0.06153 \cdot \left( \frac{A_{\text{norm}}}{12.4} + 6.807 \right) + 0.0141 \right\}^{-1}
\]

• 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