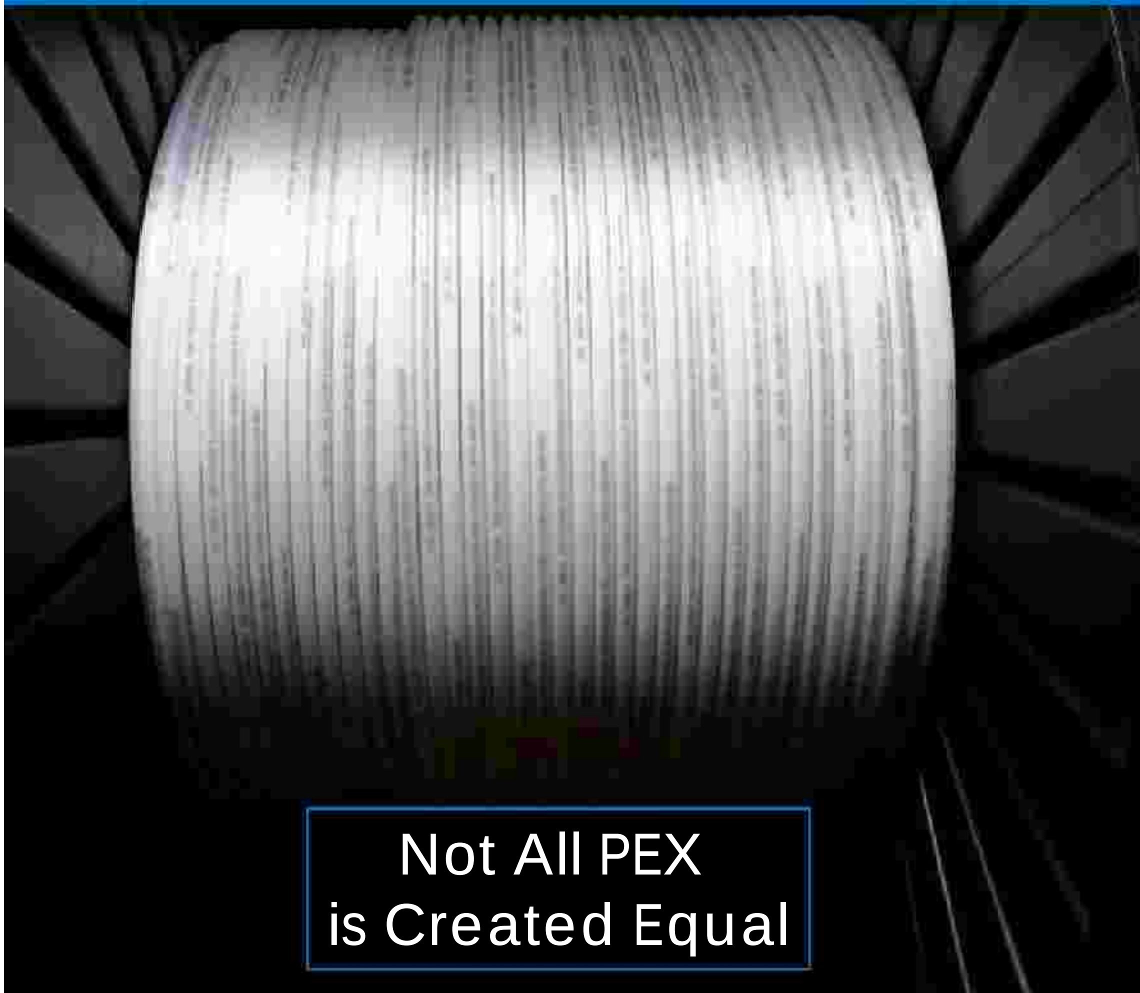
Welcome

Introductions | Commercial Systems | Experience | Sustainability | Support



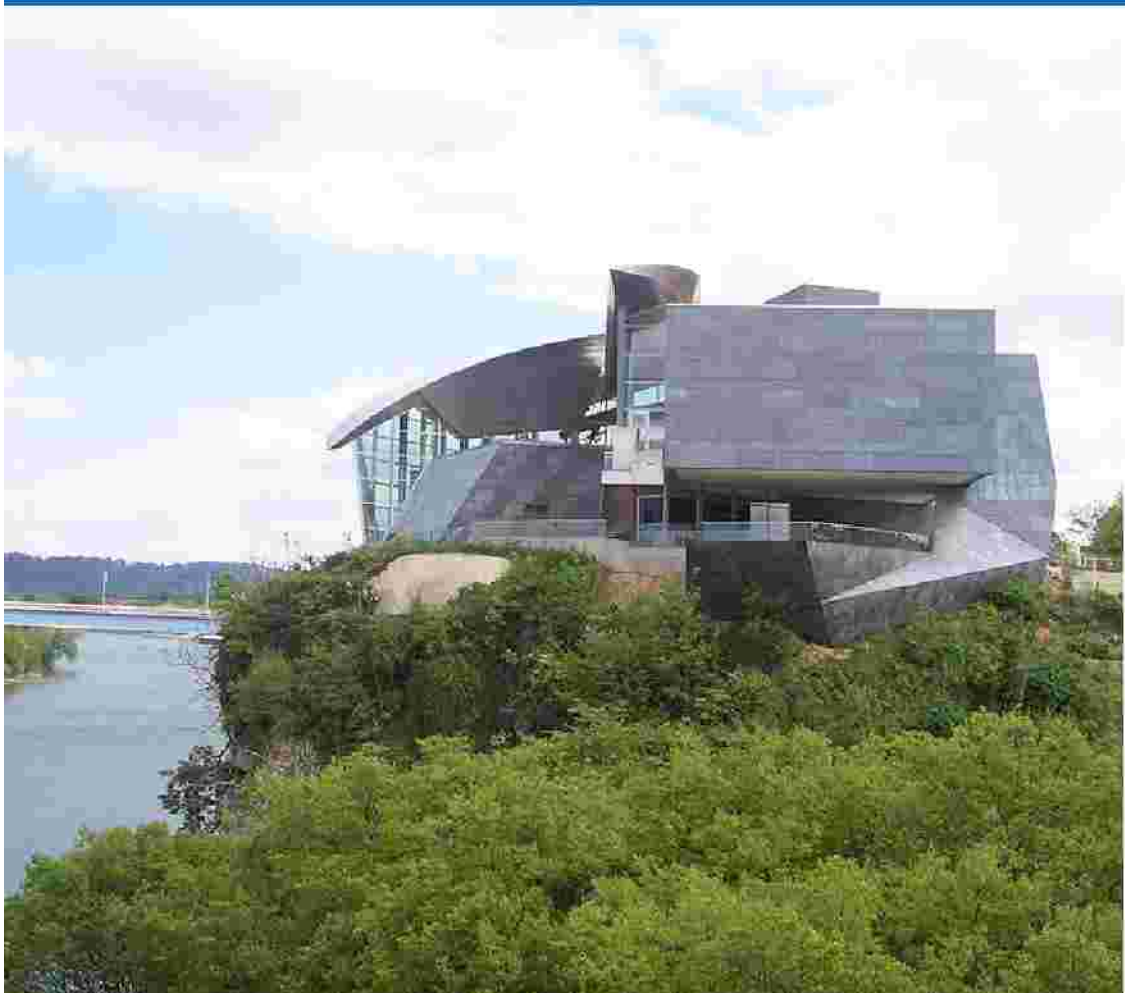
crosslinked polyethylene

X PE

What is PEX?

- Degrees of crosslinking by method:
  - PEX-a (Engel) 80% plus
  - PEX-b (Silane) 65-70%
  - PEX-c (Radiation) 70-75%
- Uponor's AQUAPEX is preferred 2-to-1 over the competition

Uponor for Radiant Cooling Systems



The Hunter Museum of Art, Chattanooga

Our innovative solutions help to preserve natural resources

Low exergy systems

- Low temperature heating and high temperature cooling integrated with the use alternative energy sources (geothermal, solar, waste, free sources)
- Thermally Activated Building Systems (TABS)
  - Combined heating and cooling
  - Insulated Tap Water (TW) systems
  - Water Recycling and Rainwater Utilisation
  - Recycling Energy from Waste Water

Radiant Cooling - Definition

- A hydronic radiant cooling system is an installation of embedded tubes or surface mounted panels that are designed to absorb and remove energy from a space
- Just as in heating, a radiant cooling system uses the structure and surfaces of an area to transfer energy
- In radiant heating systems, the energy moves away from the heated surface towards the cooler area
- In radiant cooling systems, the energy moves towards the cooled surface from the warmer area

Radiant Cooling –Then and Now

- Original challenges for radiant cooling in North America:
  - Misinformation
  - Hydronics and radiant were very small market
  - Air systems dominated the market
  - Past poor performing systems
    - No control of water temperature and humidity
  - Perception of high installed cost
  - Developers and not the owners making decisions
- The tide is changing
- ASHRAE Partners, LEED Projects, and European based vendors are designing and installing many successful projects

The Copenhagen Opera House

Common Radiant Cooling Applications

- Museums
- Institutional & educational facilities
- Office buildings
- Manufacturing & retail spaces
- Hospitals/health care facilities
- Dormitories, barracks & prisons
- Churches
- Airports

Radiant Cooling - Advantages

- Better Indoor Air Quality
  - Ventilation air is not recirculated
  - Limited wet surface of cooling coils
  - Minimized likelihood of bacterial growth

- Better User Comfort
  - Room temperatures are closer to outside air temperature
  - Radiant heat transfer is direct and draft free
  - Lower noise than normal space conditioning

Radiant Cooling –Efficiencies

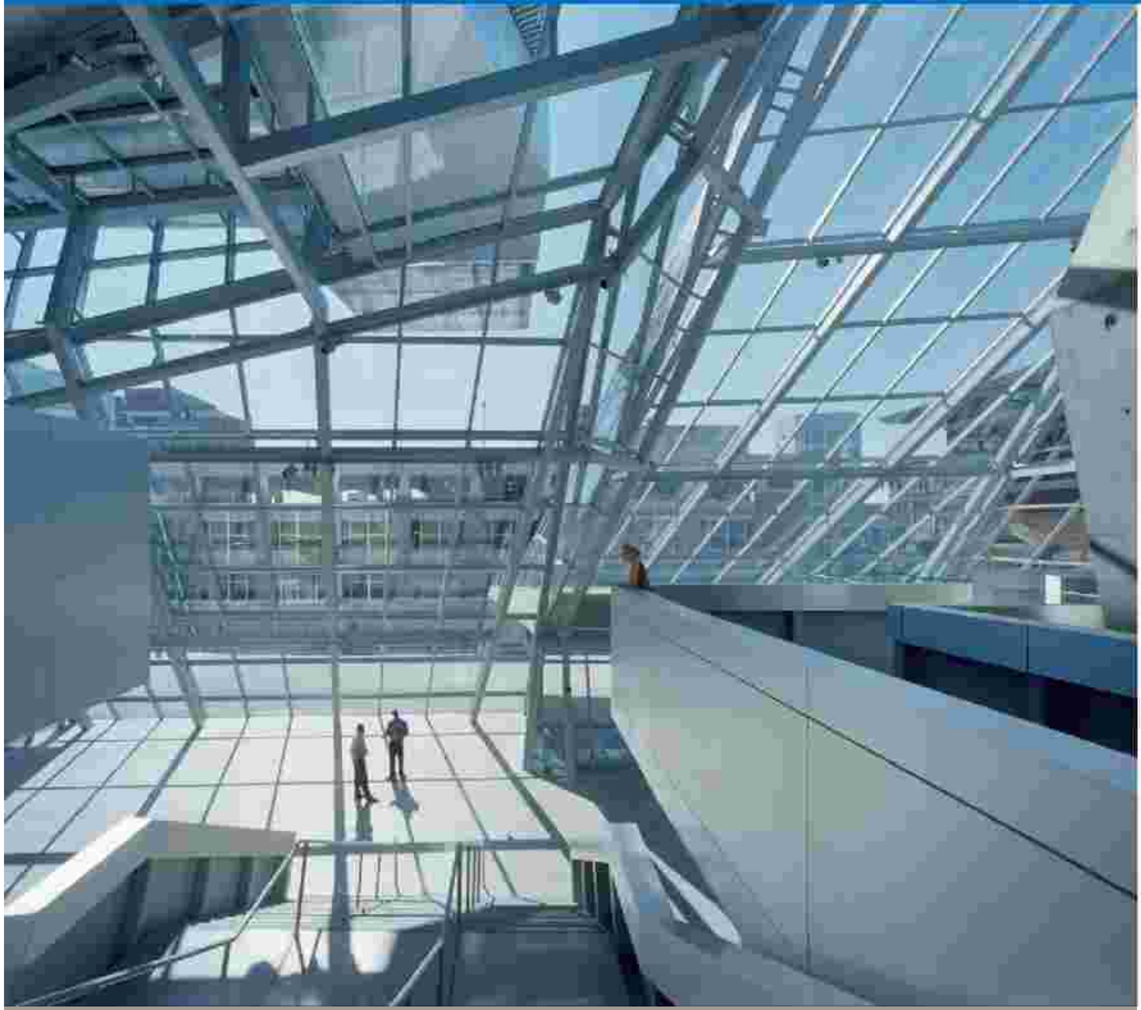
- Water has roughly 3,500 times the energy transport capacity of air
- With radiant space conditioning systems, the ventilation function is separate
  - The volume of air moved and component size can be up to 5 times less
  - Fan power and duct size is much smaller
- The cost of a radiant cooling system is comparable to traditional variable-air-volume (VAV) system

*Analysis and statistics provided by the Lawrence Berkeley National Laboratory (LBNL)


The Hearst Tower, New York City

Radiant System Economics

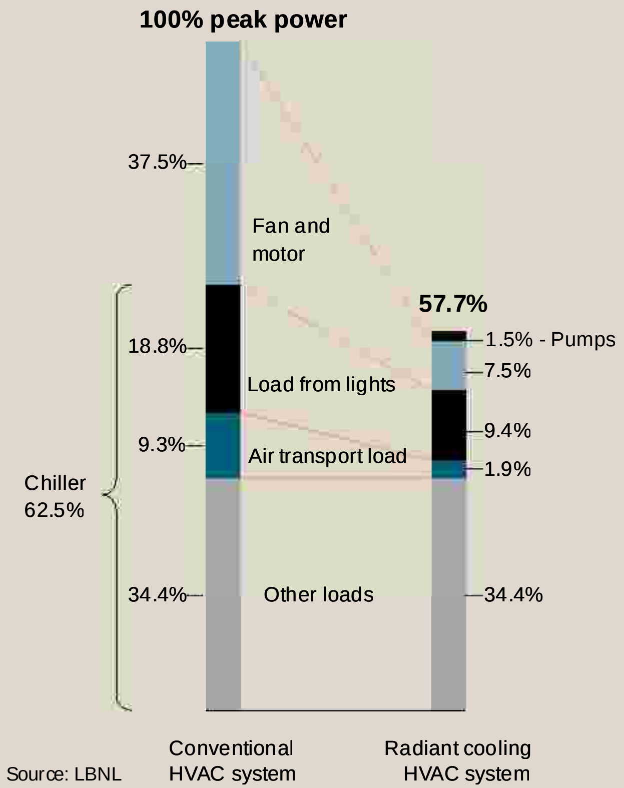
- LBNL modeled office buildings in 9 US cities comparing radiant with ventilation and all other forced air VAV systems
  - Findings:
    - Radiant cooling, on average, saves 30% overall energy for cooling and 27% on demand
    - Energy savings of
      - 17% in cold, moist climates
      - 42% in warmer, dry climates



The Akron Art Museum, Ohio

Types of Loads

- Typical radiant cooling loads consist of two primary components
  - Sensible load
  - Latent load
- Radiant cooling systems also address a third component
  - Direct solar load



A typical office building in Los Angeles as modeled by LBNL

Sensible Load

- The external loads account for only 42% of the thermal cooling peak
  - 28% of the internal gains were produced by lighting
  - 13% by air transport
  - 12% by people
  - 5% by equipment
- This is the dry bulb heat or heat gain in the space
- Radiant cooled systems can handle a significant portion of this load
- Absorption is dependant upon a decreased surface temperature

Latent Load

- This is the energy that is contained in the moisture in the air, the wet bulb load or gain
- A phase change is required to address this load
- Radiant cooling systems can not address this load
  - The ventilation system must:
    - Address the latent load
    - Balance of the sensible load if any exists
    - Control the level of humidity within the air system
      - Meet the requirements of the Indoor Air Quality Standards for fresh air

- Dew point is determined by the relative humidity and temperature within the space
- In most cases an Rh of 50% or lower will be sufficient to prevent condensation on the cooling surface
- Humidity level in the building must be controlled through the ventilation system

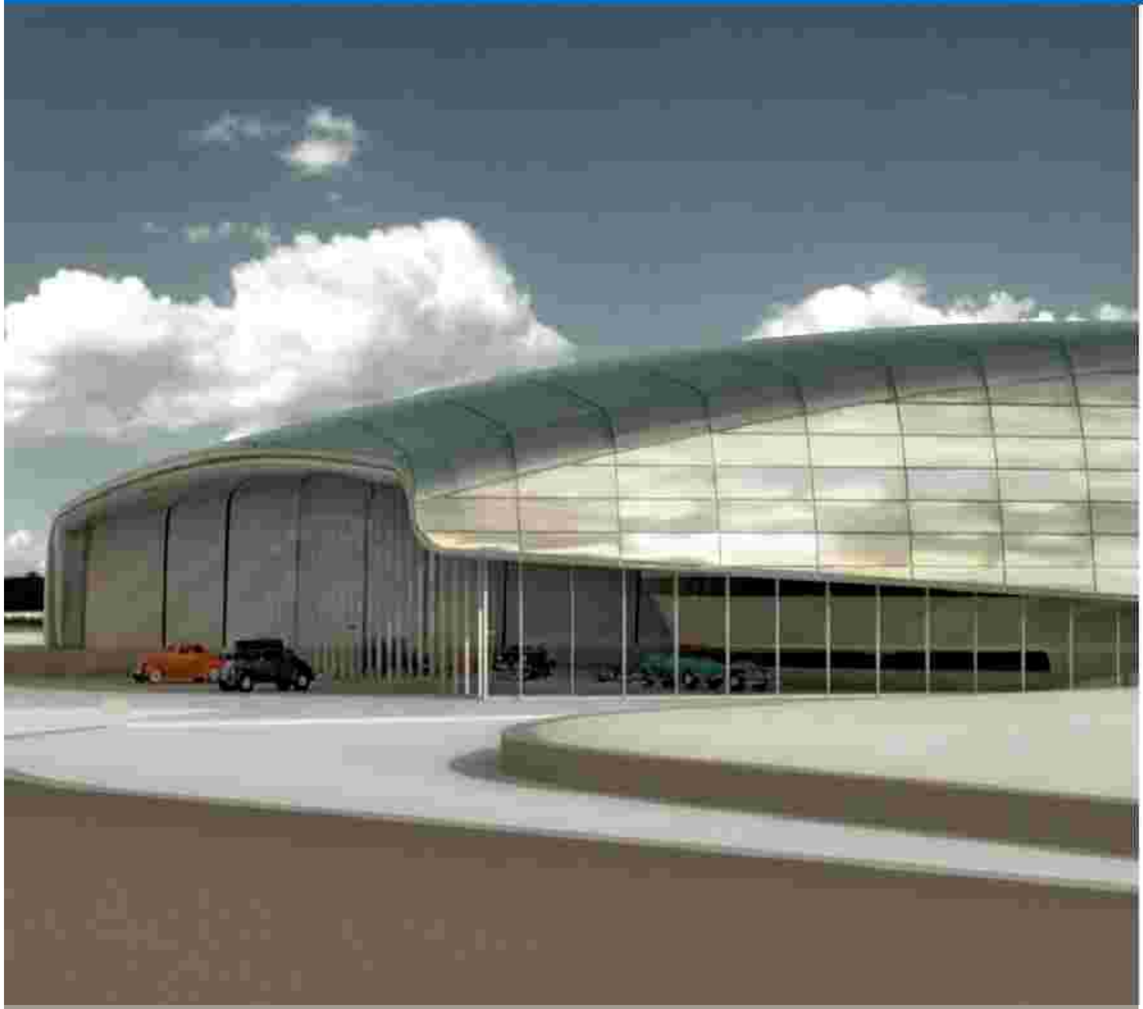
The Los Angels Federal Building, California

Direct Solar Load

- This is the solar or short wave energy that directly impacts the cooling surface
- It can be absorbed before it has a chance to reflect into the space and to become part of the sensible load
- Absorption does not require a decreased surface temperature

Direct Solar Load (continued)

- Short wave radiation (sun, electrical lights)
  - Energy transferred independent of room temperature and surrounding surfaces
- Amount of energy absorbed depends on absorbtivity of material
- Radiant Cooling capacity is 25 – 32 Btu/h/ft^2
- If Solar load exceeds cooling capacity
  - Increases the floor surface temperature
  - Emits long wave radiation back into space



The LeMay Auto Museum, Washington

Design Factors

- Load
- Surface Temperature
- Water Temperature
- Dew Point
- Spacing
- Loop Lengths
- Energy Equation
- Size of pipe

Design Considerations

- Load – 12 to 14 Btuh/sqft, up to 32 Btuh/sqft
- Surface Temperature – 67deg occupied, 65 unoccupied (ASHRAE 55-2004)
- Water Temperature – 58 deg
- Dew Point – safety factor, keep water temperature 2 deg. Above dew point
- Spacing – 6 OC (max 9 OC)
- Loop Lengths – 250 to 300 ft for 5/8"
- Energy Equation – Btuh = 500 x gpm x dt
- Size of pipe – 5/8" typical
- Design differential temperatures
  - 5°F for cooling