HEATING AND COOLING PRODUCTION

JEFF ZUMWALT

LARRY SCHUSTER

AIA Continuing Education Provider

Credit(s) earned on completion of this course will be reported to American Institute of Architects (AIA) Continuing Education Session (CES) for AIA members.

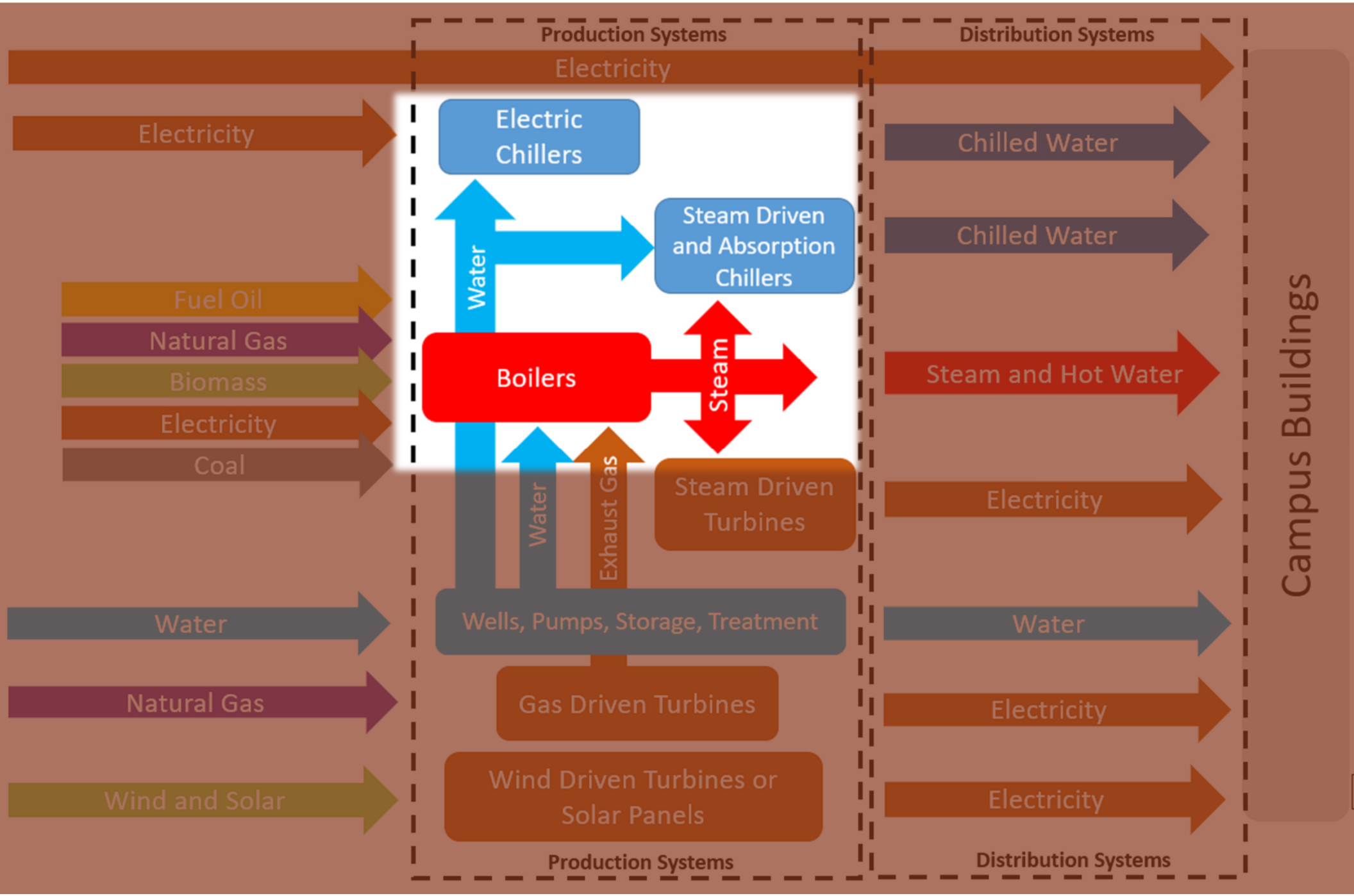
Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

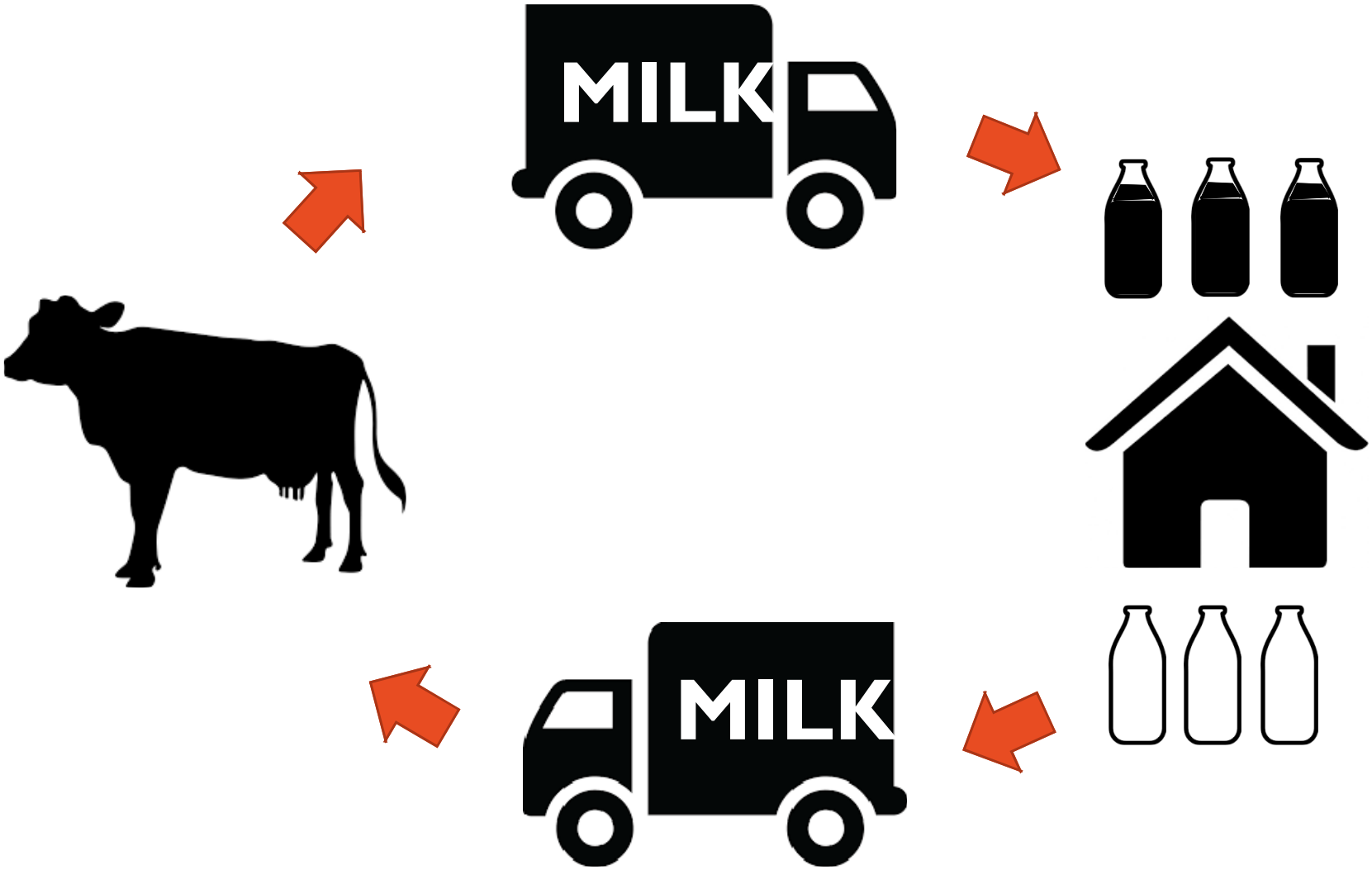
Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

AIA Continuing Education Provider

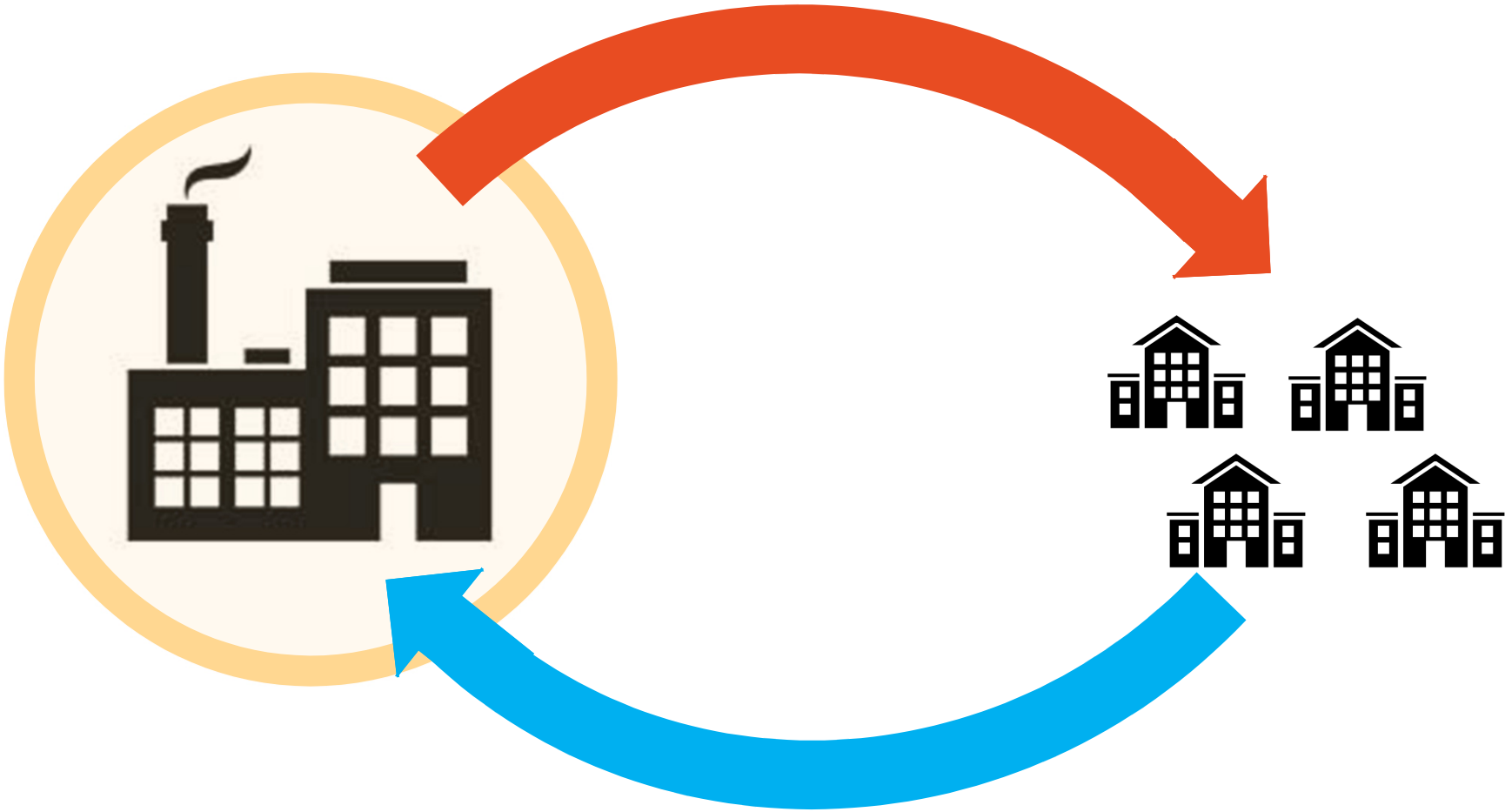
HEATING/COOLING PRODUCTION



CAMPUS HEATING/COOLING



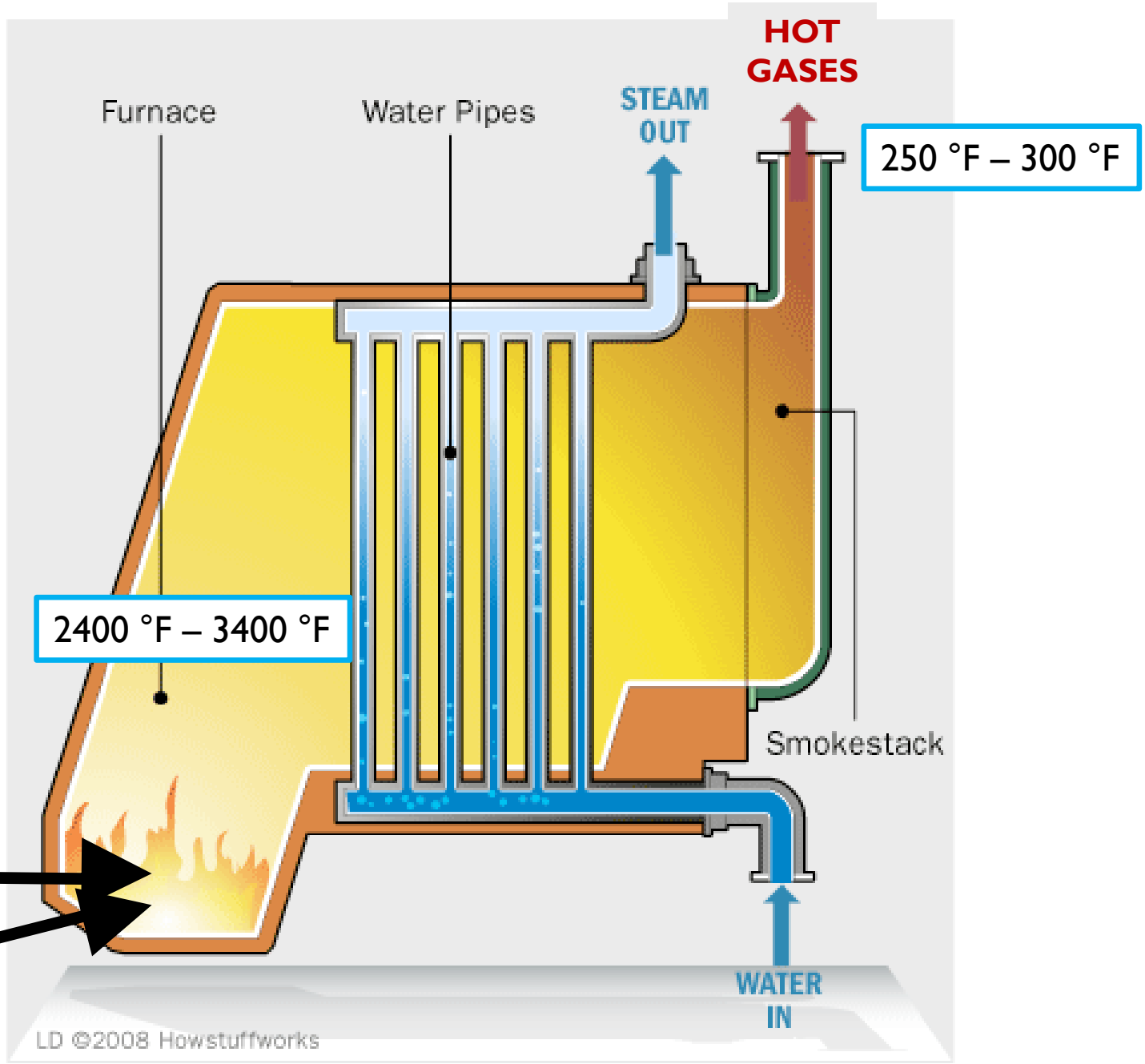
CAMPUS HEATING/COOLING



HEATING OVERVIEW

- Boilers
- Steam
- Hot Water
- Fuels
- Costs

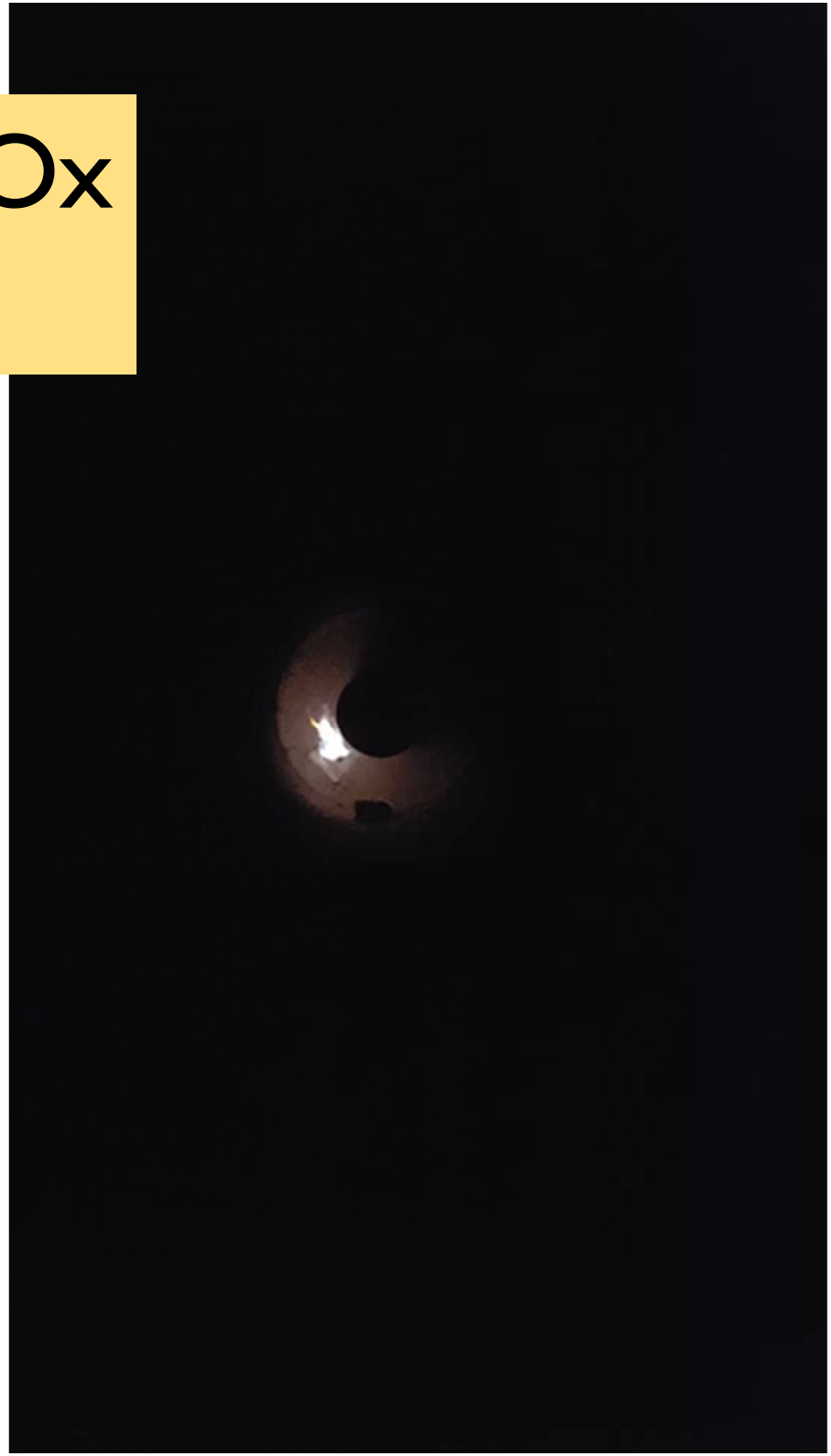
WATER TUBE BOILER



WATER TUBE BOILER

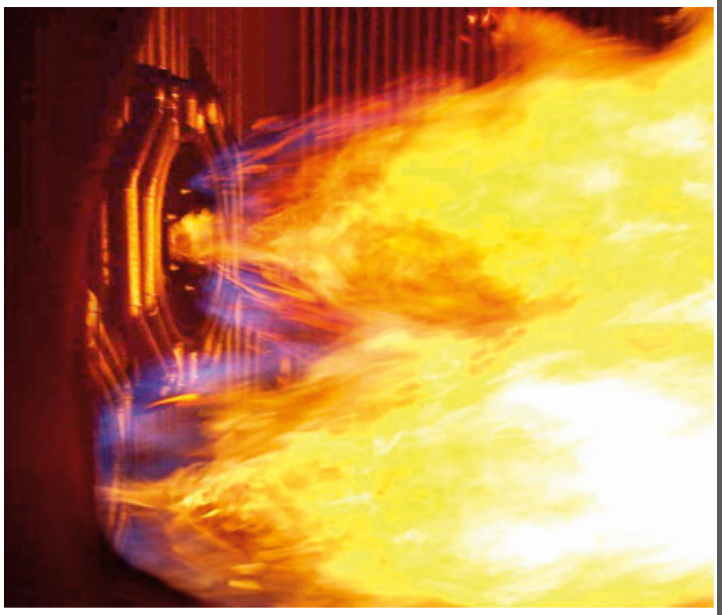
BURNER

Low NOx Burner

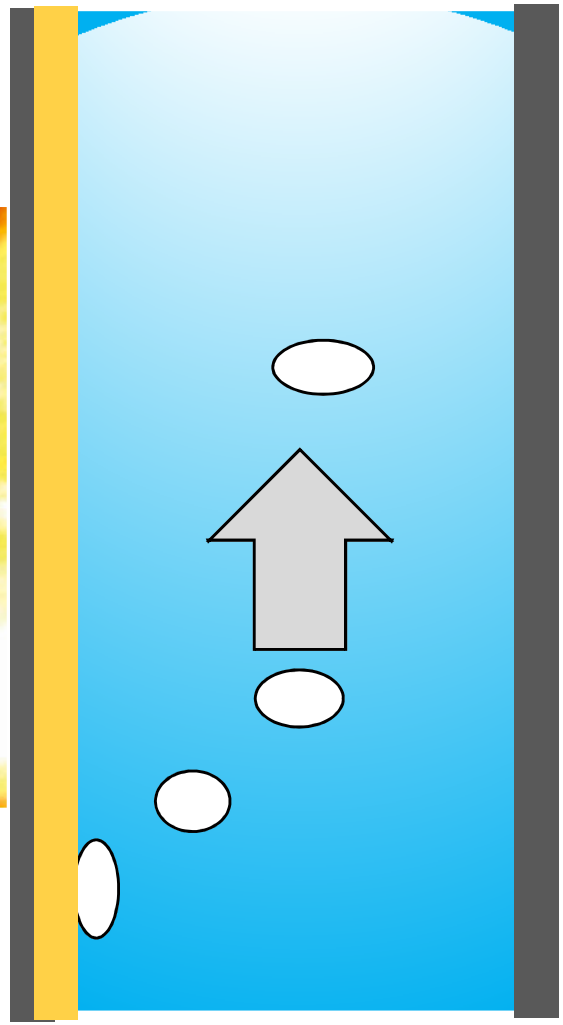


BOILER TUBE

Water Quality

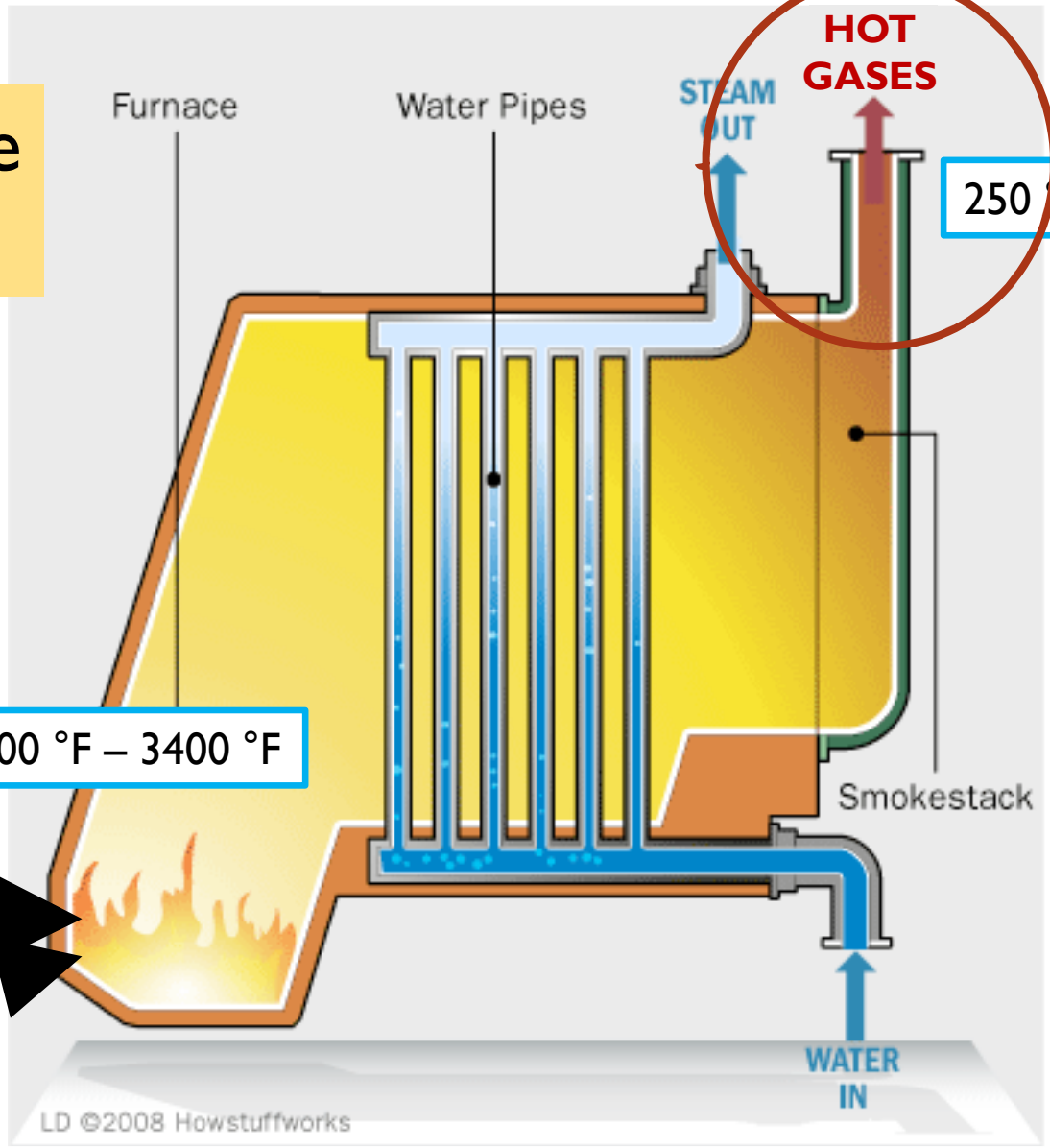


2400 °F – 3400 °F

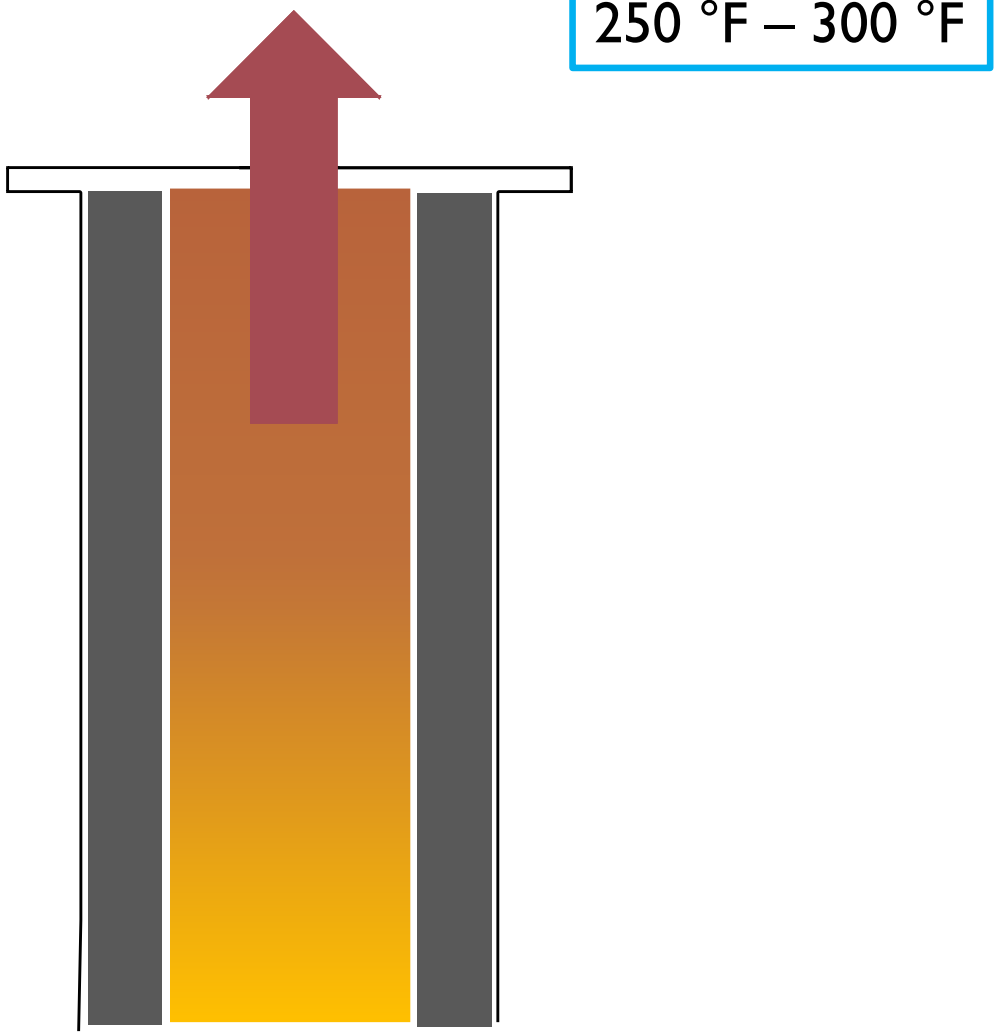


STACK TEMPERATURE

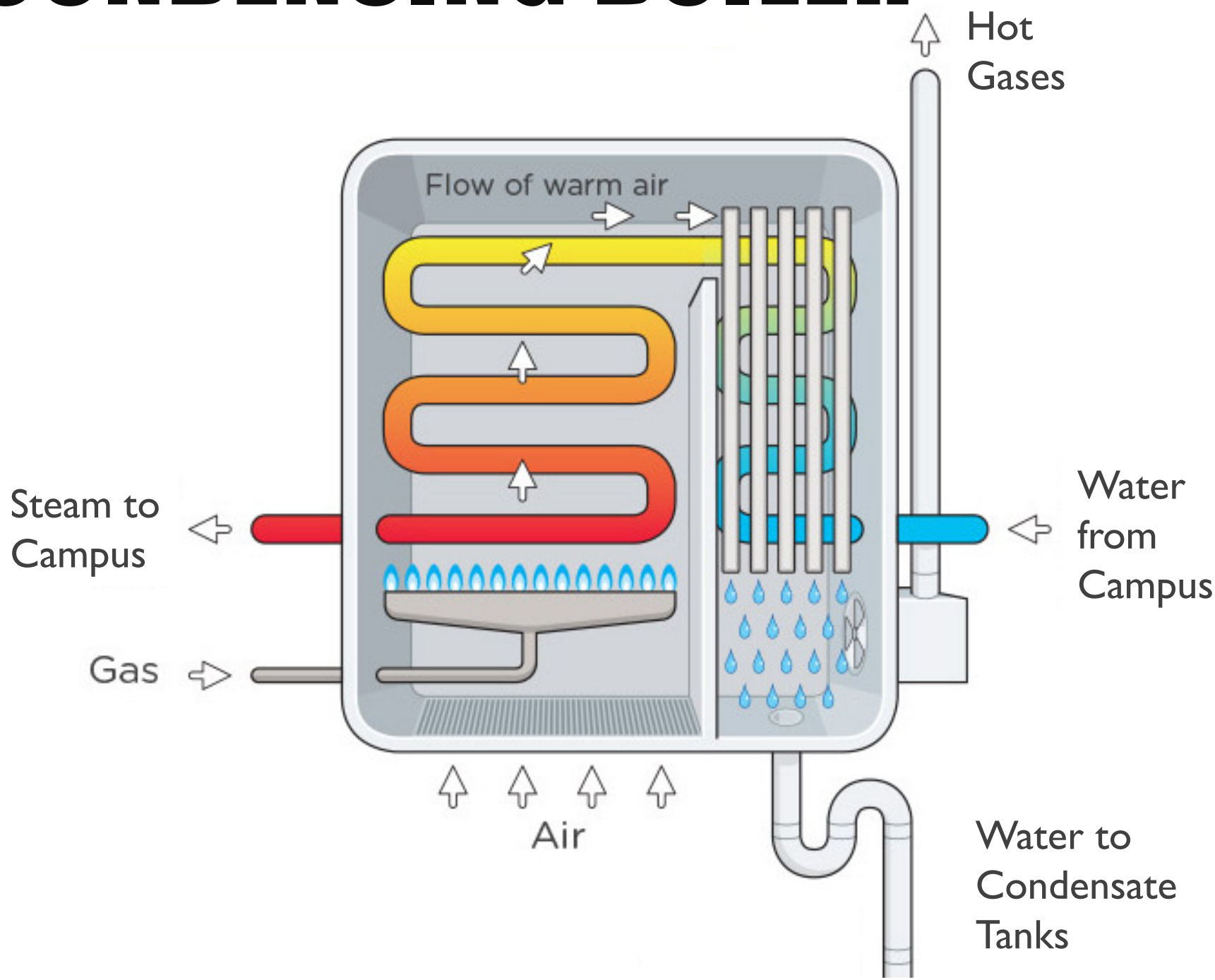
Water Tube Boiler



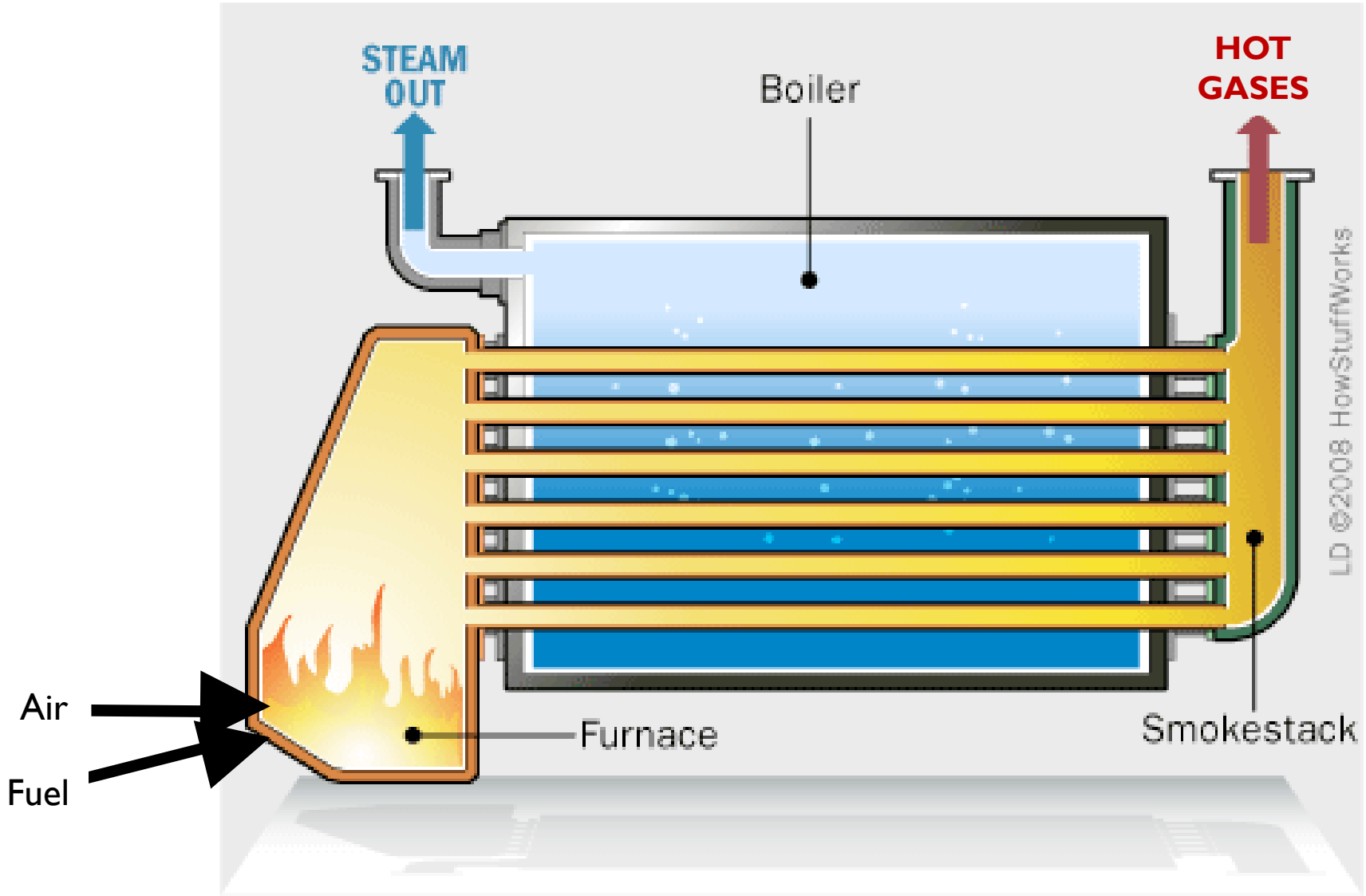
EXHAUST STACK



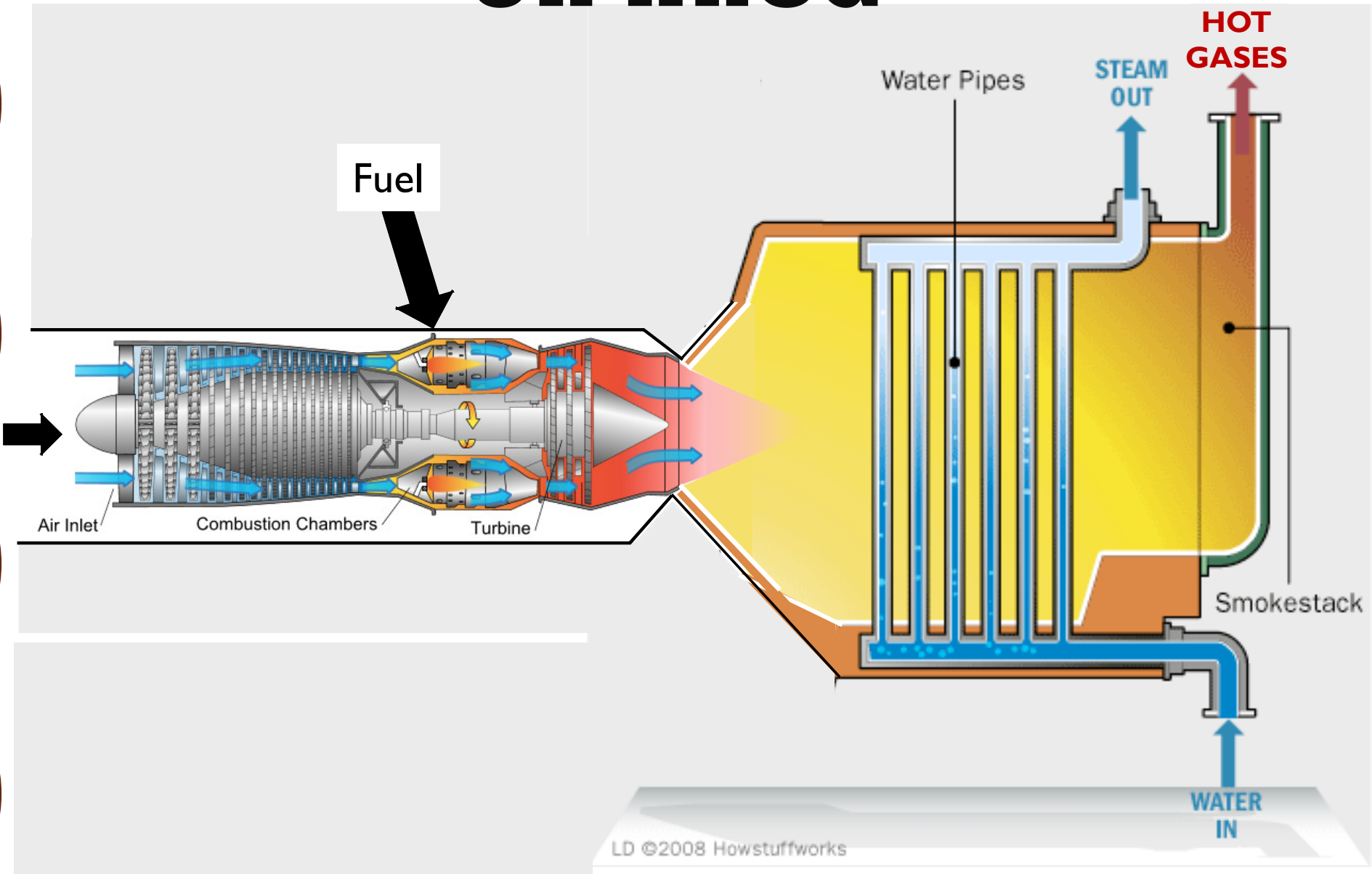
CONDENSING BOILER



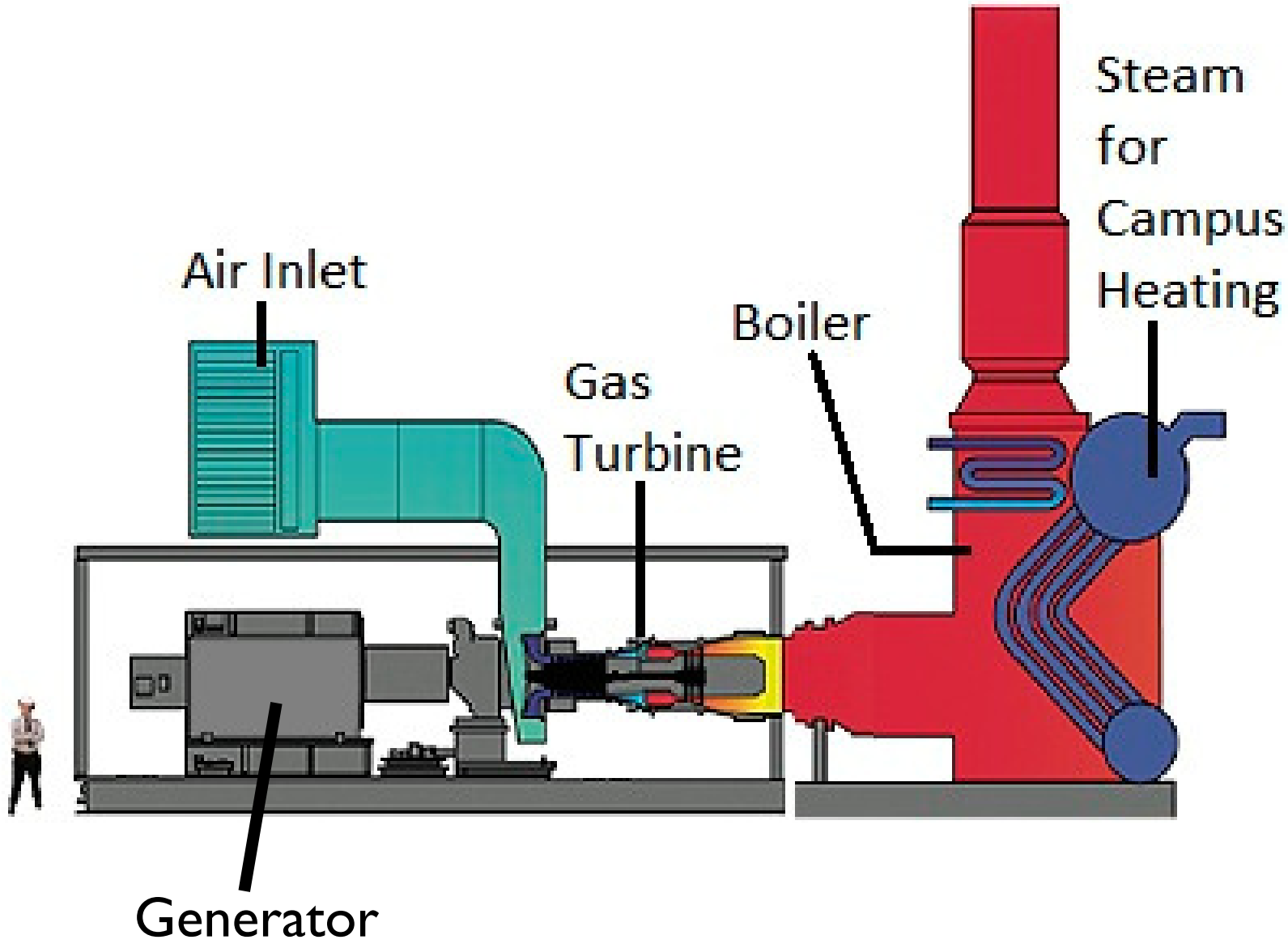
FIRE TUBE BOILER



HEAT RECOVERY BOILER OR HRSG



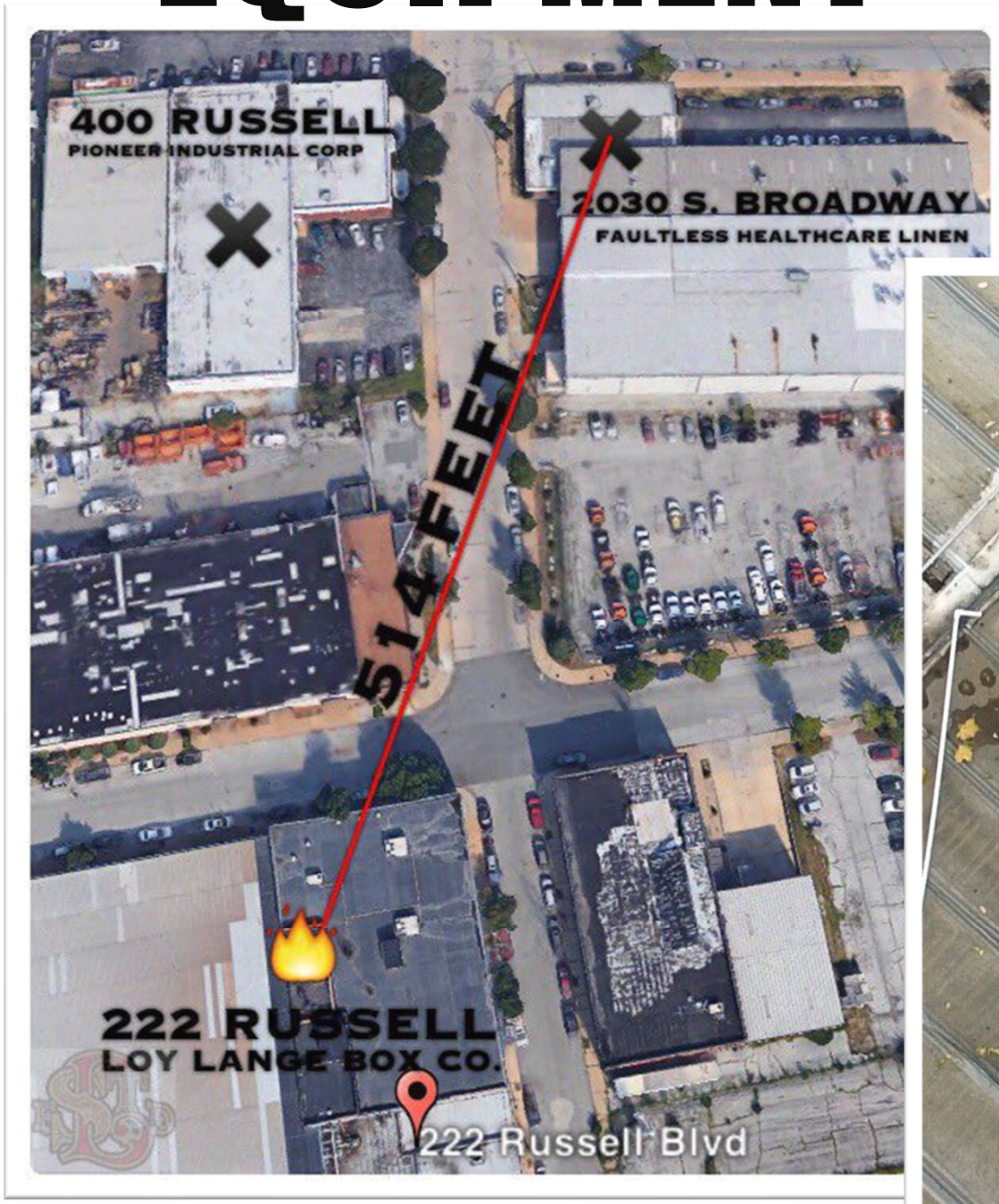
COMBINED HEAT AND POWER OR CHP

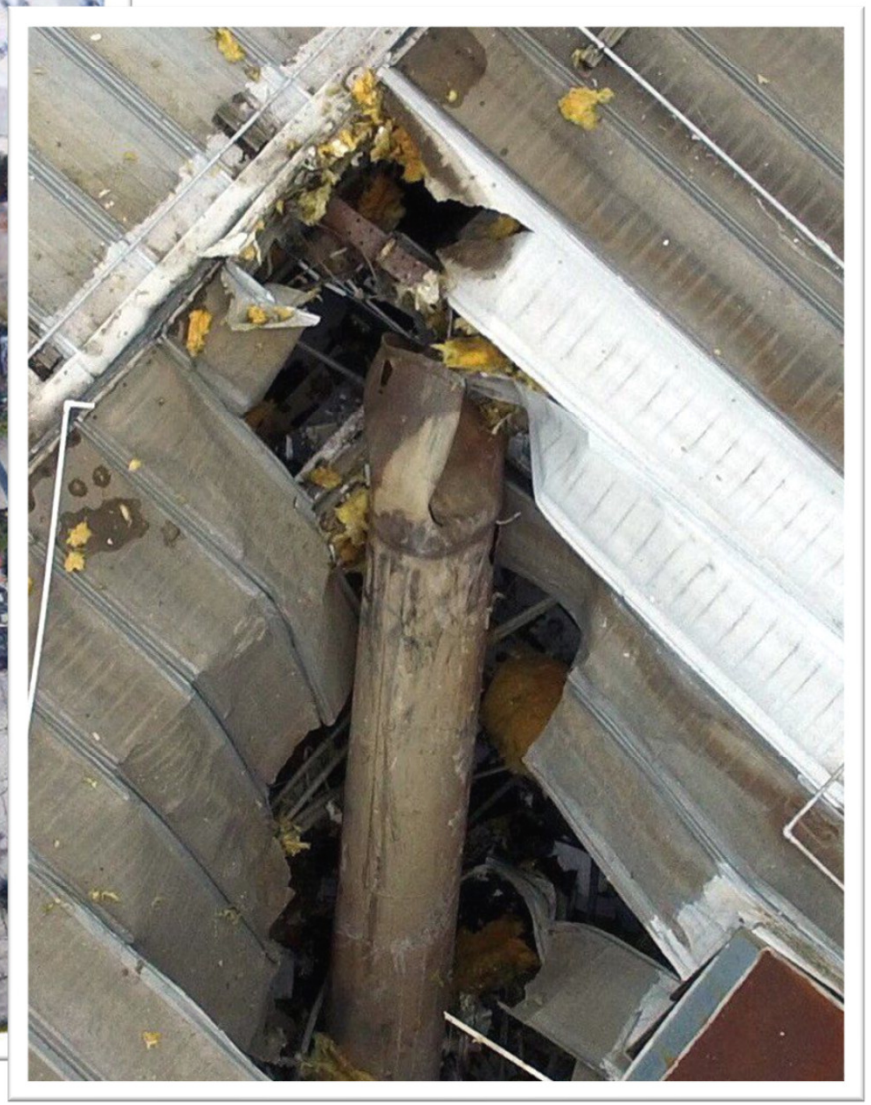


EQUIPMENT - RISKS

BOILER EXPLOSION AT BEAVER MILLS, KEENE, N. H., MAY 22, 1893.

EQUIPMENT - RISKS





WHAT HAPPENS IF YOU DEFEAT PRESSURE SAFETIES?

BOILER REGULATIONS

Construction
Repair
Operation

- ASME Boiler and Pressure Vessel Code
- Air Permit
- Operator Licensing
- Insurance Companies

HEATING COSTS

	Kentucky	New Mexico
Fuel	48%	55%
Labor & Maintenance	29%	34%
Chemicals	6%	2%
Electricity	4%	5%
Water	3%	1%
Other	10%	3%

CENTRAL OR DISTRIBUTED

Central

Distributed

CENTRAL VS. DISTRIBUTED

Pros

- Consolidation of operations/maintenance
- Backup fuel capability
- Can last over 50 years
- Combined Heat & Power
- Safer

Cons

- Requires pipe distribution
- Complex systems

Pros

- Lower first cost
- Less complex
- Reduced exposure to catastrophic failure

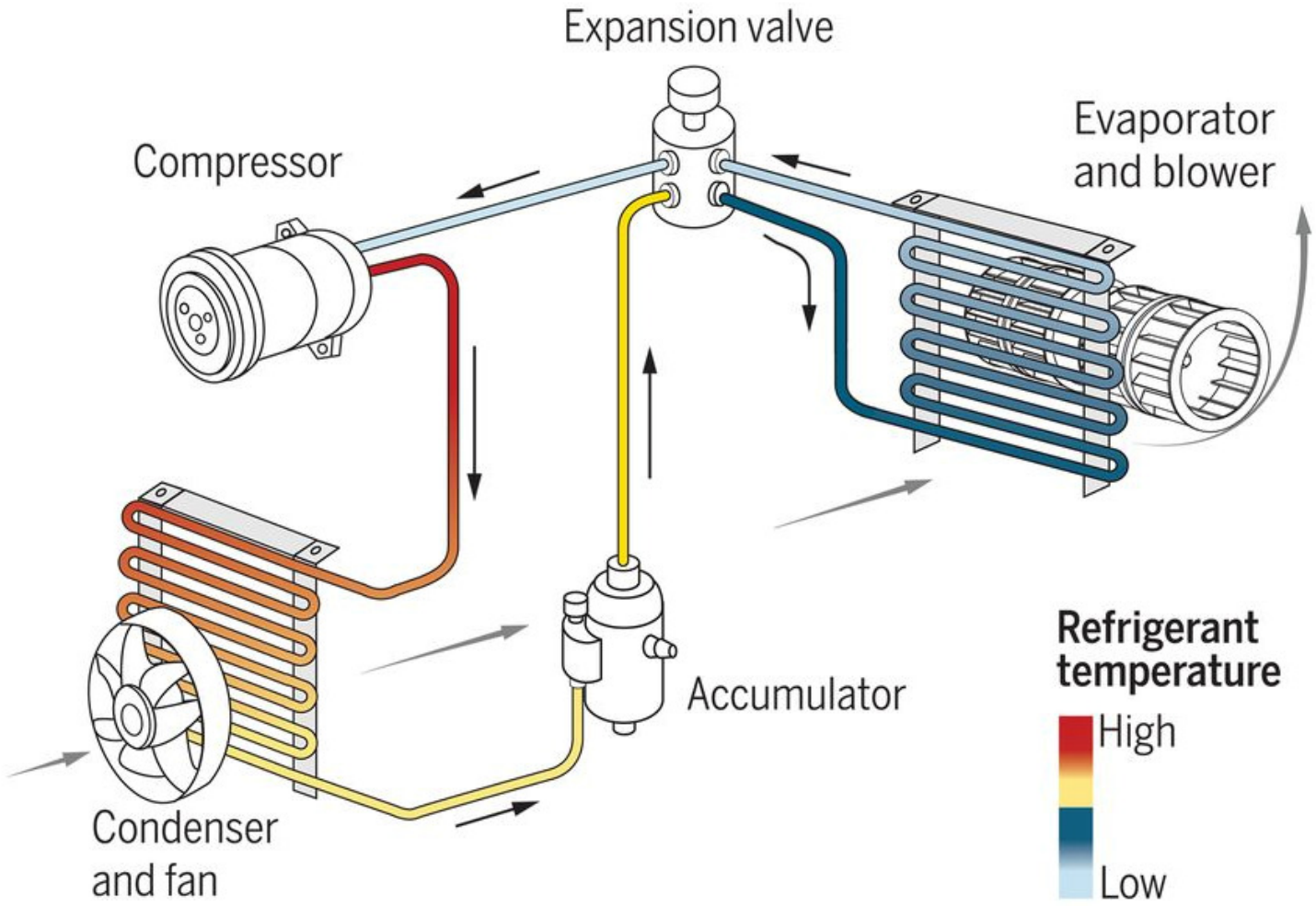
Cons

- Less reliable
- Less flexibility
  - Fuel
  - CHP
  - Emissions

COOLING OVERVIEW

Chillers
Refrigerants
Water

VAPOR COMPRESSION CYCLE



- Evaporation (or boiling)
- Pressure manipulation

REFRIGERANTS

https://en.wikipedia.org/wiki/List_of_refrigerants

- Chlorofluorocarbons (CFCs)
- Hydrochlorofluorocarbons (HCFCs)
- Hydrofluorocarbons (HFCs)
- Natural Refrigerants

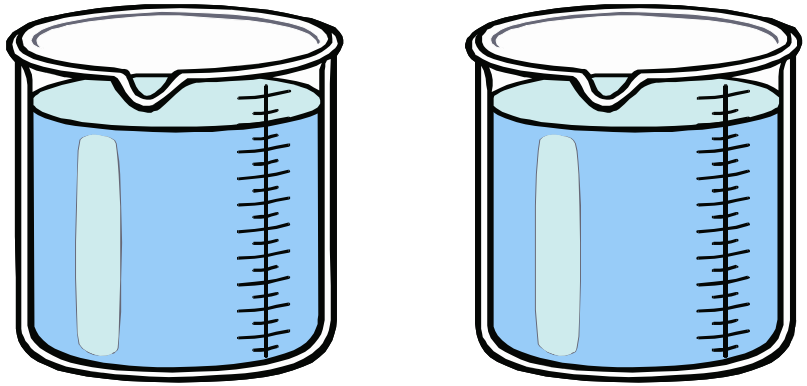
RISKS WITH REFRIGERANTS

REFRIGERANT TYPE	CLASS	OZONE DEPLETION POTENTIAL	GLOBAL WARMING POTENTIAL
CFC	Synthetic	High	Very High
HCFC	Synthetic	Very Low	Very High
HFC	Synthetic	Zero	High
HC	Natural	Zero	Negligible
CO2	Natural	Zero	Negligible

WATER – IDEAL HEAT TRANSFER FLUID

Specific Heat of Water

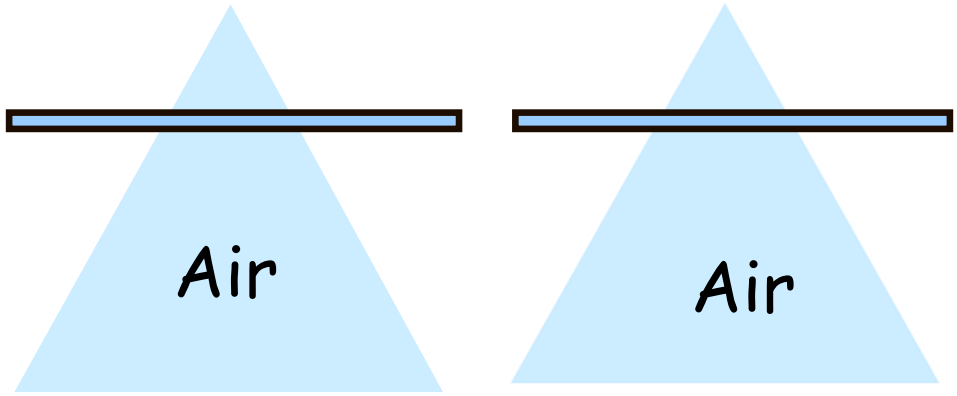
1 BTU/lb



75ºF ***Plus 1 BTU*** **= 76ºF**

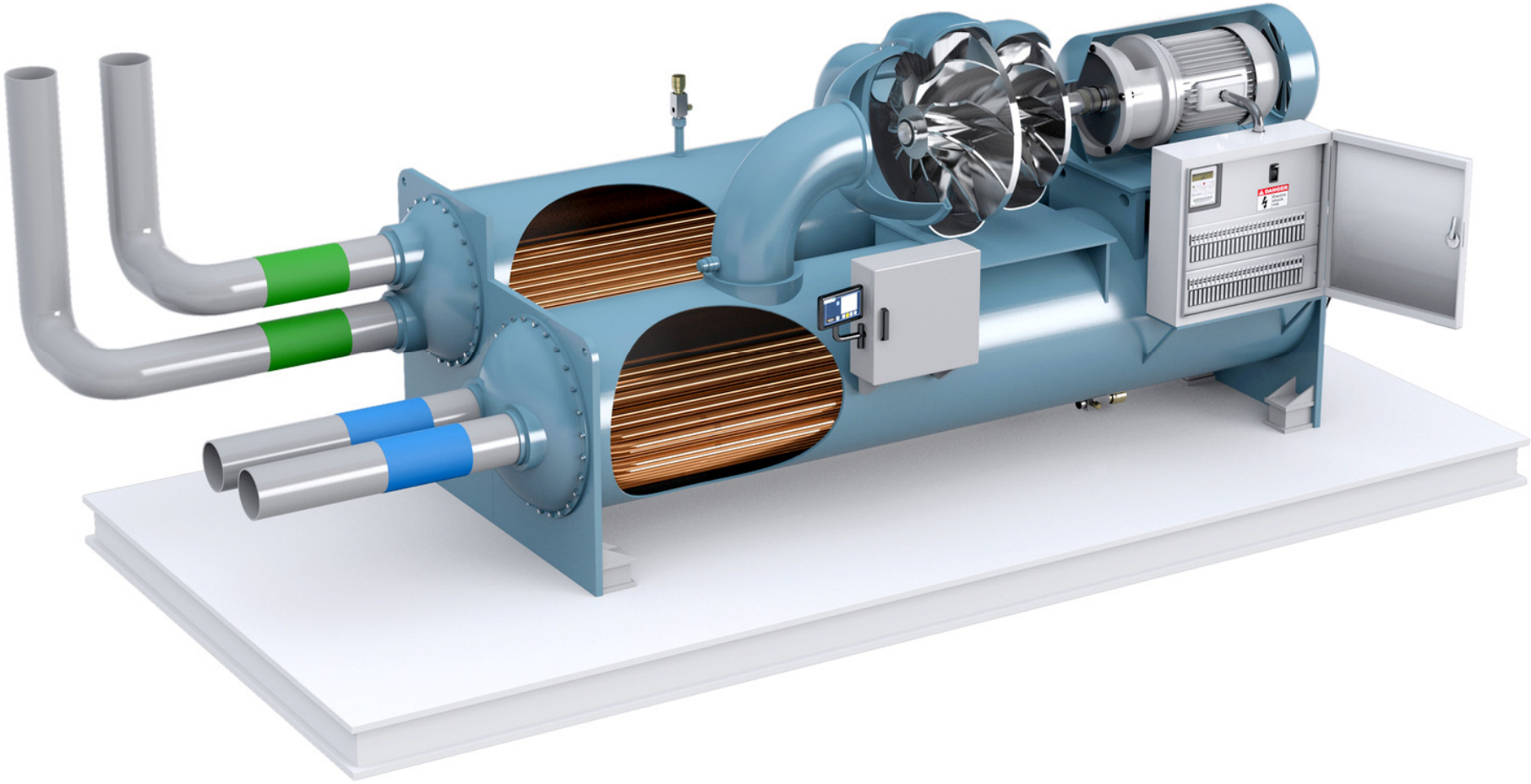
Specific Heat of Air

0.24 BTU/lb



75ºF ***Plus 4 BTUs*** **= 76ºF**

CENTRIFUGAL CHILLER



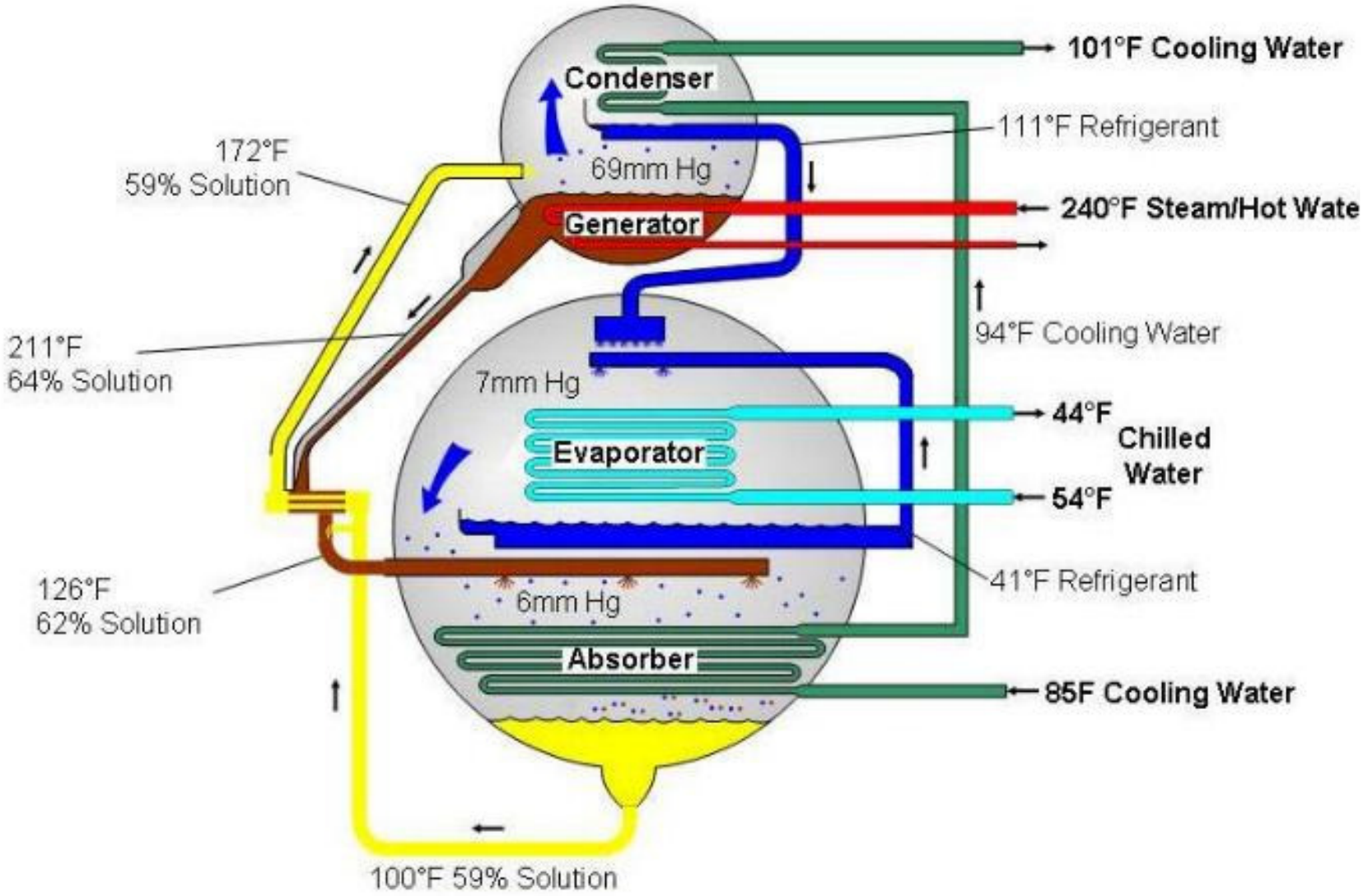
- Electric motor driven
- Also steam driven chillers

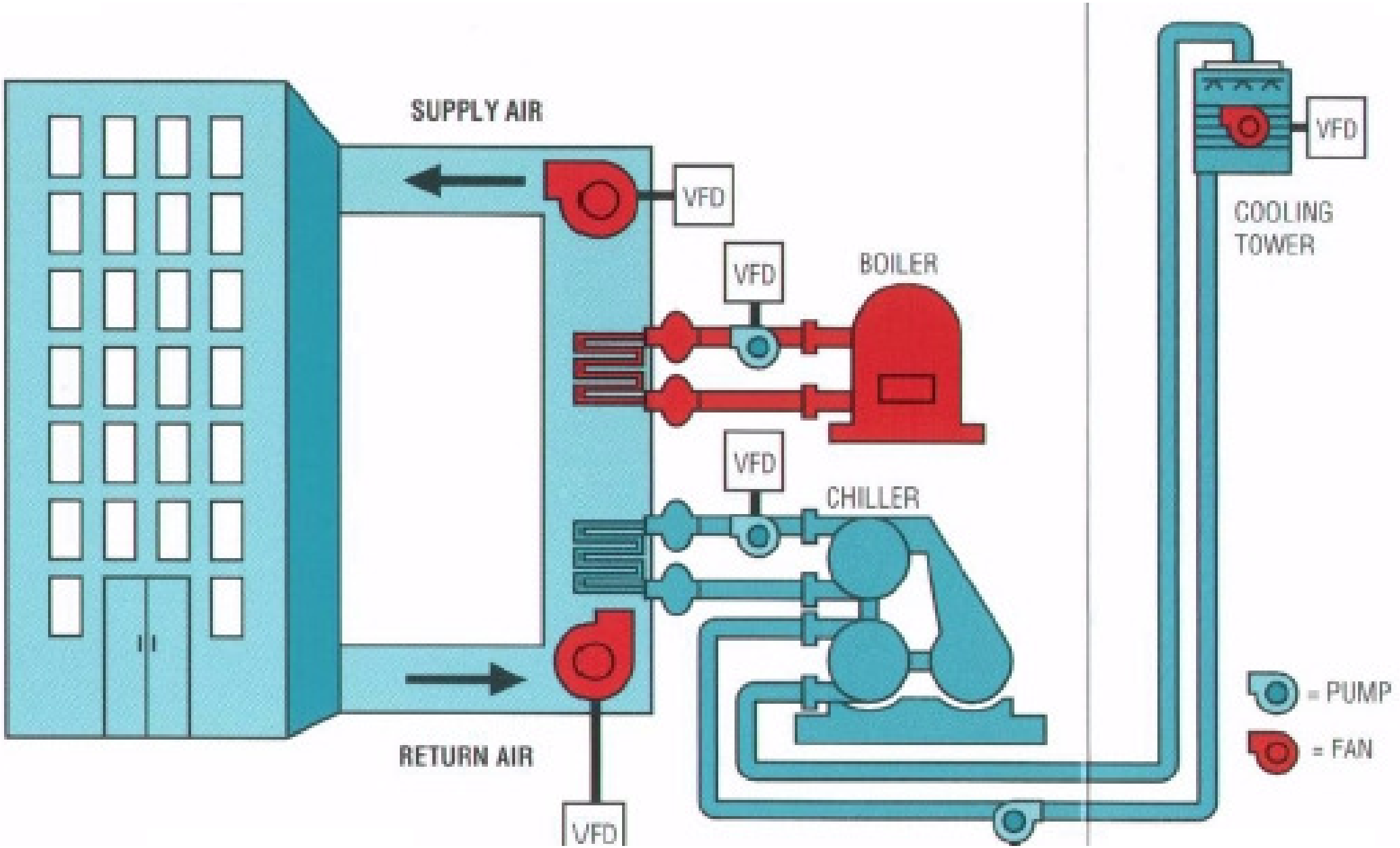
CENTRIFUGAL CHILLER

- 5,000 ton chiller

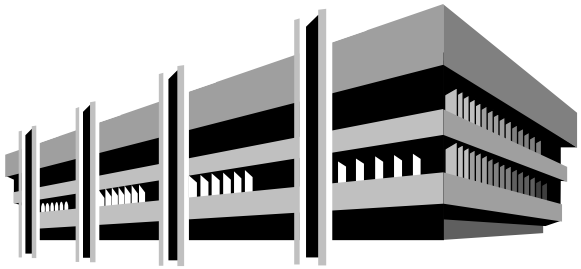
ABSORPTION CHILLER

ABSORPTION CHILLER

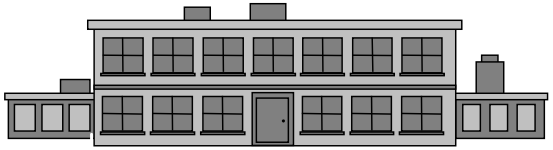



SUPPLY AIR
VFD
VFD
BOILER
VFD
CHILLER
VFD
RETURN AIR
VFD
COOLING
TOWER
= PUMP
= FAN

DISTRICT COOLING

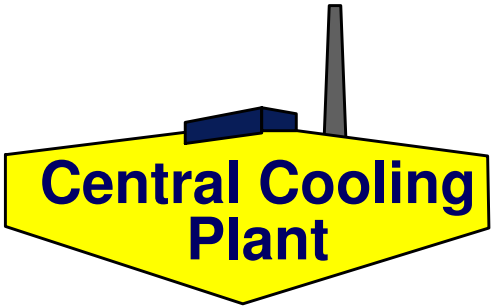


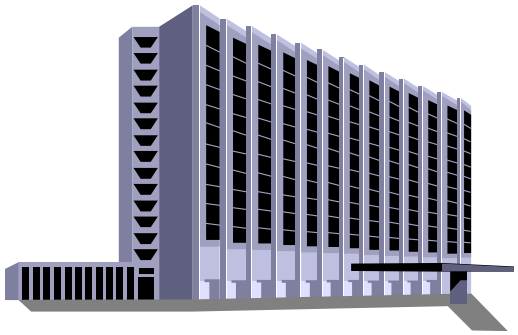
Classrooms



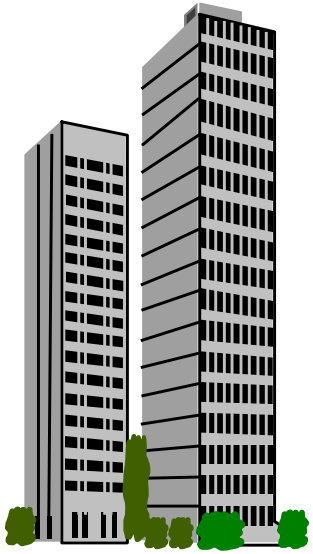
Labs

Library





Hospital



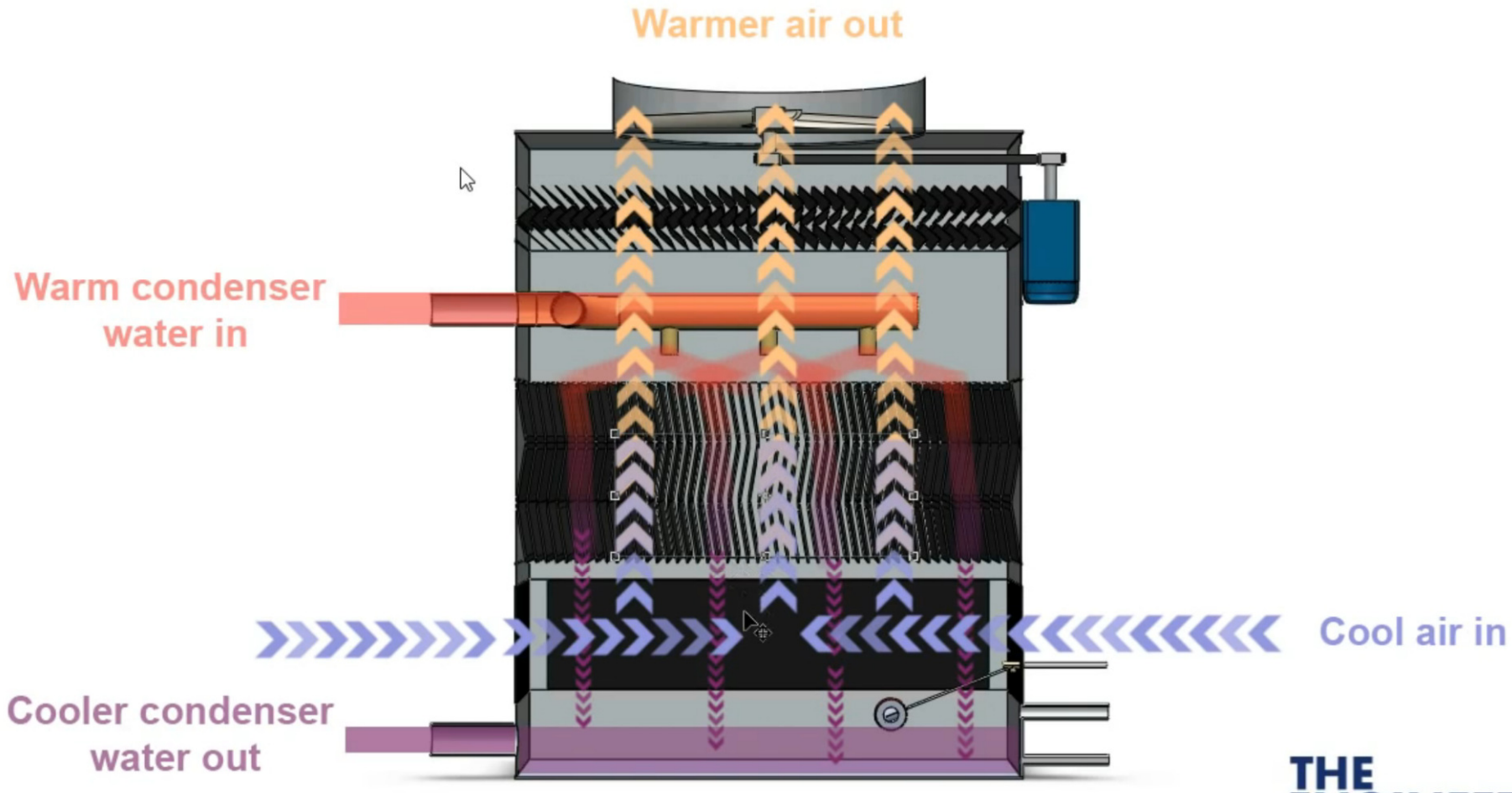
Housing

DISTRICT COOLING - PROS AND CONS

- Integrated solutions
- Less equipment
- Lower service cost
- Better space utilization
- Alternate technological option
- Lower operating costs
- Better management and energy control
- Higher overall efficiency
- Multiple fuel capabilities
- Aesthetic

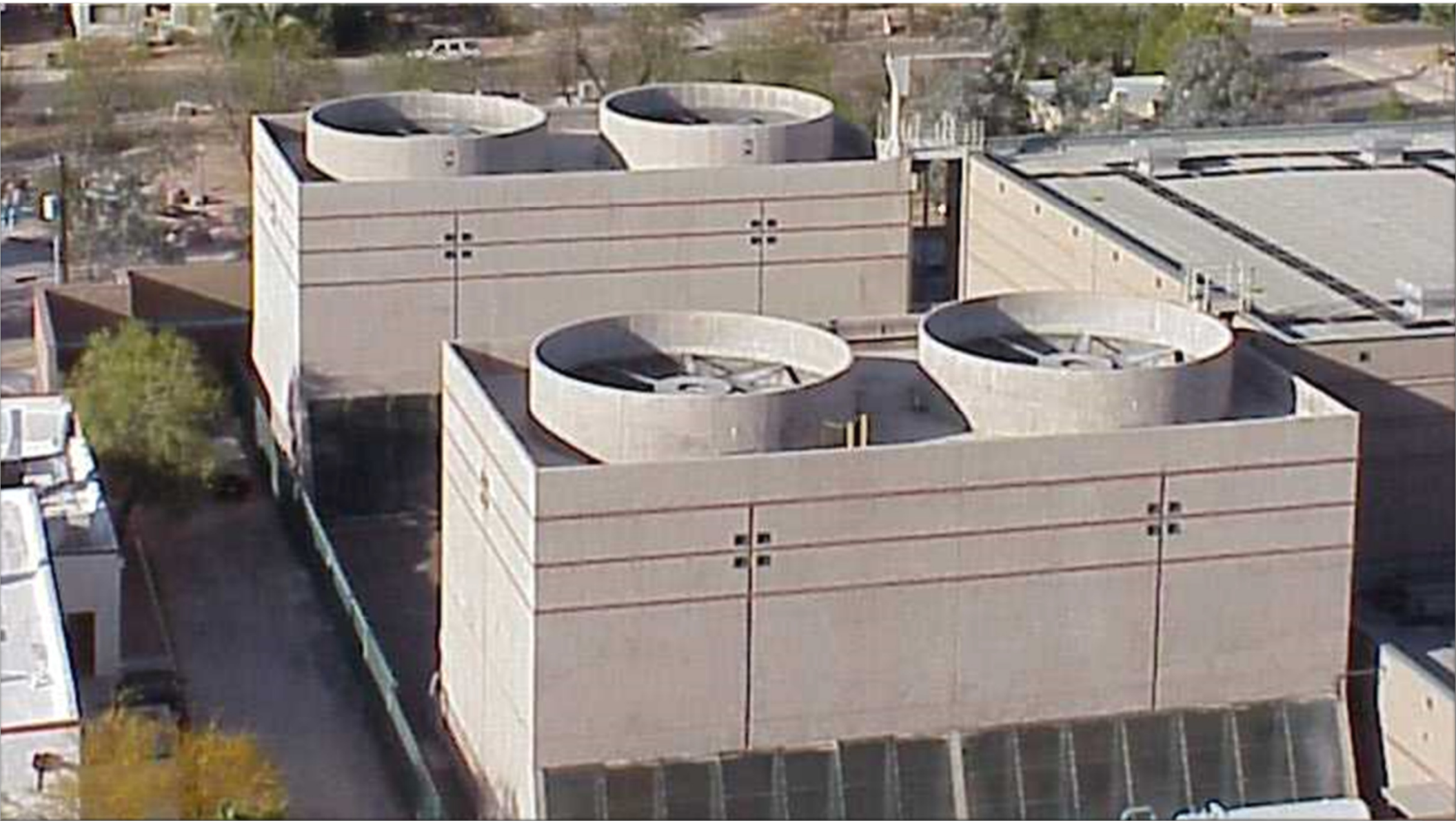
- High first cost
- Inflexible once constructed
- Distribution losses
- Need for specialized technicians

COOLING TOWERS



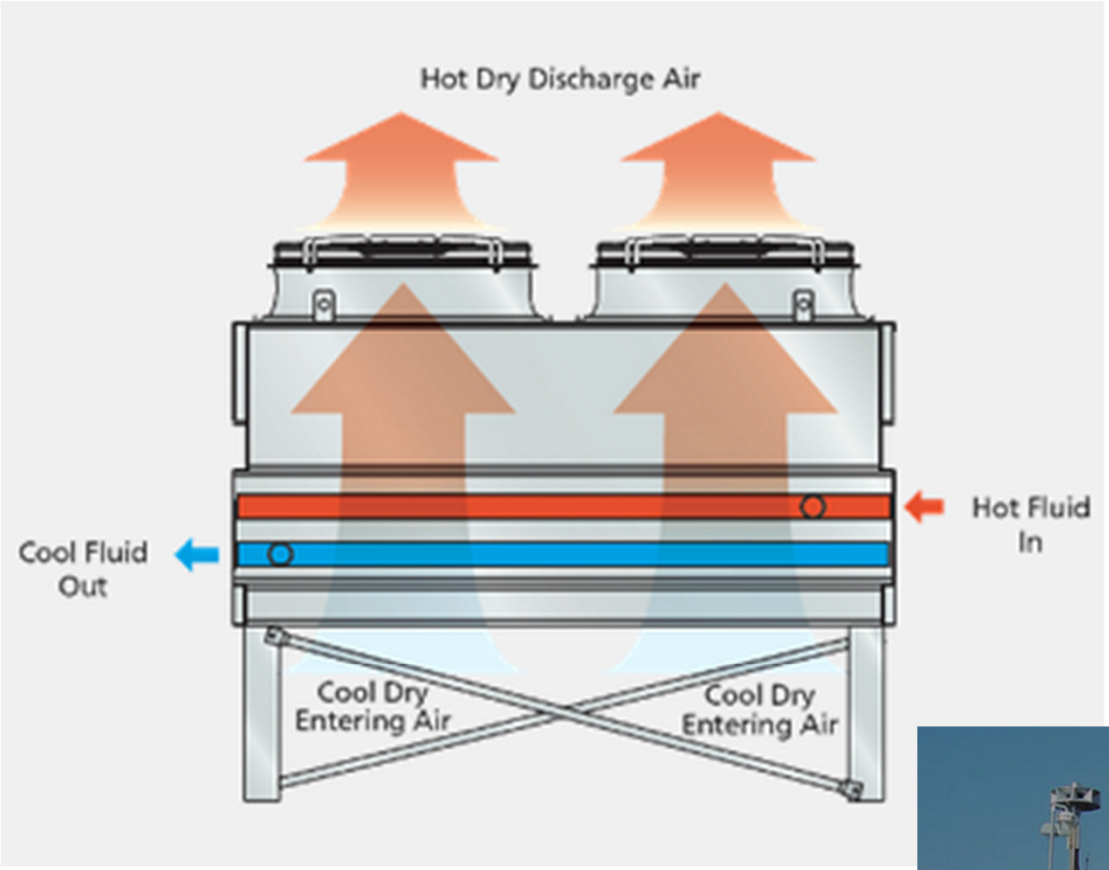
UNIVERSITY OF ILLINOIS

UNIVERSITY OF ARIZONA

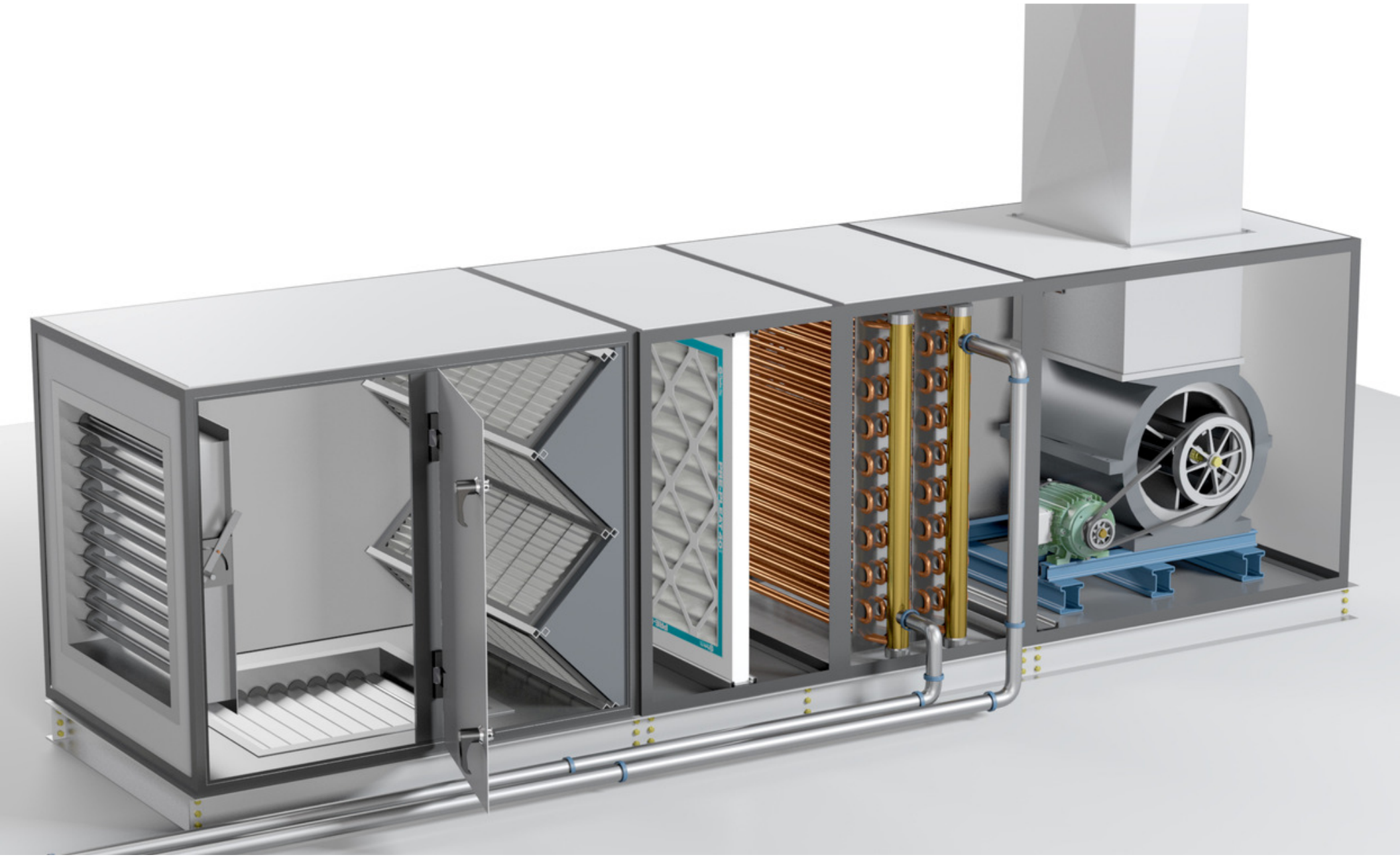


HIDDEN IN PARKING GARAGE

AIR COOLED COOLING TOWER

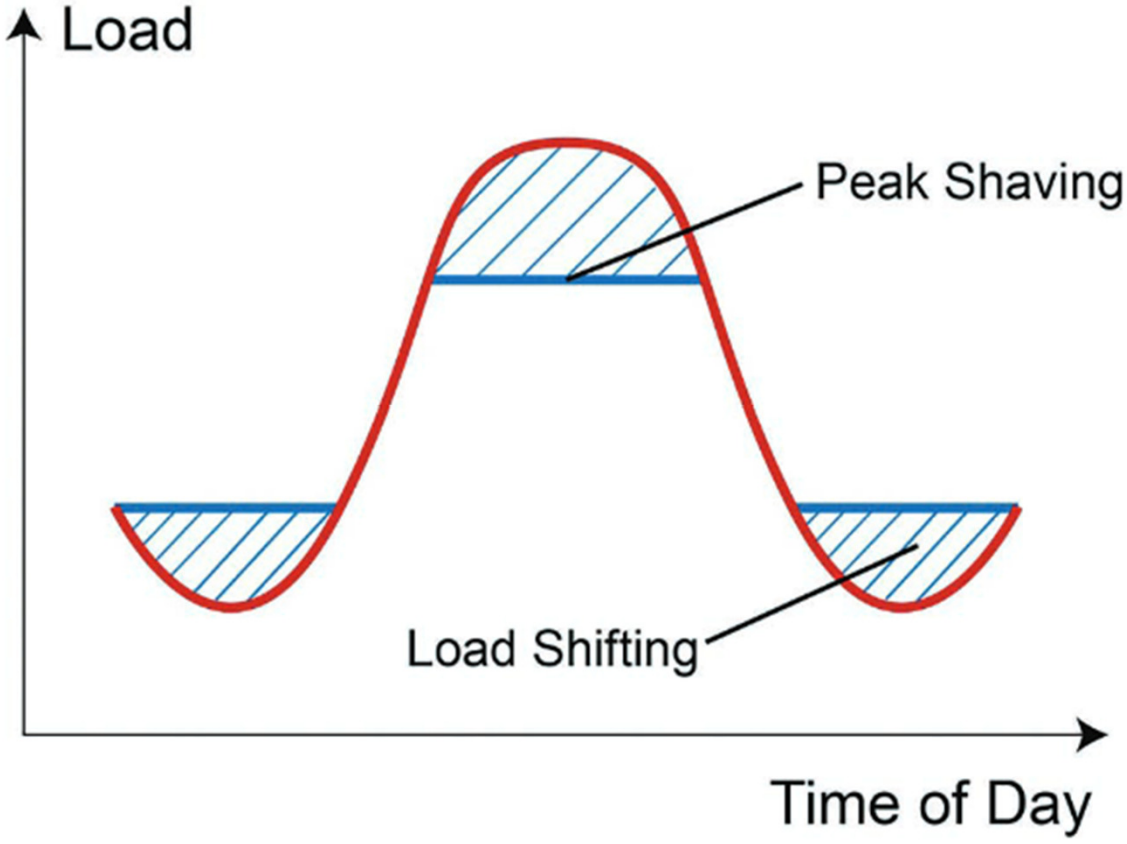


AIR HANDLERS



COOLING LOAD PROFILE

SHAVING THE PEAK WITH TES



THERMAL ENERGY STORAGE

- Benefits
  - Shifting system load demand
  - Stability of cooling capacity
  - Dual-duty operation
  - Managing energy costs
  - Reduction in demand charges

DUKE UNIVERSITY - WATER

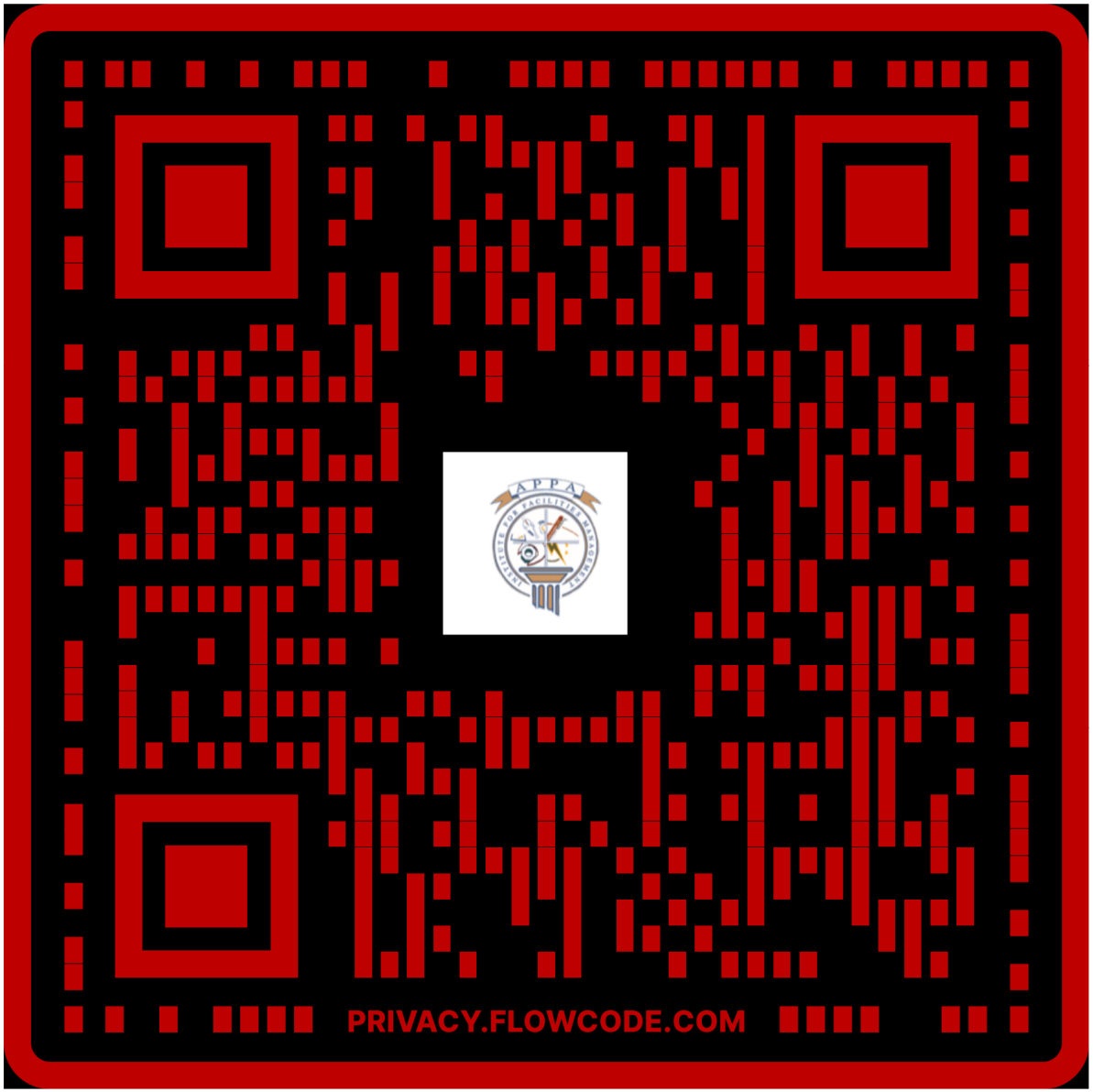
ICE TES

EFFICIENT CHILLER OPERATION

- Chillers
  - Variable speed drives
  - Mechanical unloading
- Towers
  - Variable speed fans and pumps
- Distribution Pumps
  - Variable speed pumps
- Good Maintenance
- Metering / Analytics
- Thermal Energy Storage
- Free Cooling

QUESTIONS?

THIS CONCLUDES THE AMERICAN INSTITUTE OF ARCHITECTS CONTINUING EDUCATION SYSTEMS COURSE



AIA
Continuing
Education
Provider