Geothermal Powered Absorption Chiller

presented by:

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Chena Hot Springs Resort

2005 GeoPowering the West Workshop

Nome, Alaska

June 28th, 2005

CHENA HOT SPRINGS RESORT Alaska

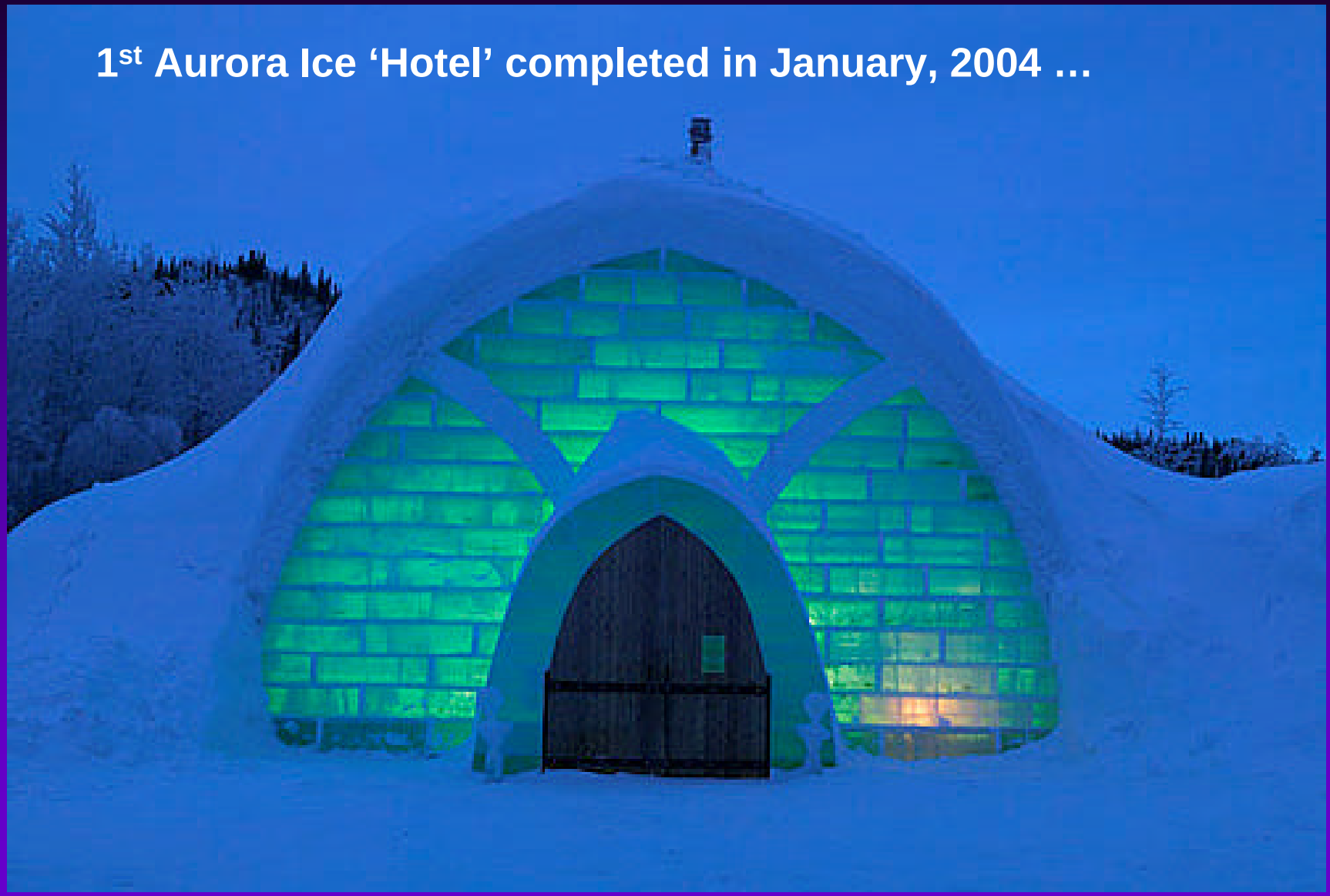
'Hot Springs builds Ice Hotel'

Resort Chills Ice Hotel with Hot Water

-- The Tonight Show with Jay Leno

AURORA ICE MUSEUM

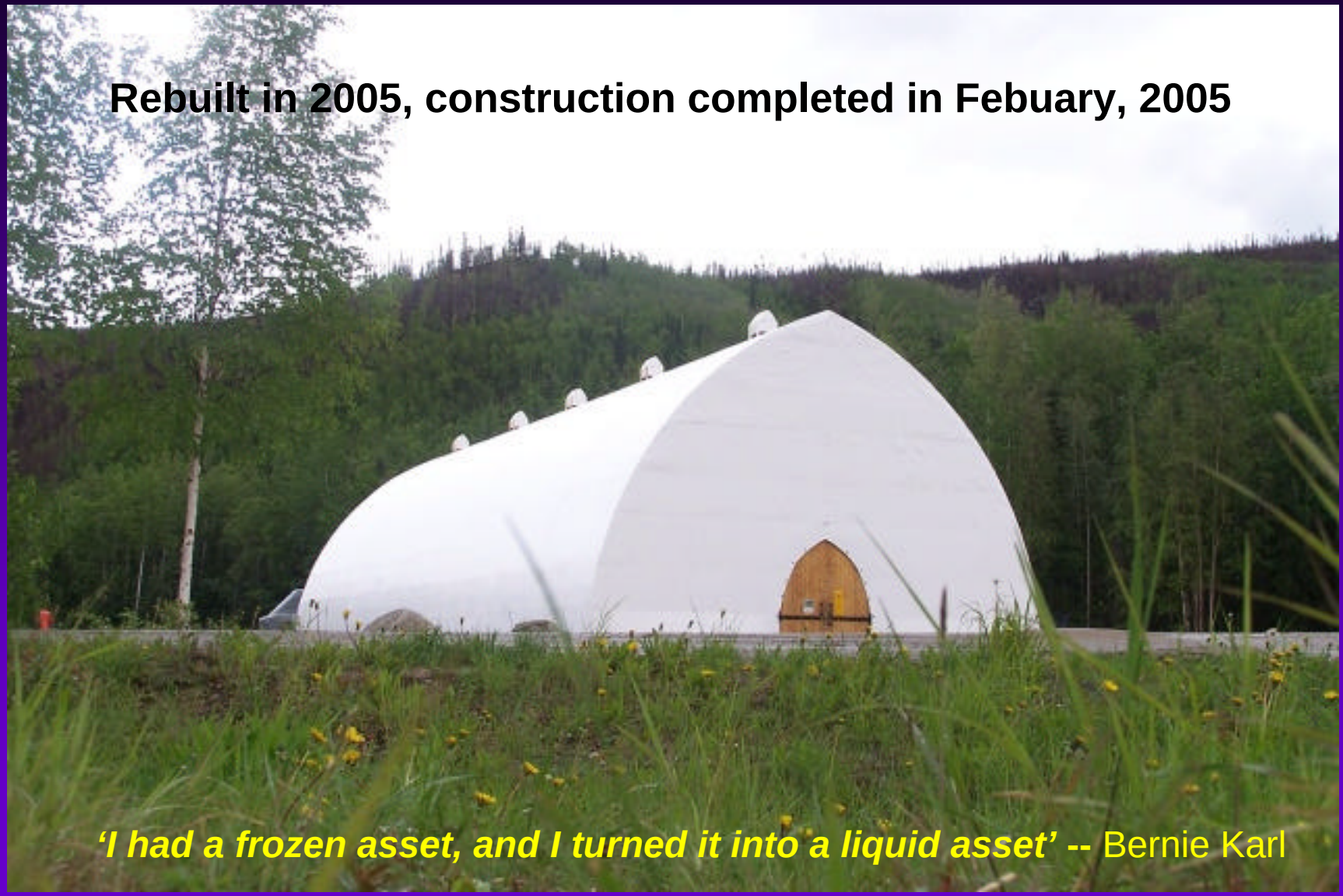
1st Aurora Ice 'Hotel' completed in January, 2004 …



AURORA ICE MUSEUM

1st Aurora Ice ‘Hotel’ melted in June, 2004 …

AURORA ICE MUSEUM



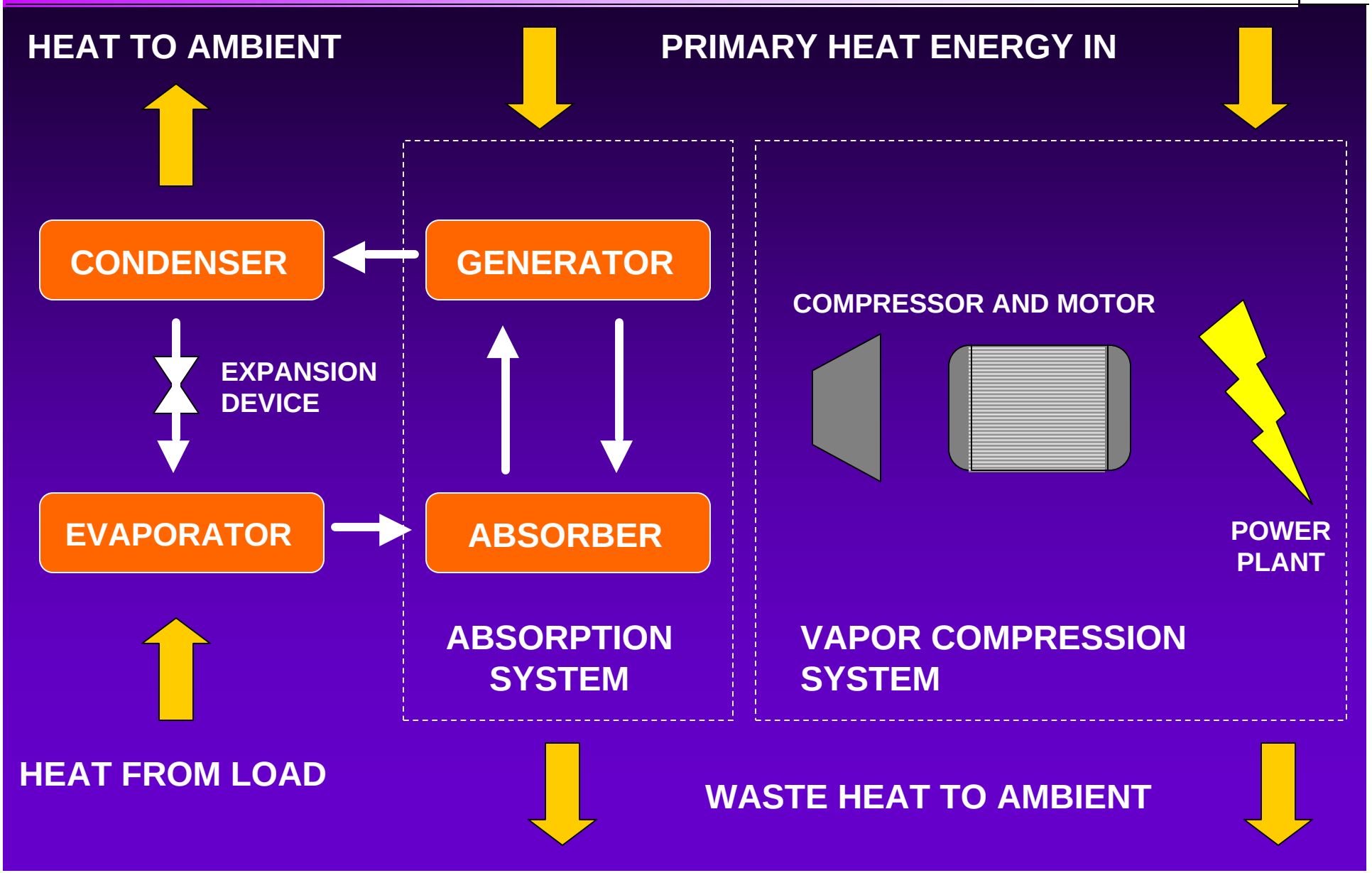
AURORA ICE MUSEUM

ABSORPTION REFRIGERATION BASICS

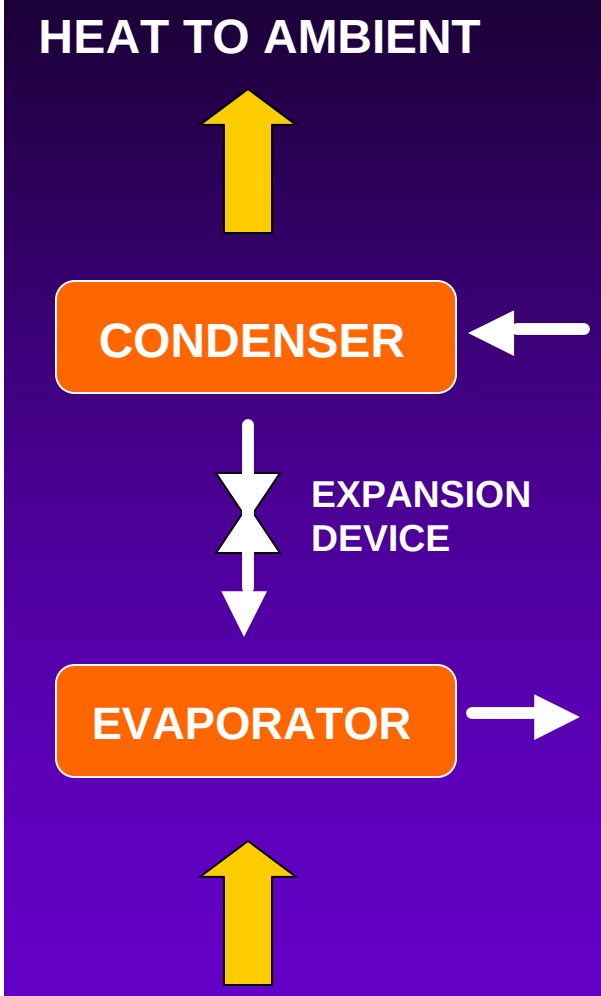
An absorption refrigeration cycle removes heat through evaporation of a fluid (refrigerant) at low pressure and the rejection of heat through the condensation of a fluid (refrigerant) at a higher pressure

- Ammonia absorption cycle invented by Ferdinand Carre in 1846
- Efficient when a waste heat source is available, including: Geothermal, Exhaust from Generators, Solar
- Absorption systems have few or no moving parts
- Generally has low thermal efficiency and therefore most economical if used to take advantage of a waste heat source or in a remote location where power is expensive or not readily available

COMPARISON OF REFRIGERATION CYCLES

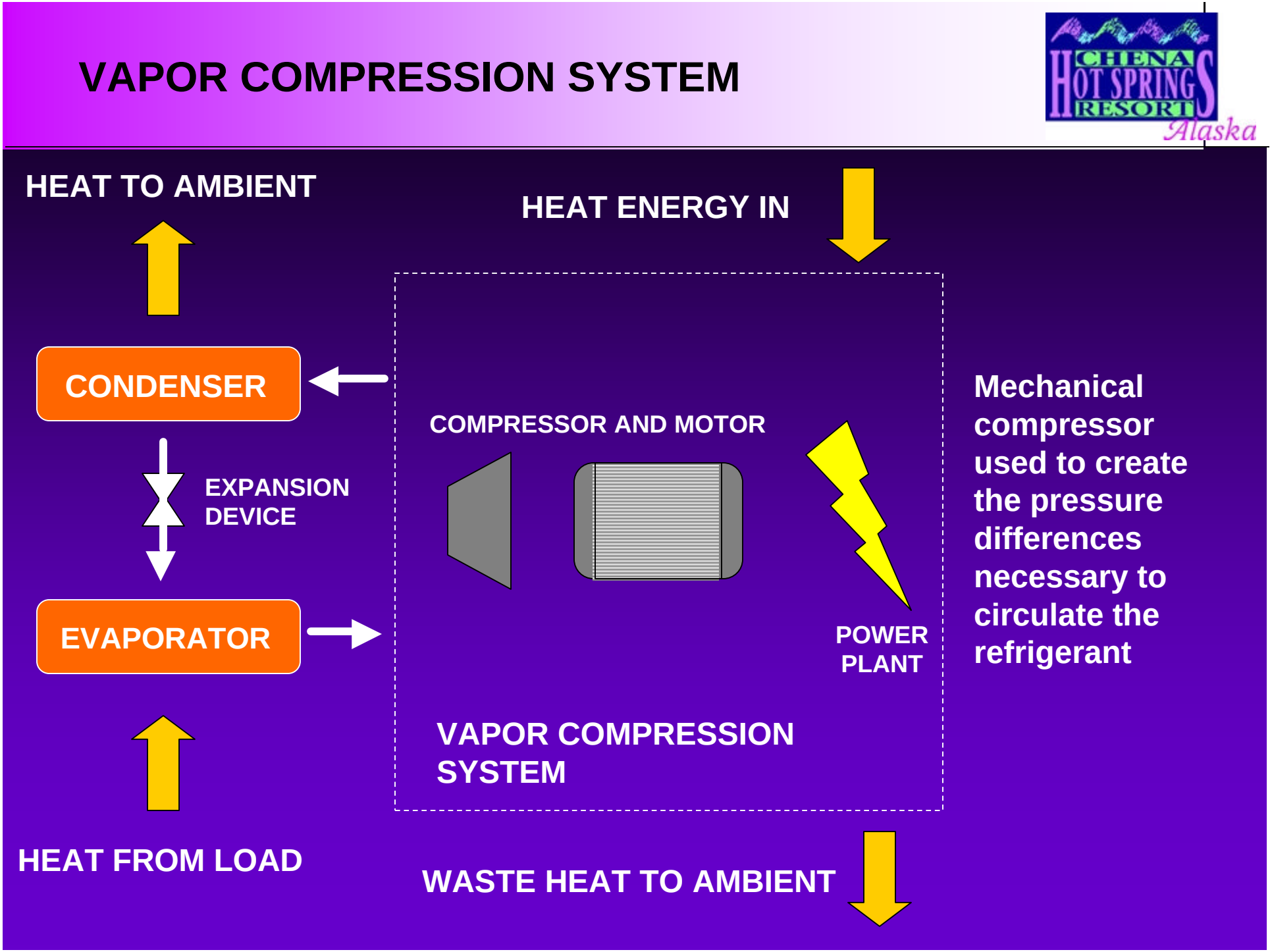


COMPARISON OF REFRIGERATION CYCLES

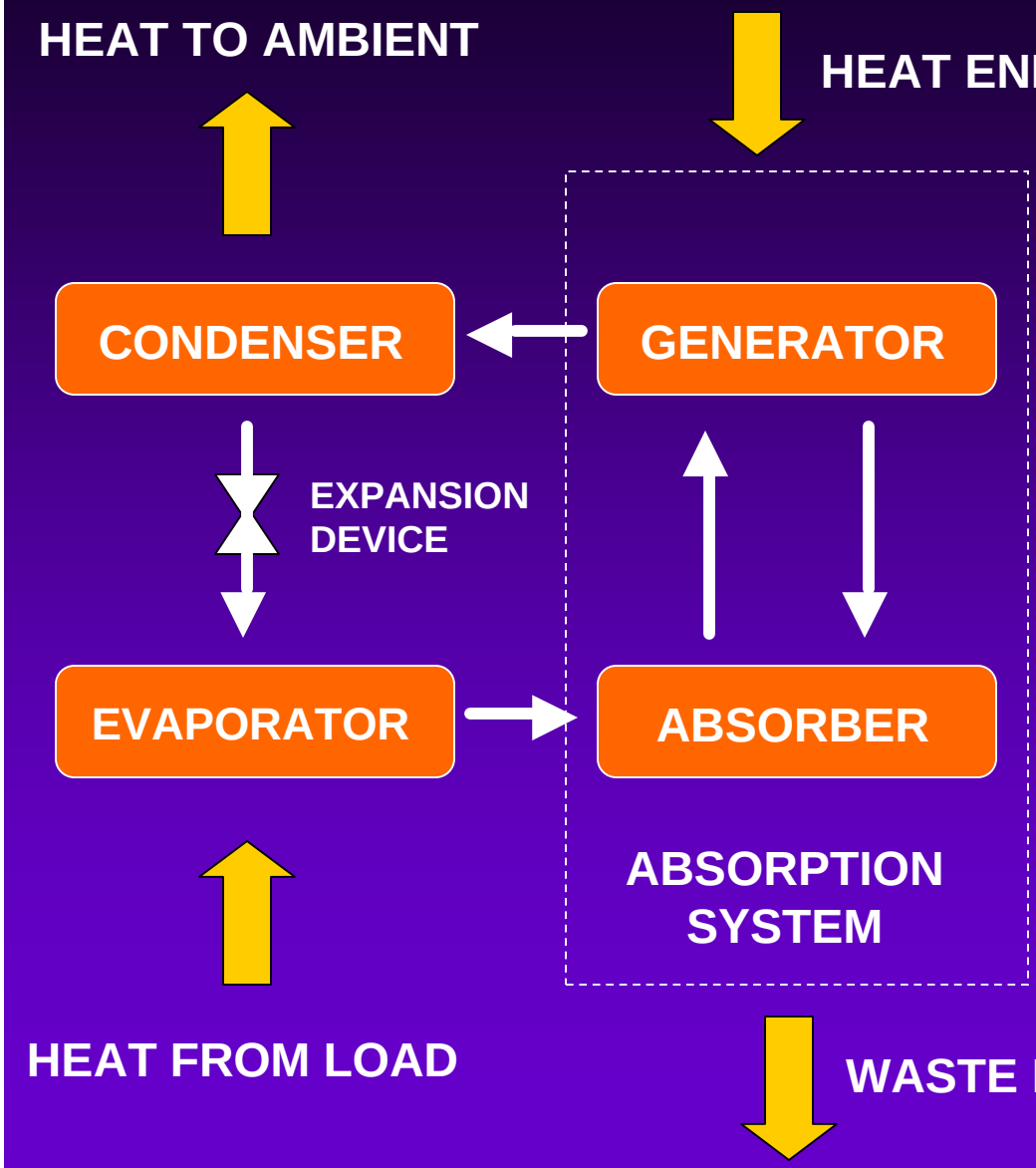


Both vapor compression and absorption refrigeration cycles accomplish the removal of heat through the evaporation of a refrigerant at a low pressure and the rejection of heat through the condensation of the refrigerant at a higher pressure.

VAPOR COMPRESSION SYSTEM



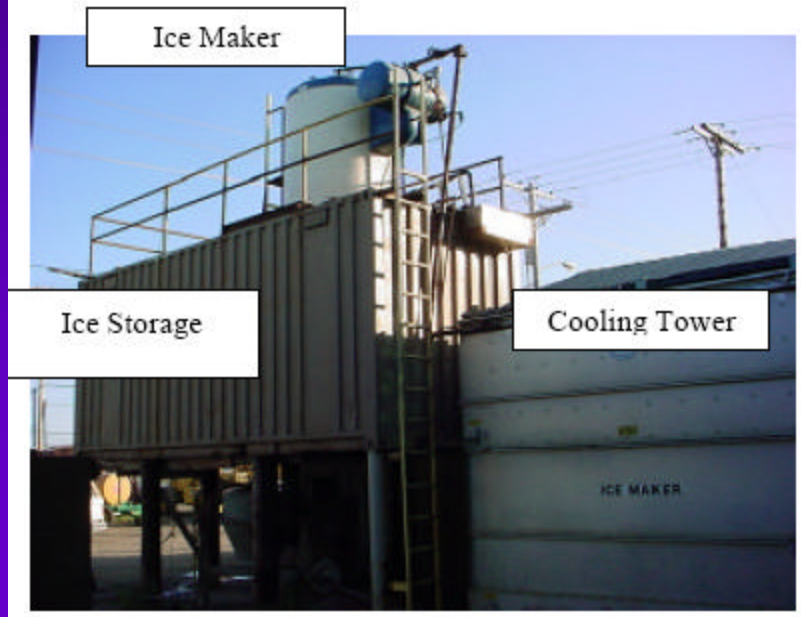
ABSORPTION REFRIGERATION SYSTEM

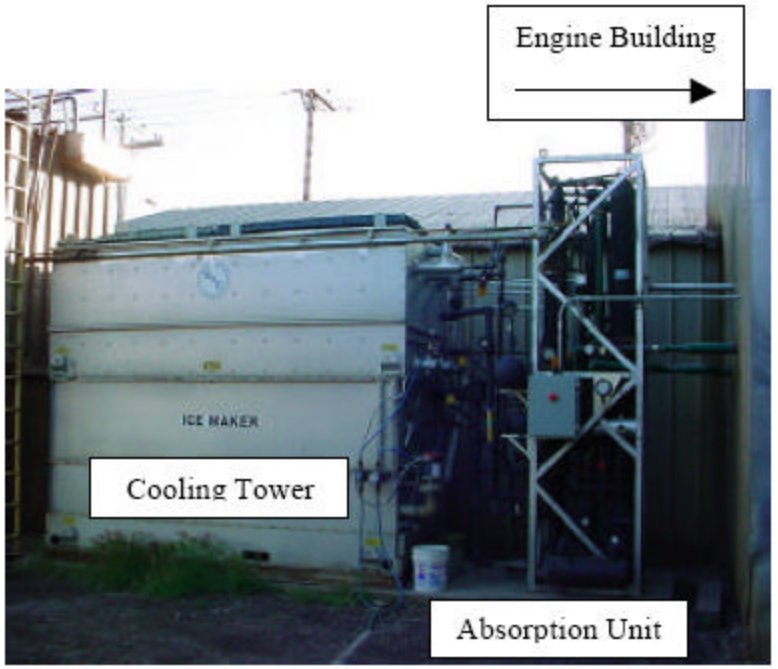


In the absorption system, a secondary fluid or absorbent is used to create a pressure differential and circulate the refrigerant

KOTZEBUE ICE MAKER

- Installed in 1992 to provide ice for commercial salmon catch
- Single stage ammonia/water system
- Uses waste heat -- cooling water from diesel generator (192F)
- Delivers 10F cold storage (ice)





O.I.T. ABSORPTION CHILLER

Geothermally Operated Li-Br Absorption Chiller at O.I.T.

- Installed in 1980 to supply a base cooling load to five campus buildings totaling ~277,000ft2
- Installation cost was $171,300
- Single Stage Lithium Bromide System
- 150 Ton operational capacity
- Used 685 GPM of Geothermal Fluid at 192F
- Decommissioned in 1999 and replaced with a centrifugal water chiller due to low efficiency and high water use

CHENA HOT SPRINGS ABSORPTION CHILLER

Absorption Unit Specifications

Heat Source	Hot Springs of 165 ^{o}F
Creek Water Temp.	40 ^{o}F (4.4 ^{o}C)
Required Brine Temp.	-21 ^{o}F (-29.4 ^{o}C)
Required Capacity	16 - RT
Size	4ft x 4ft x 6ft

Designed and Built by Energy Concepts Co

Annapolis, MD

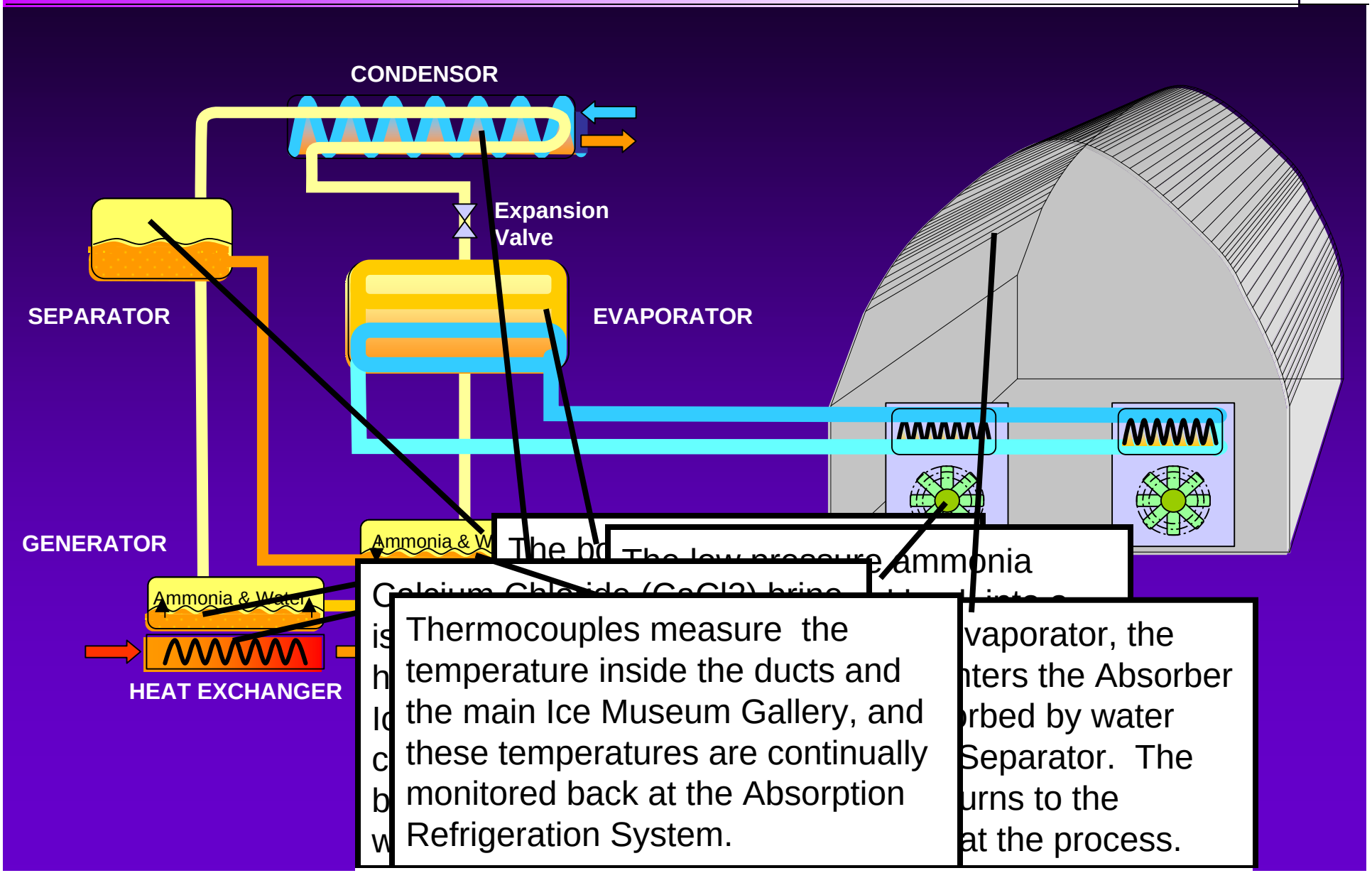
CHENA HOT SPRINGS ABSORPTION CHILLER

Monument Creek Provides Cooling Water (~40F)

Geothermal Wells Provide Hot Water (~165F)

Approximately 15 tons of Refrigeration Required for Ice Museum (180 BTU per hour)

CHENA HOT SPRINGS ABSORPTION CHILLER



CHENA HOT SPRINGS ABSORPTION CHILLER

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ABSORPTION CHILLER

Cold Water Pump	10hp
Hot Water Pump	10hp
System Pumps	2-1/2hp
CaCl2 Pump	1-1/2hp
Air Handler	20hp
TOTAL	**44hp**

BACKUP UNIT

Operation	107hp
Circulating pump	10hp
CaCl2 Pump	1-1/2hp
Air Handler	20hp
TOTAL	**148hp**

THE BOTTOM LINE

ABSORPTION CHILLER

kWhr Used	50kW
Fuel Cost	$180.00
Operational Cost	**$300.00**

BACKUP UNIT

kWhr Used	150kW
Fuel Cost	$540.00
Operational Cost	**$900.00**

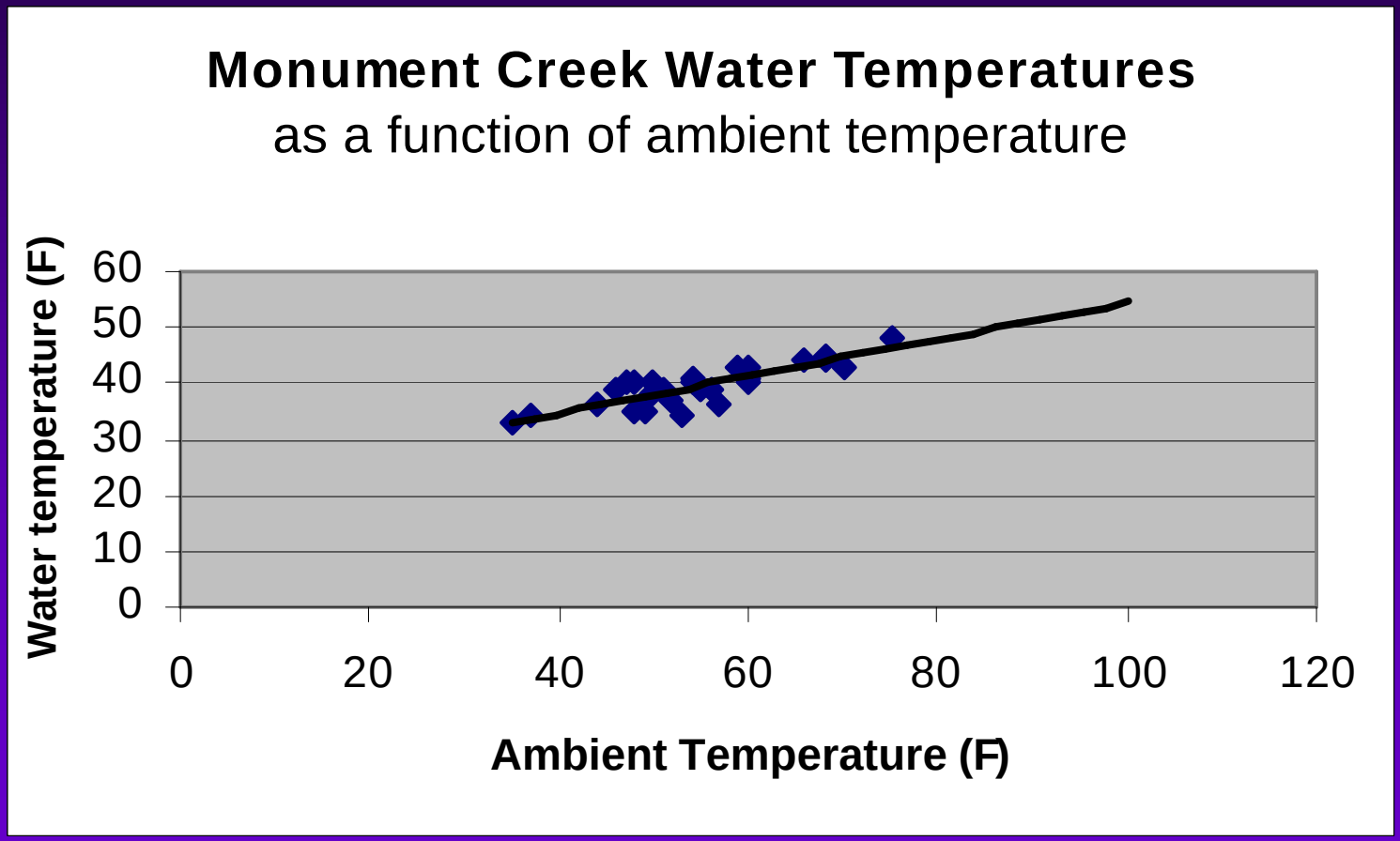
Operating cost per day

SYSTEM CHALLENGES

Challenges associated with the defrost system for the air handlers

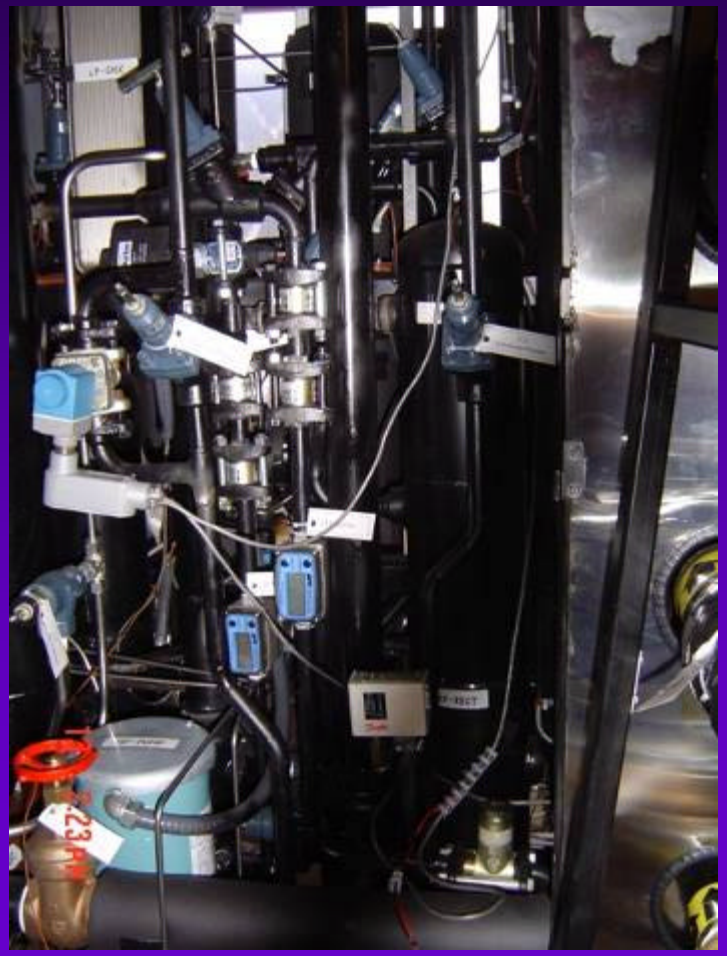
SYSTEM CHALLENGES

Inconsistent cooling water temperatures



SYSTEM CHALLENGES

Challenges of Working With a Prototype Unit



CONCLUSIONS

Is Absorption Chilling viable for low temperature geothermal or other low grade waste heat applications?

FROM THE GEOTHERMAL ENGINEERING HANDBOOK PUBLISHED BY THE O.I.T GEO-HEAT CENTER:

‘Substantial derating factors must be applied to equipment at temperatures less than 220F. Very high source temperatures or two-stage systems are required for low temperature refrigeration.’

YES

CHENA HOT SPRINGS RESORT

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