

## Mechanical Cooling: A Tale of Two Systems



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## The two systems for large buildings:

- Compression-Based
- Absorption-Based

And you can't tell from  
the building's exterior.



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## Compression Cooling: Principle and Parable

### Principle #1

- Compress gas – it heats up
- Decompress gas – it cools down



### Parable #1

The scuba diver who doesn't submerge his tank while filling it burns his hands. (The water dissipates the released heat of compression.)

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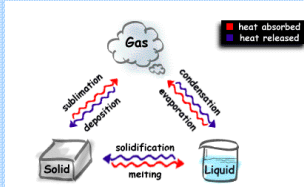
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## Compression Cooling: Principle and Parable

### Principle #2 Change-of-State

- Liquid to vapor—absorbs heat from environment
- Vapor to liquid—gives off heat to environment



### Parable #2

The person who's hand is placed in steam (at 212°F) is burned. (The steam condenses on the hand releasing 970 btu/lb of water. You can put your hand into a 500°F oven for a short time without burning it.)

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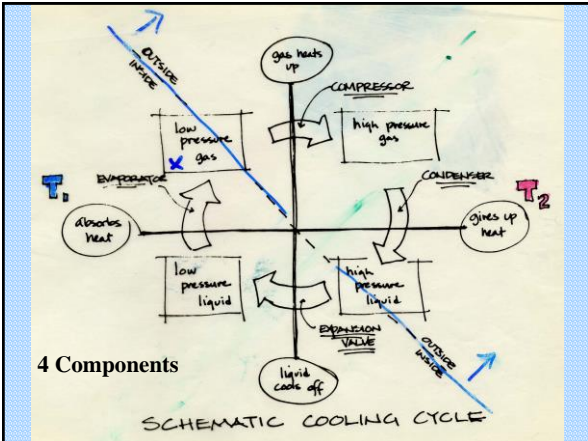
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222 INDOOR CLIMATE CONTROL

Fig. 5.48 Schematic arrangement of a compressive refrigeration cycle.

**Refrigerant properties:**

- Boils at atmospheric pressure at ~0°F
- Condenses at high pressure at ~100°F

**Hot arid solution: Swamp coolers**

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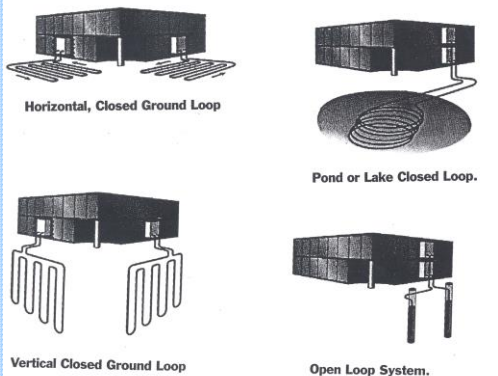
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...or use a ground source (geo-exchange)



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### Water-coupled GeoExchange System



Jubilee Campus  
University of Nottingham  
—Michael Hopkins



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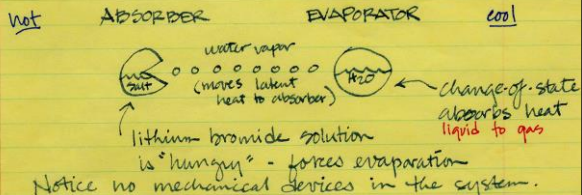
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### Absorption Cooling

Principle:  
change-of-state  
(with hygroscopic drive)



...what about equilibrium?

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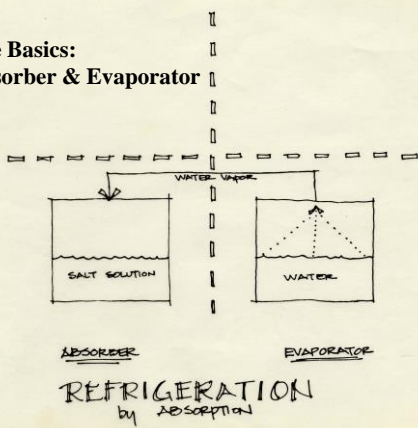
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The Basics:  
Absorber & Evaporator



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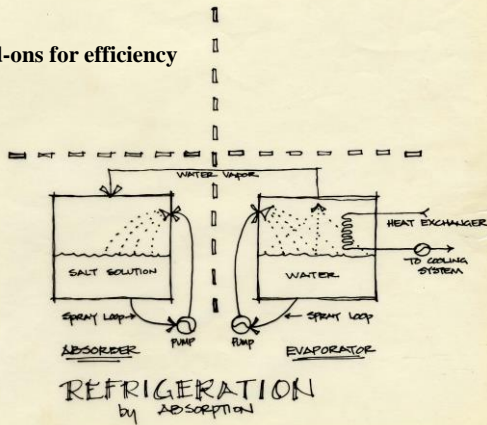
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Add-ons for efficiency



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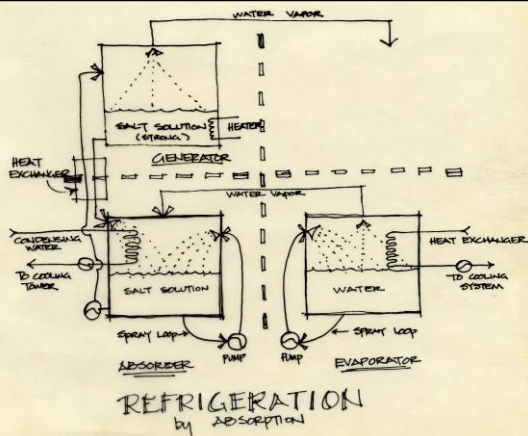
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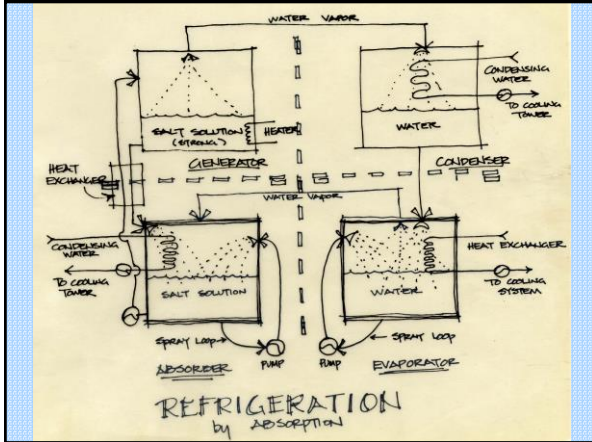
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**SOLAR ENERGY**  
Innovative design provides heat in the winter and cooling in the summer

**AIR-CONDITIONING CYCLE**

**HEATING CYCLE**

**Solar-Powered Absorption Cooling**

Clearwater Times Bldg  
Clearwater, FL

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Compression	Absorption
High pressure	Low pressure
High grade fuel for compressor & pumps	High grade fuel for pumps
Energy efficient when ground-coupled	Energy efficient when solar-coupled
Noise, CFC use?	Use of waste heat?

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## The Big Picture

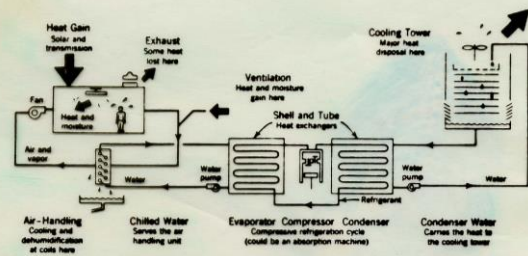


Fig. 5.43 In most large central systems, water is the vehicle that extends the effects of the refrigeration cycle. Circulated water carries heat from the room via the air-handling unit to the refrigeration unit, and a similar water circuit carries it to the cooling tower for disposal. This diagram includes only the cooling process of an air-conditioning system. For equipment, see Figures 5.44 [compressor-refrigeration machine (water chiller)], 5.45 [absorption machine (water chiller)] and 5.48 (cooling tower).

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## Cooling System Issues in Design

<b>Cooling Towers</b>
Replace with ground-source?
<b>Heat Transfer Medium</b>
Water vs. Air?
<b>Centralized System</b>
Isolate mechanical noise?
<b>Thermal Zoning</b>
Organize by thermal need?

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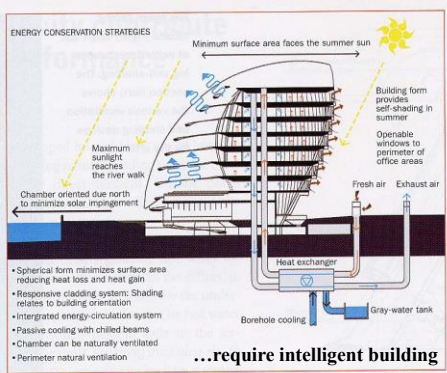
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## Intelligent Buildings




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**Definition:**

“Provides for unique and changing assemblies of recent technology in **appropriate** physical, environmental, and organizational settings—to enhance occupants’ comfort/productivity/life quality.”

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**Criteria 1**

Accommodates integrated package of new technology that manages:

- Communications
- Maintenance/Diagnosis
- Comfort



Eastgate, Harare, Zimbabwe by Mick Pearce

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**Criteria 2**

Appropriate physical and environmental setting—includes:

- Structure
- Massing
- Orientation



Jean-Marie Tjibaou Cultural Centre Renzo Piano

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### Criteria 3

Address crucial environmental conditions such as:

- Spatial quality
- Physical safety
- Thermal, acoustic, & visual quality
- Indoor air quality



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### Diversity of Approaches

	American	Focus on workstation
	Japanese	Focus on core
	European	Focus on shell
	British	Focus on materials and details

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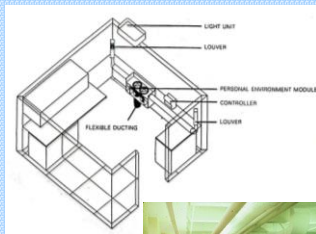
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### American Approach: The Workstation



Personal environment by Johnson Controls

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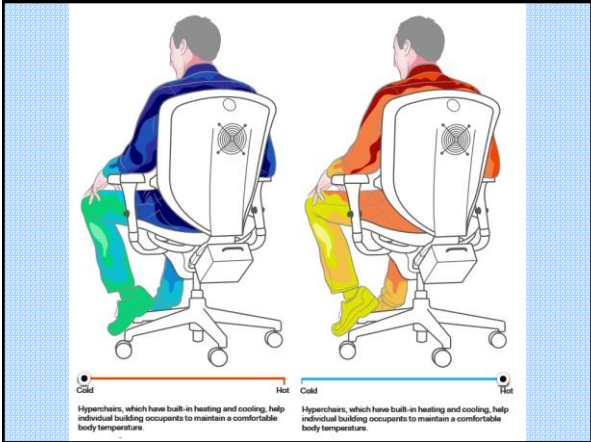
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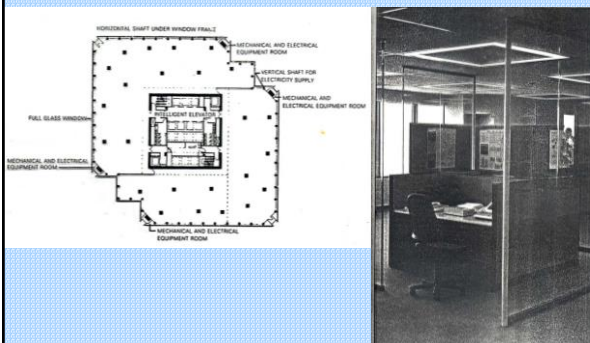
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### Japanese Approach: The Core



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### Planning for thermal zoning

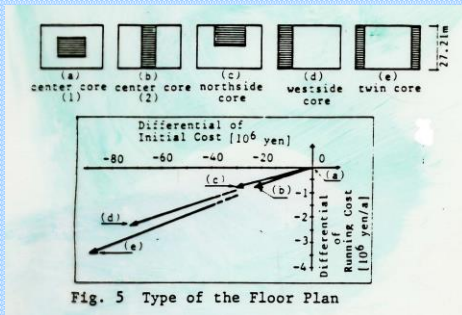


Fig. 5 Type of the Floor Plan

Life cycle cost analysis for a 9-story Tokyo building in 1984.

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### Wells Fargo, nee Farm Credit Bank, Spokane



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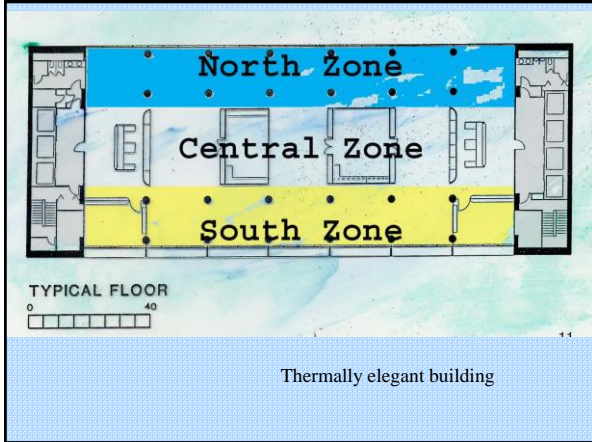
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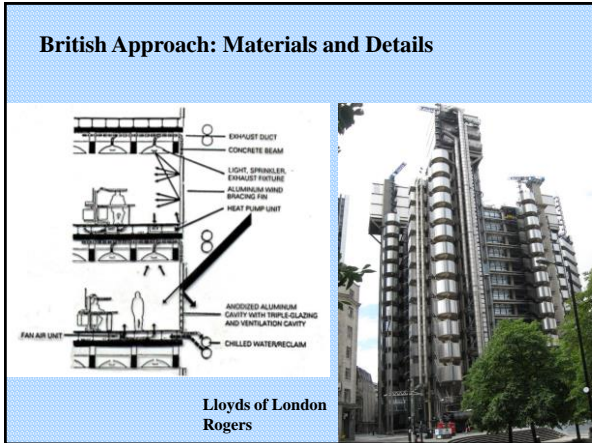
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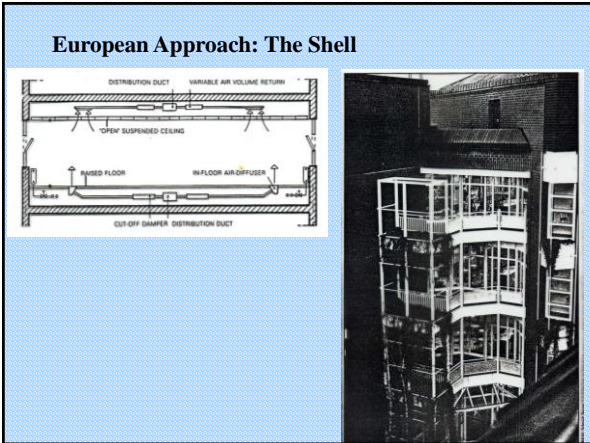
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