Cascade Energy®

ENERGY EFFICIENCY IN INDUSTRIAL REFRIGERATION SYSTEMS

Presented by:

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DOWN ON THE FARM

HOW MANY CHICKENS DO WE EAT *PER HOUR* IN THE U.S.?

a. 1,000

b. 10,000

c. 100,000

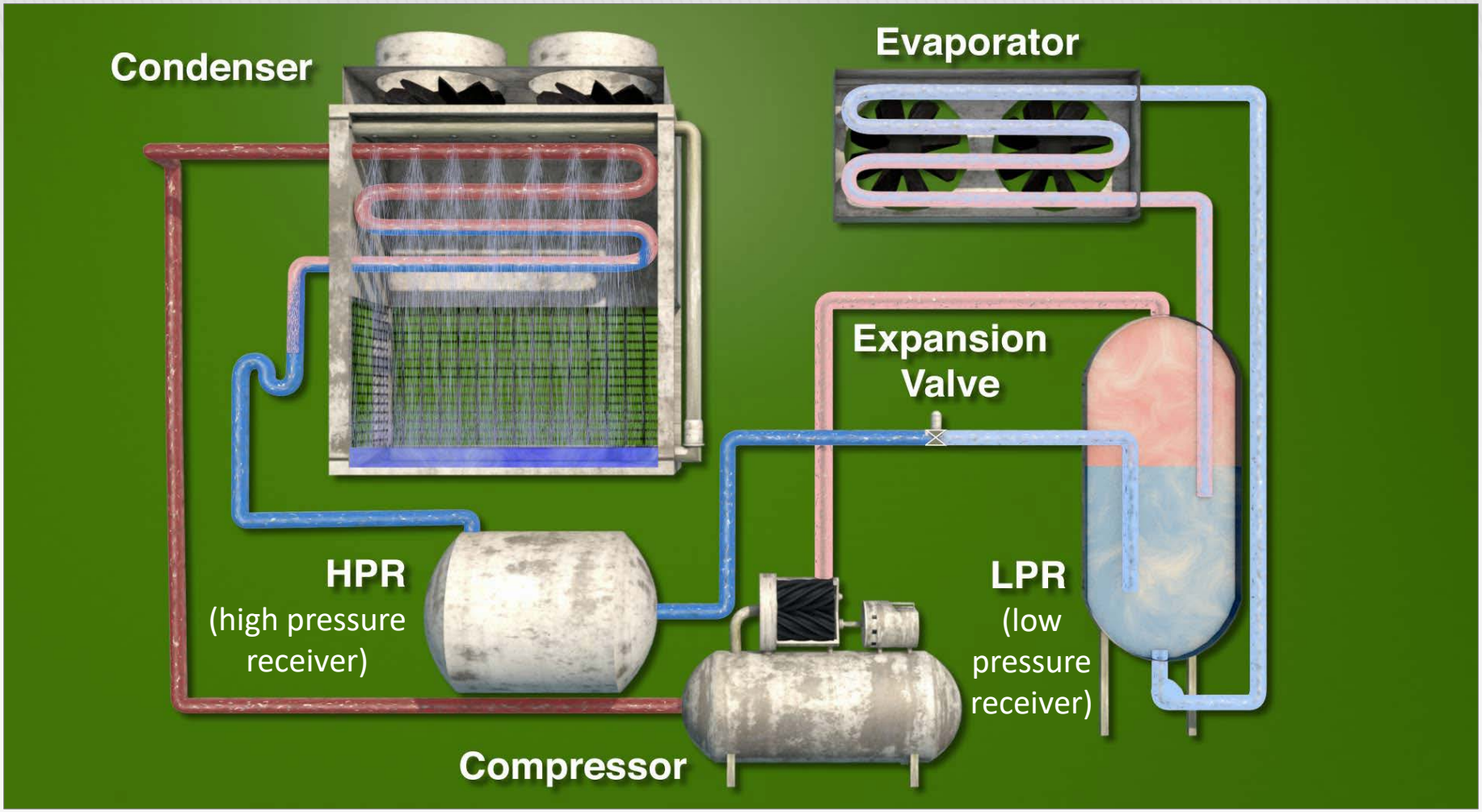
d. 1,000,000

BLAST FREEZER

INDUSTRIAL REFRIGERATION USES

- Refrigerated storage
  - Frozen
  - Unfrozen
- Blast freezing
- Food processing
- Freeze drying

SIMPLE AMMONIA OVERFEED SYSTEM



WHERE IS THE ENERGY USED?

65%

15%

15%

5%

ARE WE TALKING NEW OR EXISTING SYSTEMS?

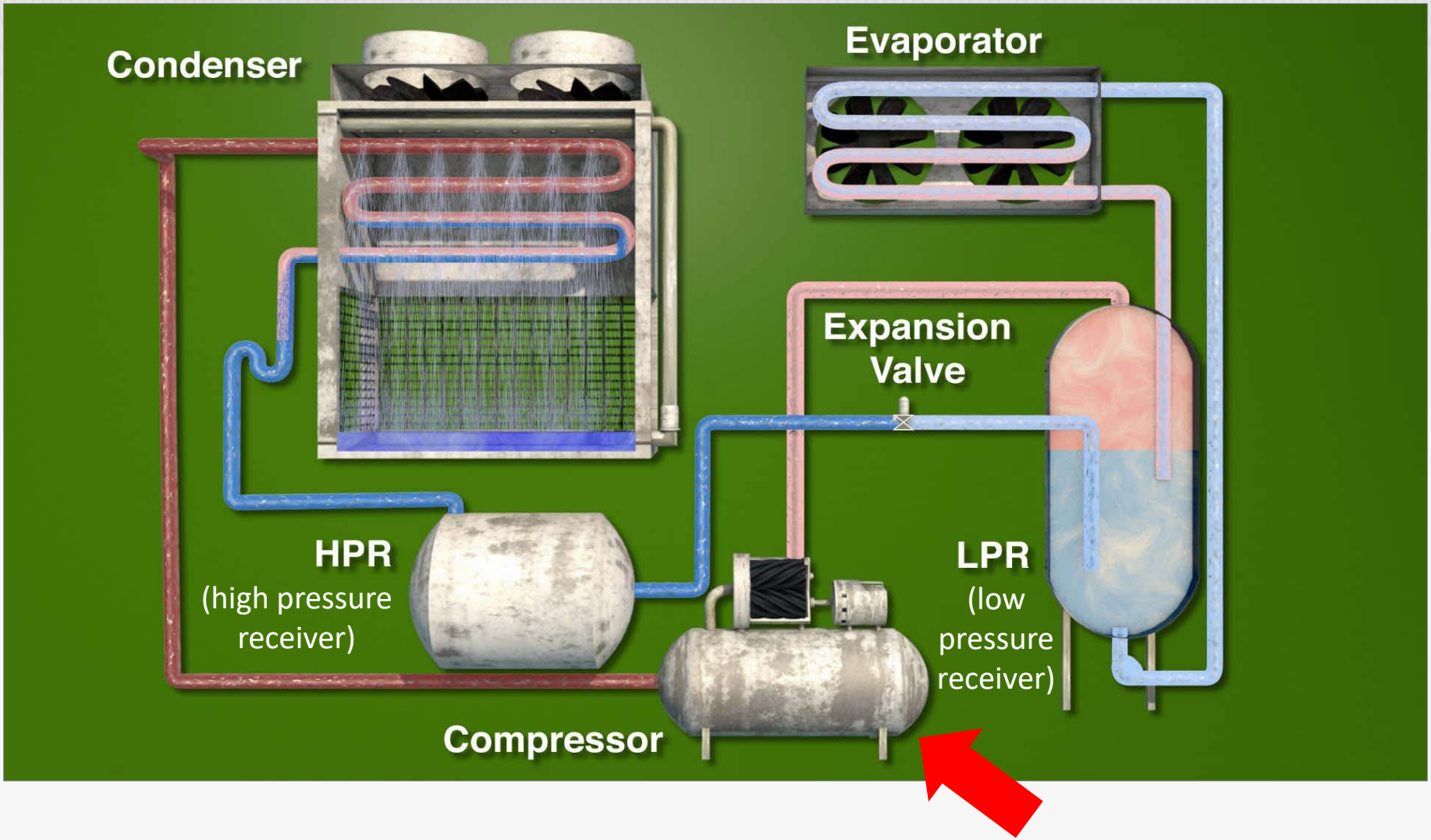
Both.

The concepts discussed in this presentation apply to both new and existing systems.

COMPRESSORS

Usually there's a few of them

WHAT ARE SOME TYPICAL EE OPPORTUNITIES?



MINIMIZE LIFT TO IMPROVE EE

Lift = condensing pressure minus suction pressure

- Minimize condensing pressure
  - 1.5% compressor energy savings per °F decrease in condensing temperature
- Maximize suction pressure
  - 2% compressor energy savings per °F increase in suction temperature

CONDENSING PRESSURE – HOW LOW CAN YOU GO?

Common limits:

- Hot gas defrost
- Heated zones
- Icing or other winter issues
- Water defrost and common sump
- Oil separator performance
- Gas-powered valves or unloaders
- Liquid injection oil cooling
- Screw compressor oil carryover
- Underfloor heating
- Pumper drum operation
- Direct expansion coils
- Process or door hot gas
- Inadequate liquid pressure to serve loads
- Condenser fan and pump energy concerns
- Misperceptions about volume ratio and efficiency
- Tradition

SUCTION PRESSURE – HOW HIGH CAN YOU GO?

Limits:

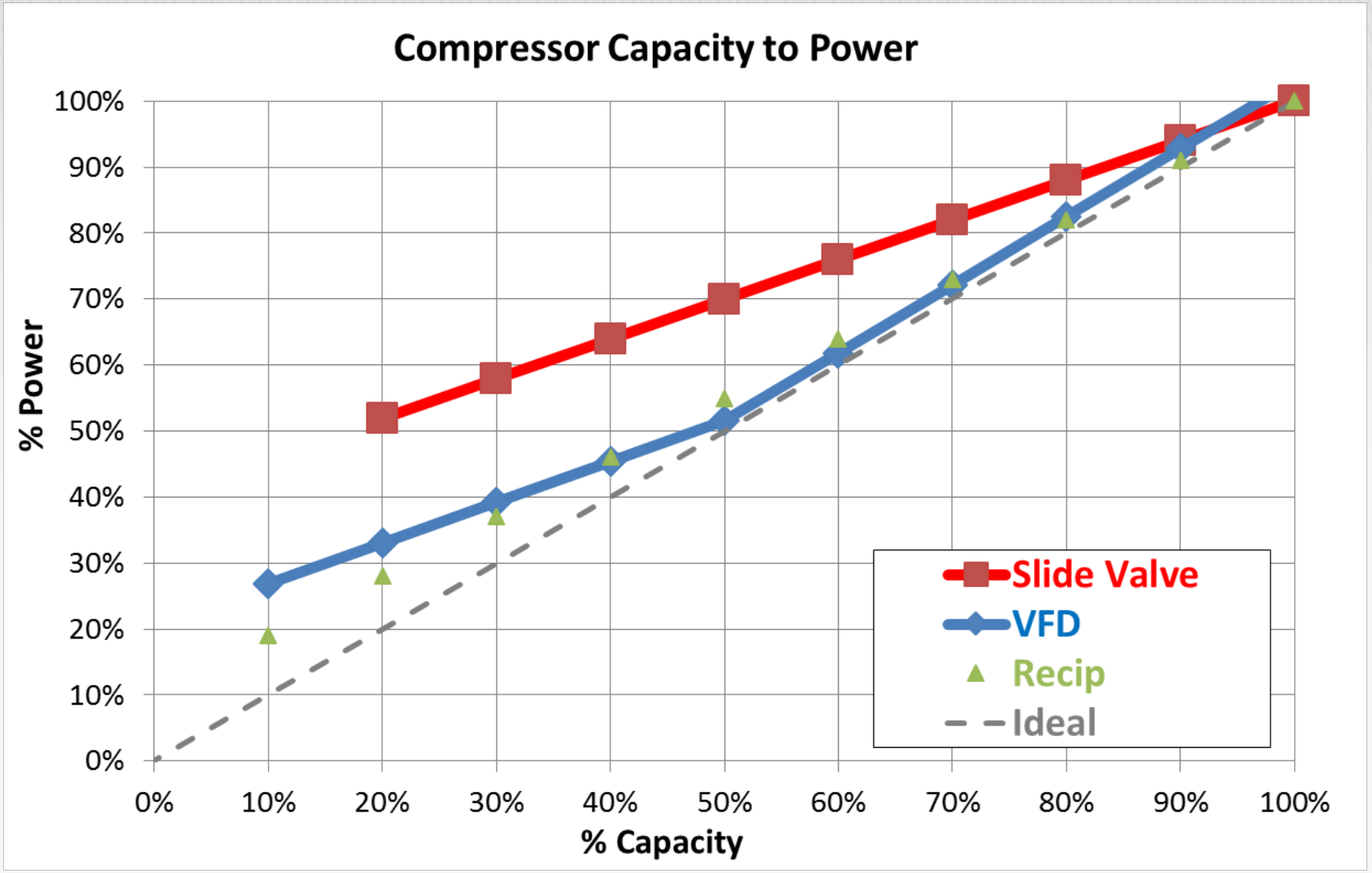
- Room temperature setpoint
- Evaporator design
- Piping restrictions

Example:

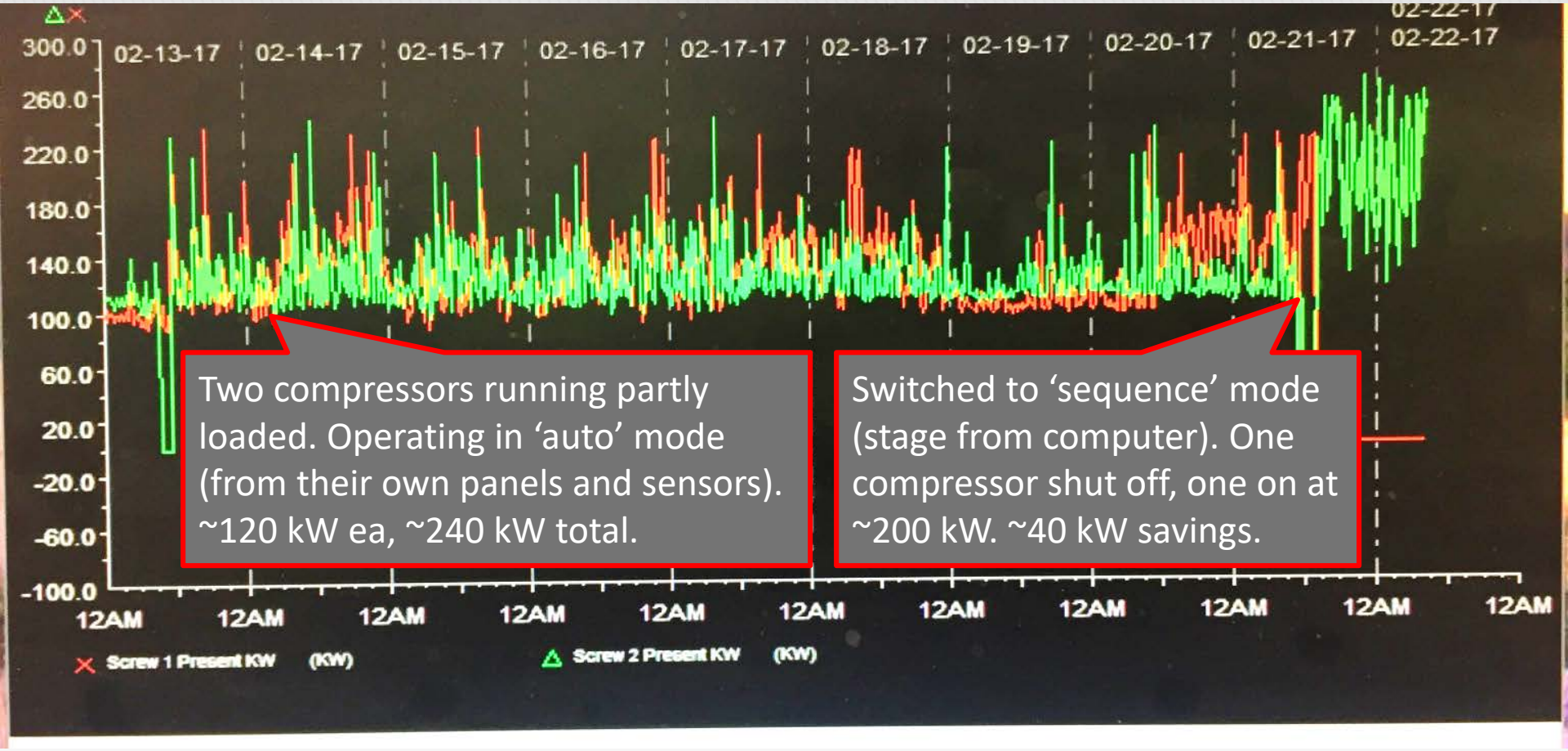
0°F room temperature setpoint,
evaporator TD = 10°F,
2°F piping losses.

Suction temperature =
0°F - 10°F - 2°F = -12°F.
-12°F ammonia = 8 psig.

COMPRESSOR PART LOAD PERFORMANCE



MINIMIZE NUMBER OF OPERATING COMPRESSORS



TOP LOW COST COMPRESSOR EE OPPORTUNITIES

- Optimize (minimize) condensing pressure
- Optimize (maximize) suction pressure
- Optimize compressor staging
- Calibrate sensors

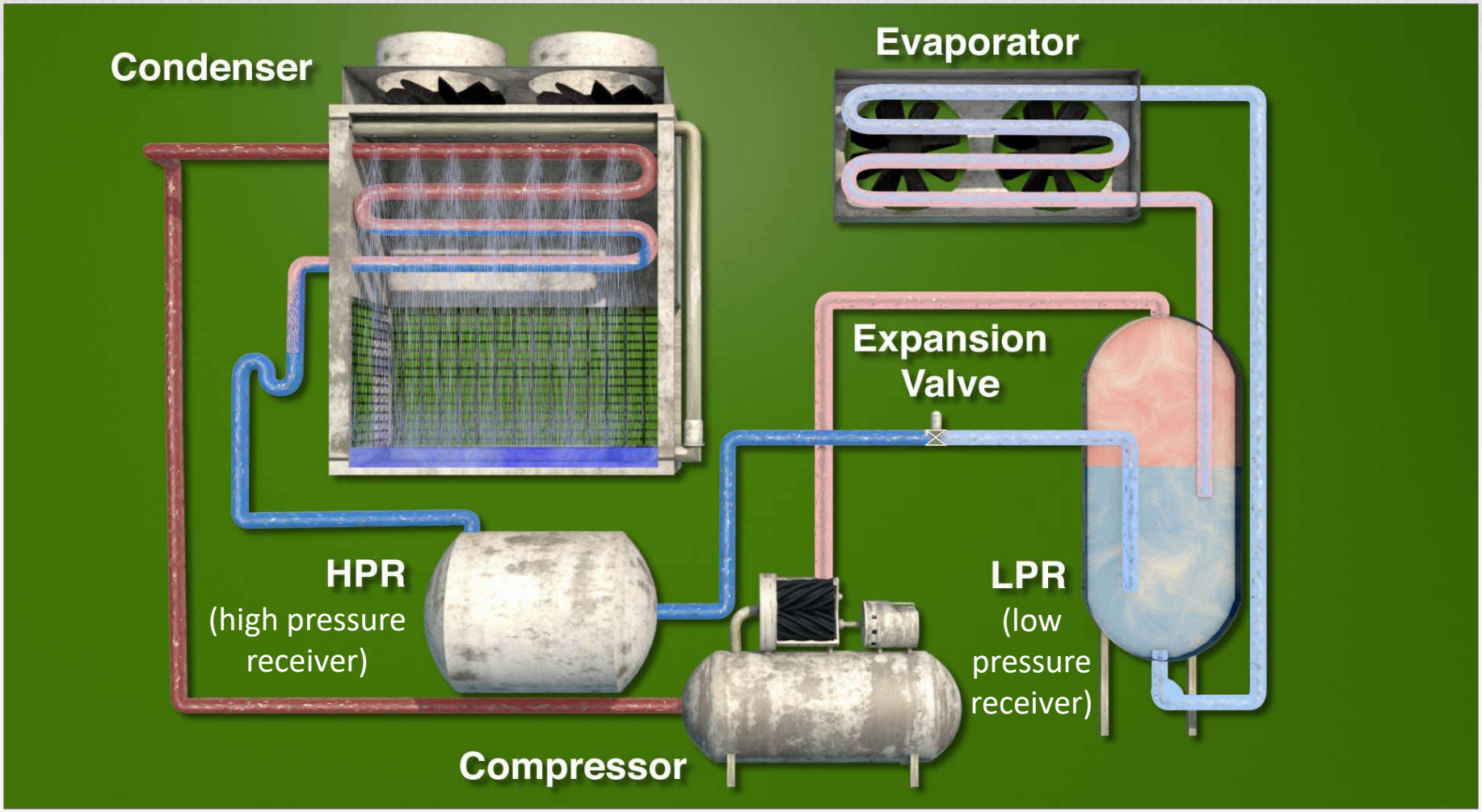
TOP CAPITAL COMPRESSOR EE OPPORTUNITIES

- Add VFD to compressor(s)
- Stage compressors from central control system
  - Trim with reciprocating or VFD screw compressors

CONDENSERS

Usually there's a few of them

SIMPLE AMMONIA OVERFEED SYSTEM



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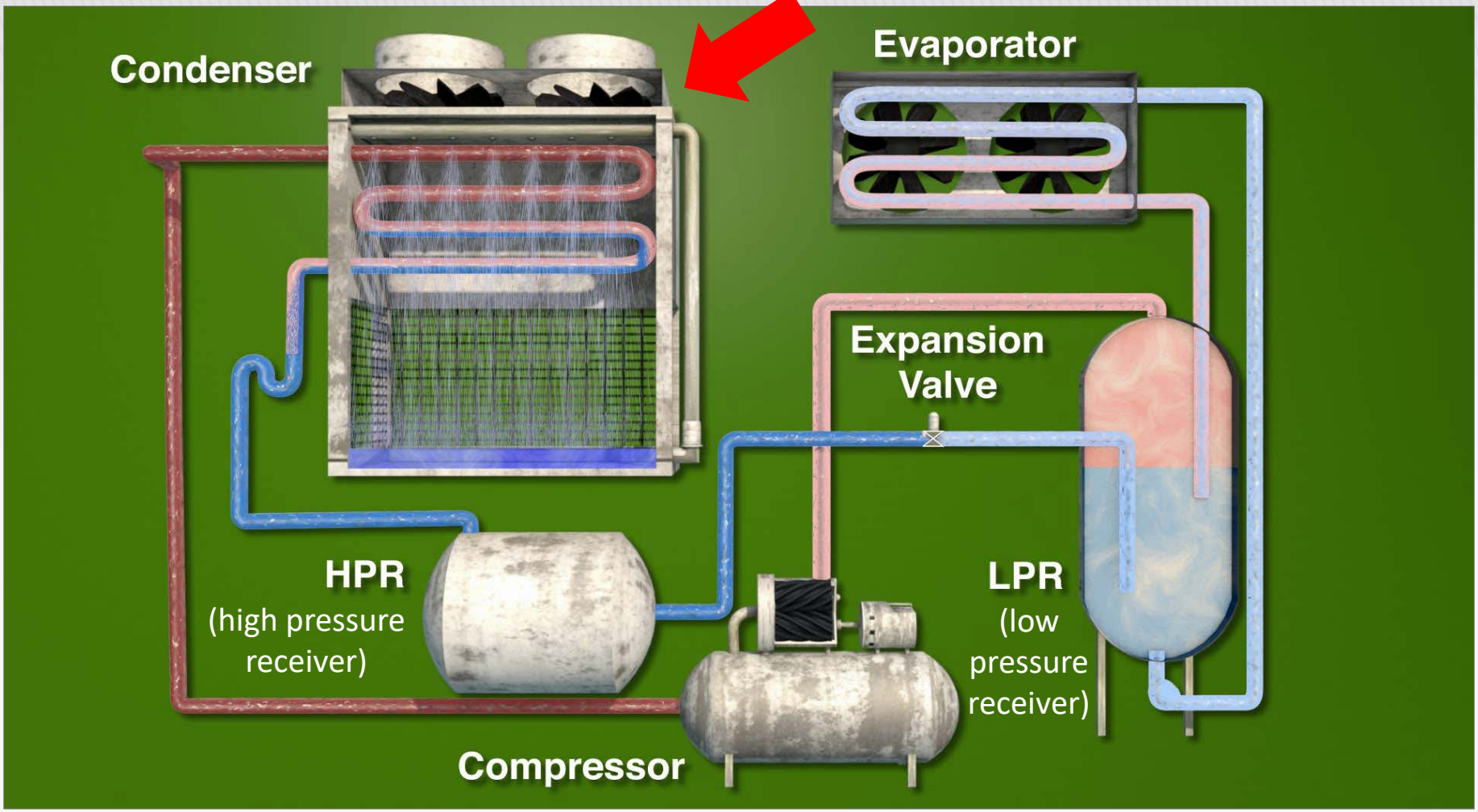


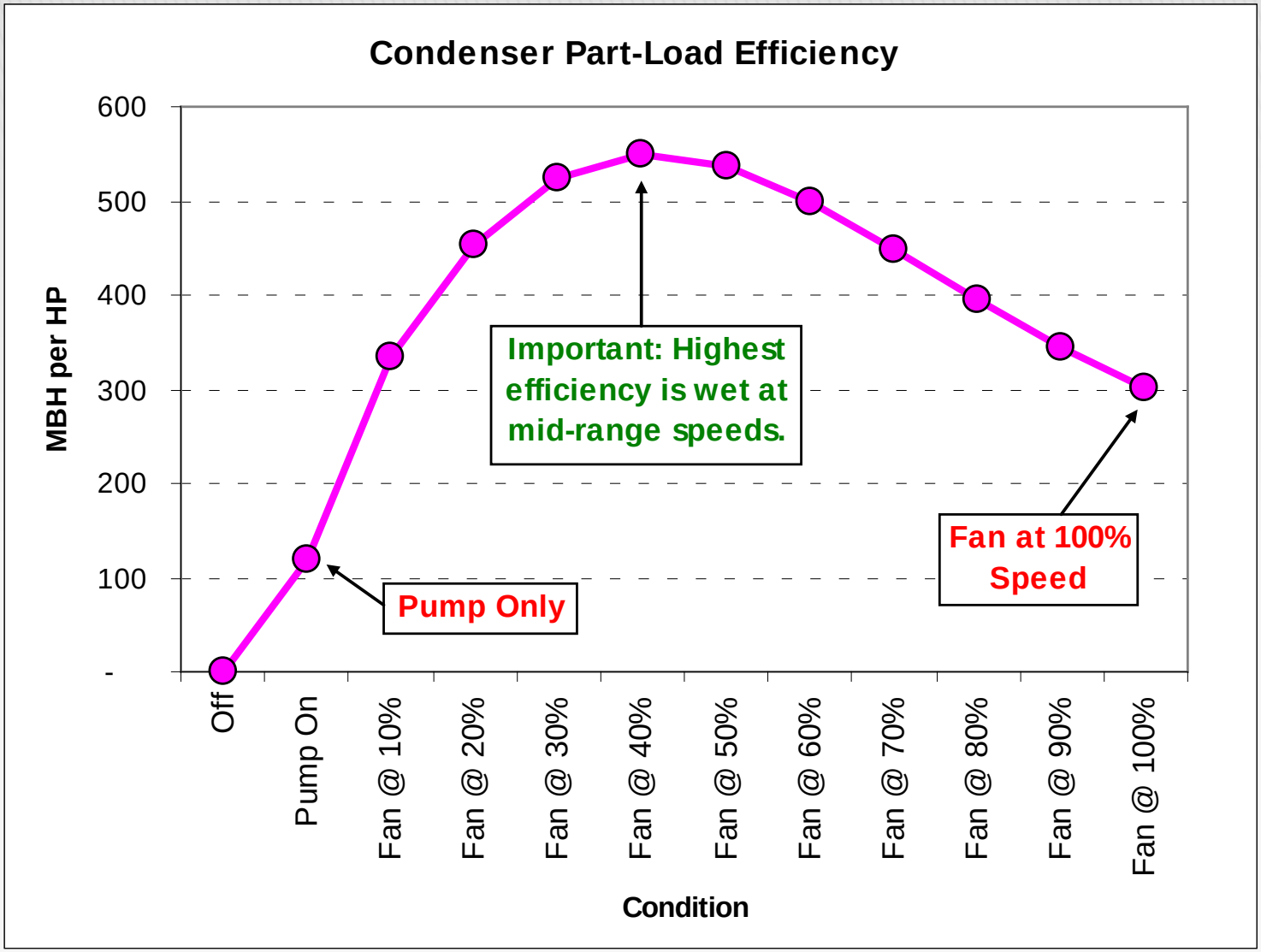
CONDENSER WATER DISTRIBUTION

Common issue: plugged nozzles

CONDENSER WATER DISTRIBUTION

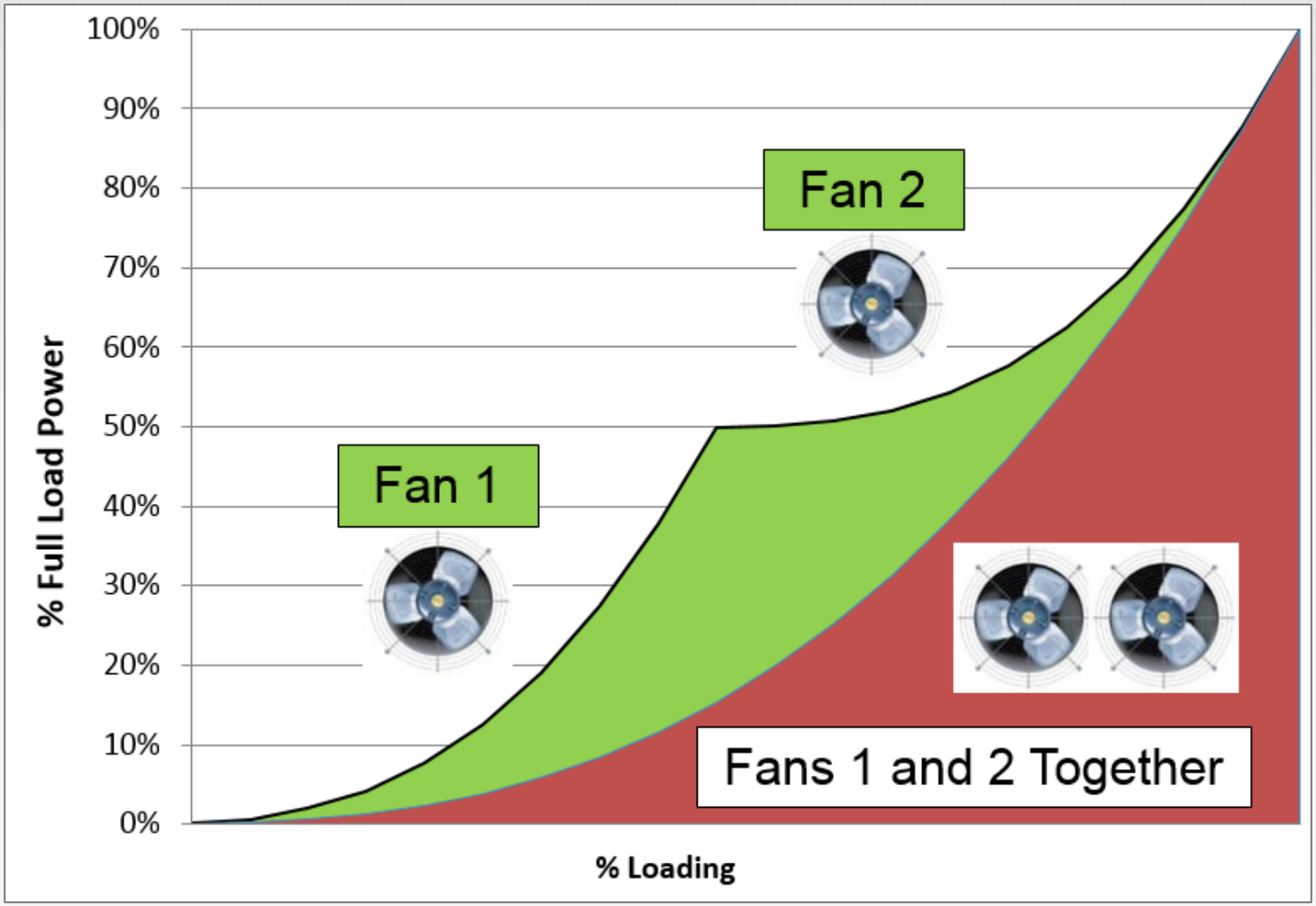
From bad to worse: plugged *and* missing nozzles

CONDENSER CAPACITY AND EFFICIENCY



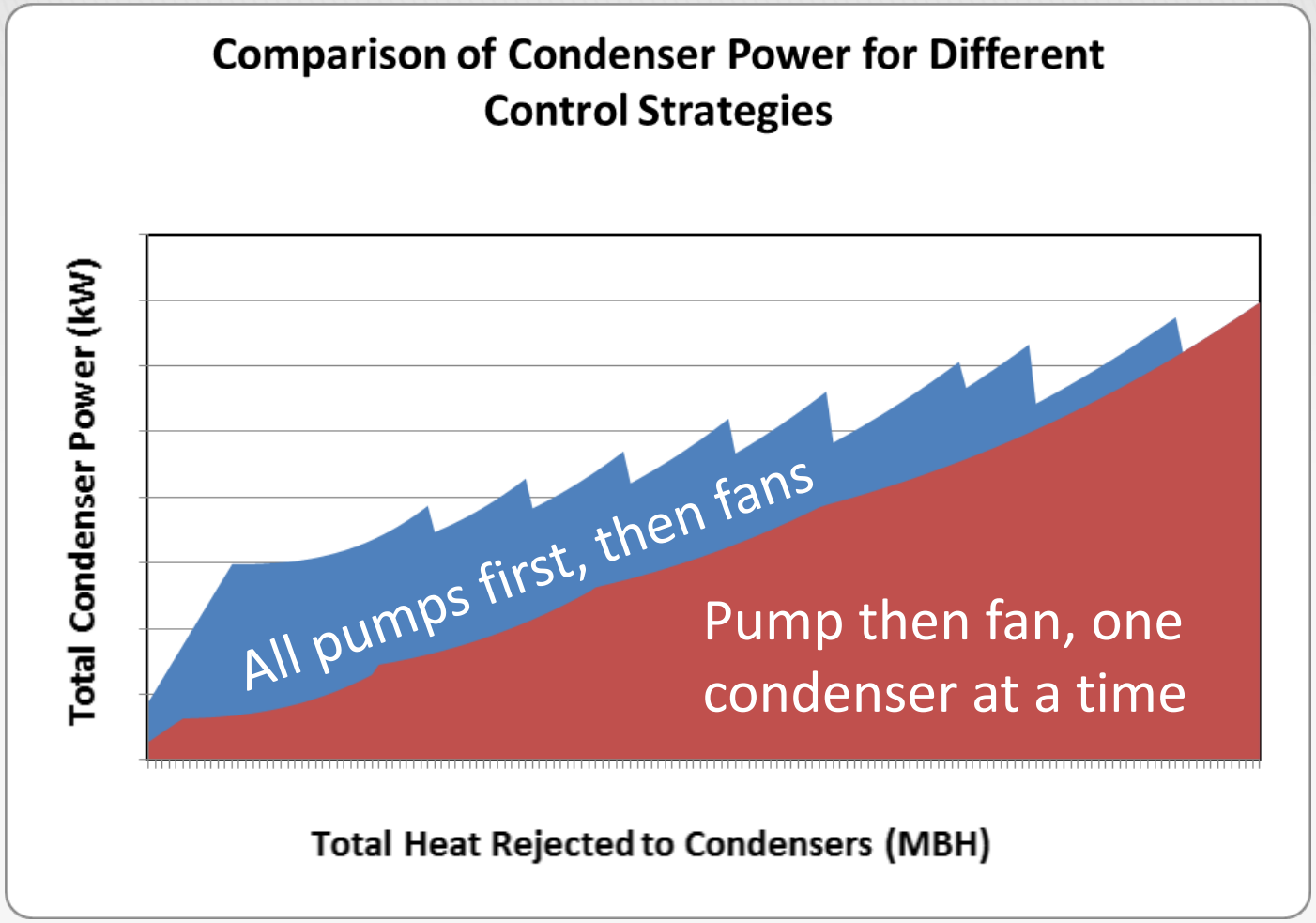
CONDENSER FAN CONTROL

Run all fans at the same speed



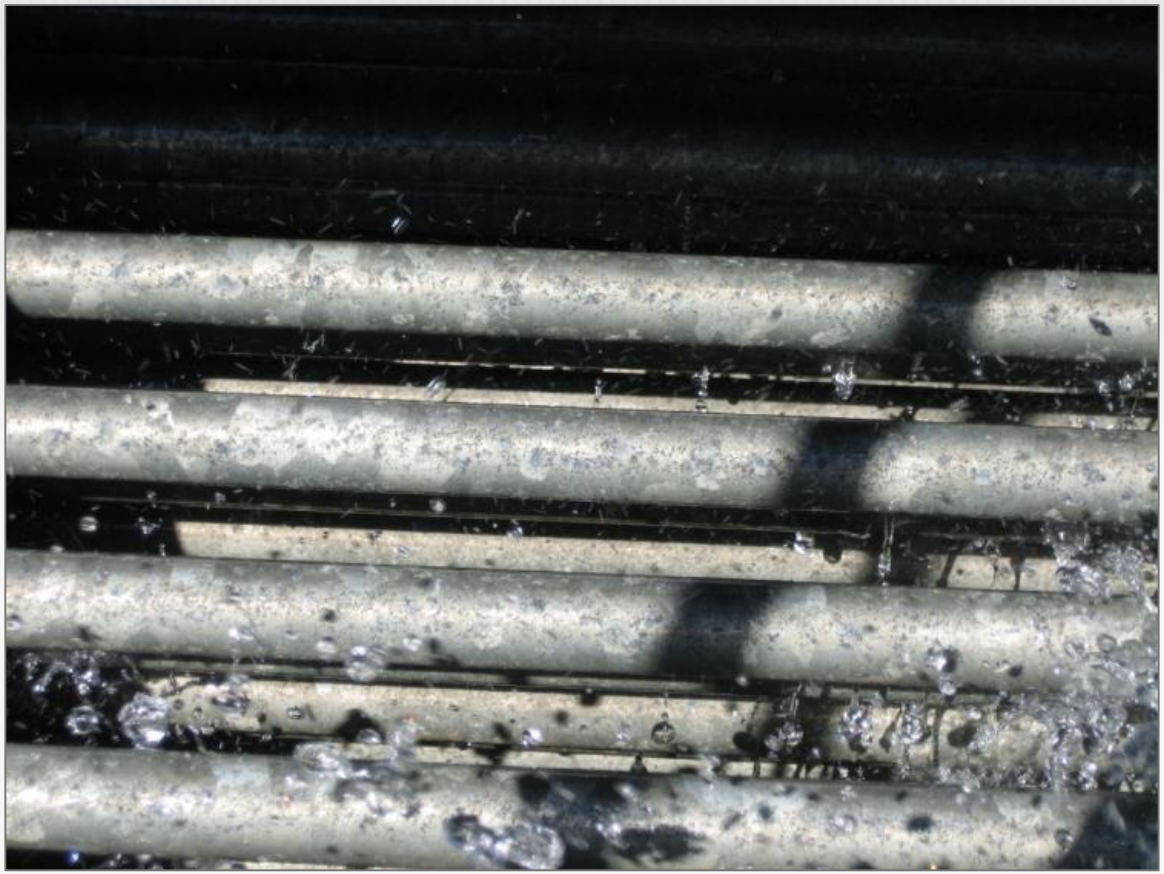
CONDENSER STAGING

Goal: wet coils and mid-range fan speeds



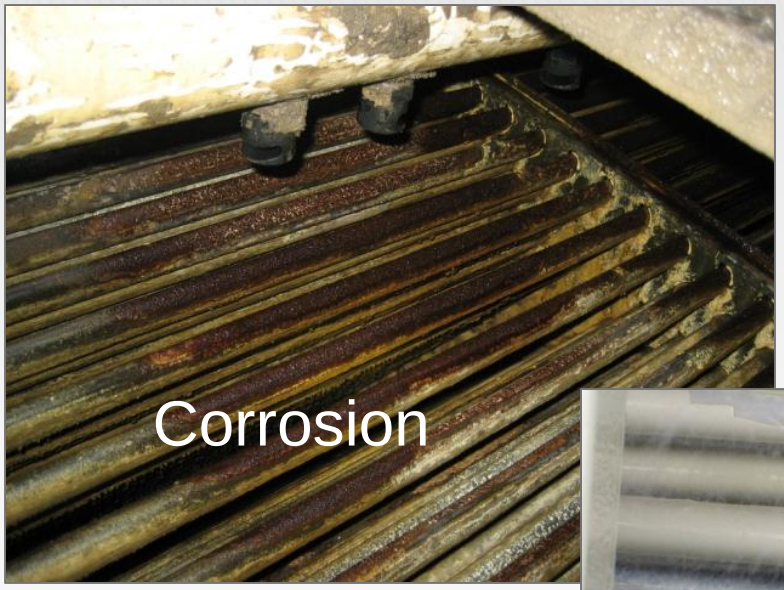
CONDENSER WATER TREATMENT

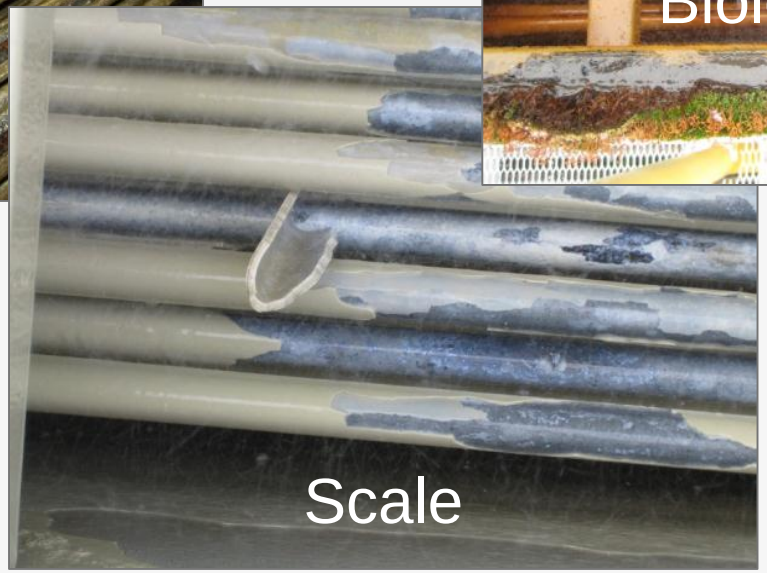
New condenser



CONDENSER WATER TREATMENT

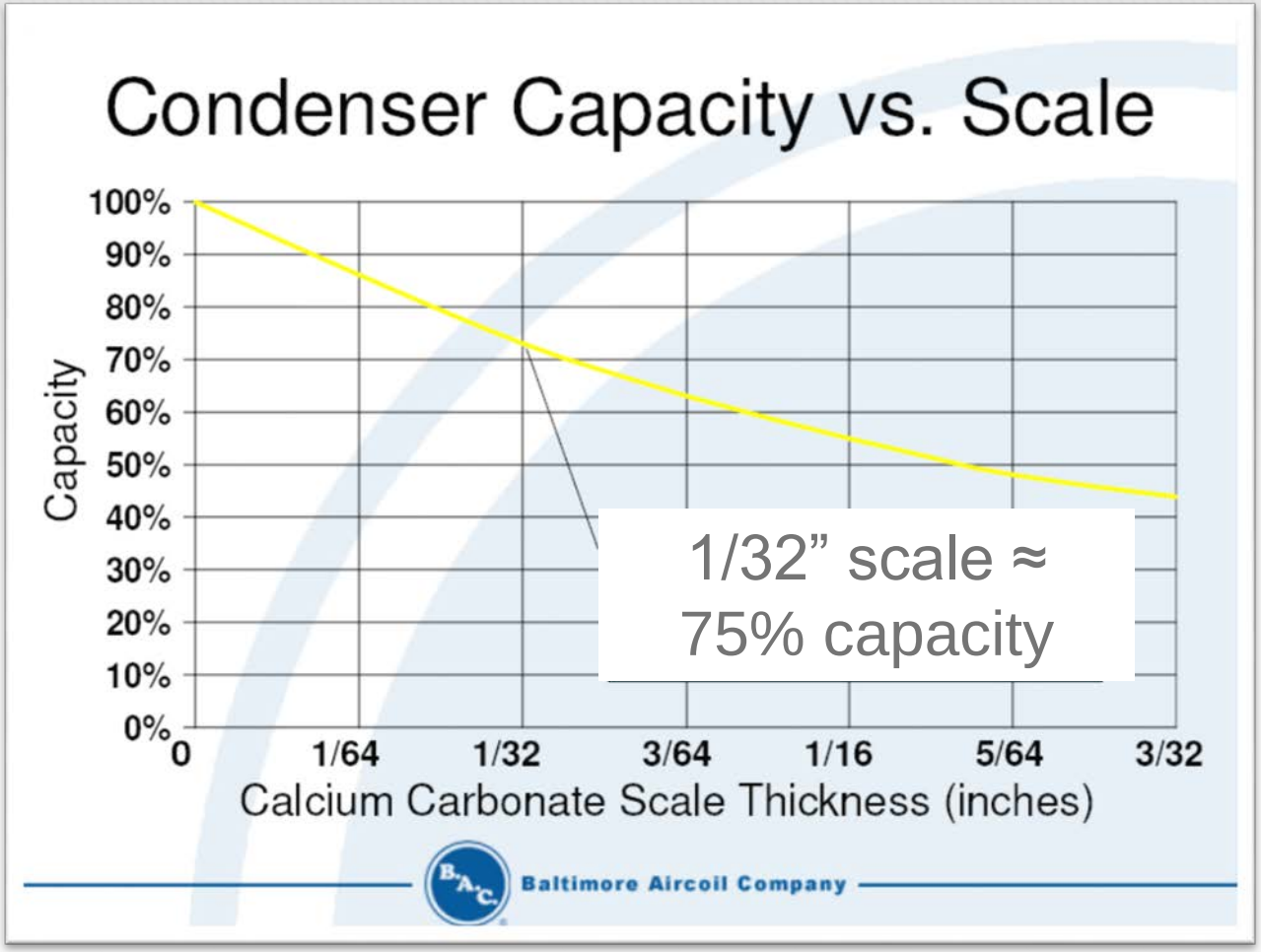
Results of bad water treatment





CONDENSER WATER TREATMENT

Impact of scale



TOP LOW COST CONDENSER EE OPPORTUNITIES

- Optimize water delivery (pumps and nozzles)
- Run the most efficient condenser first
- Optimize staging / part load performance
- Improve water treatment

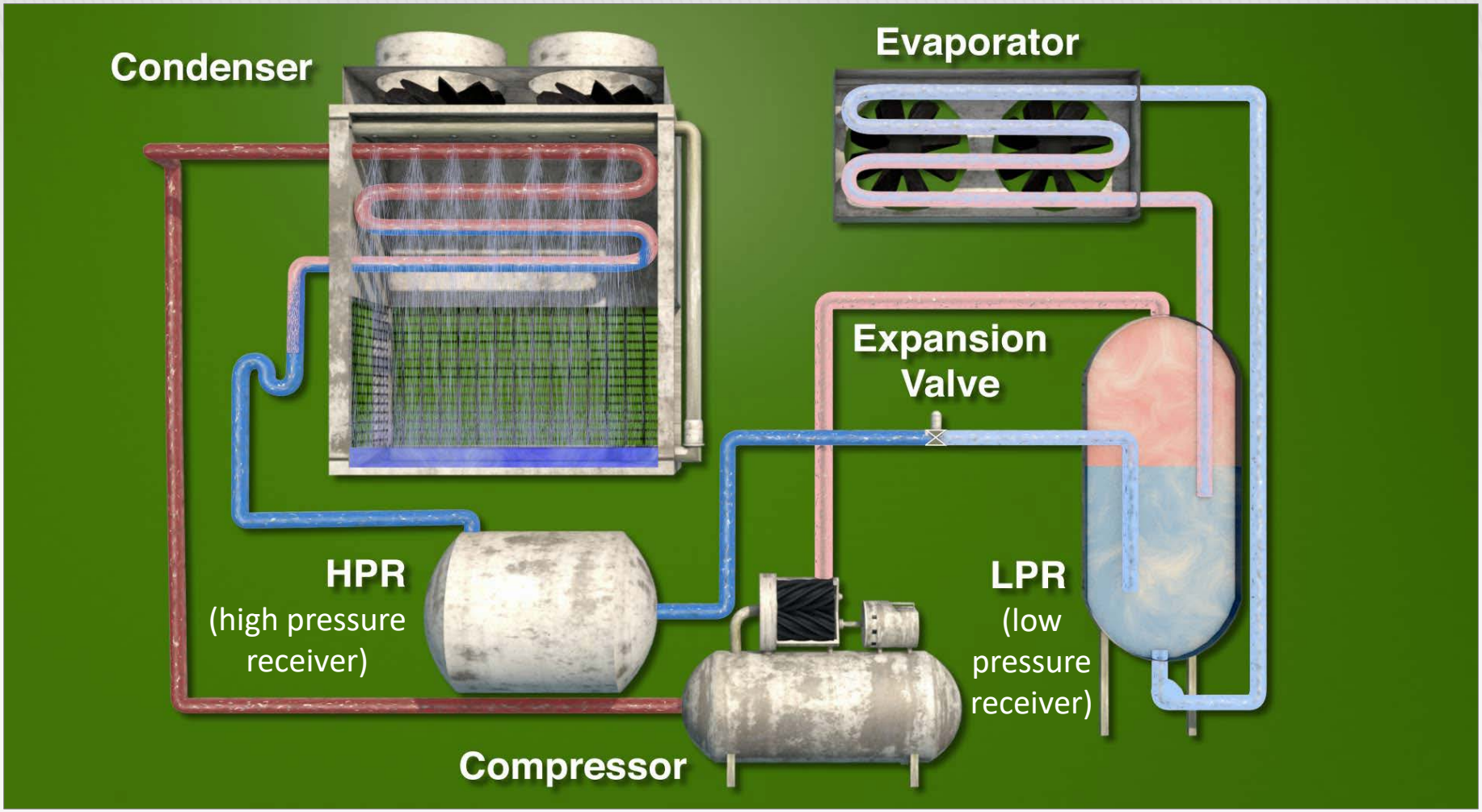
TOP CAPITAL CONDENSER EE OPPORTUNITIES

- Utilize wet bulb approach control of condensing pressure setpoint
- Add VFDs to condenser fans
- Stage condenser pumps and fans from central control system

EVAPORATORS

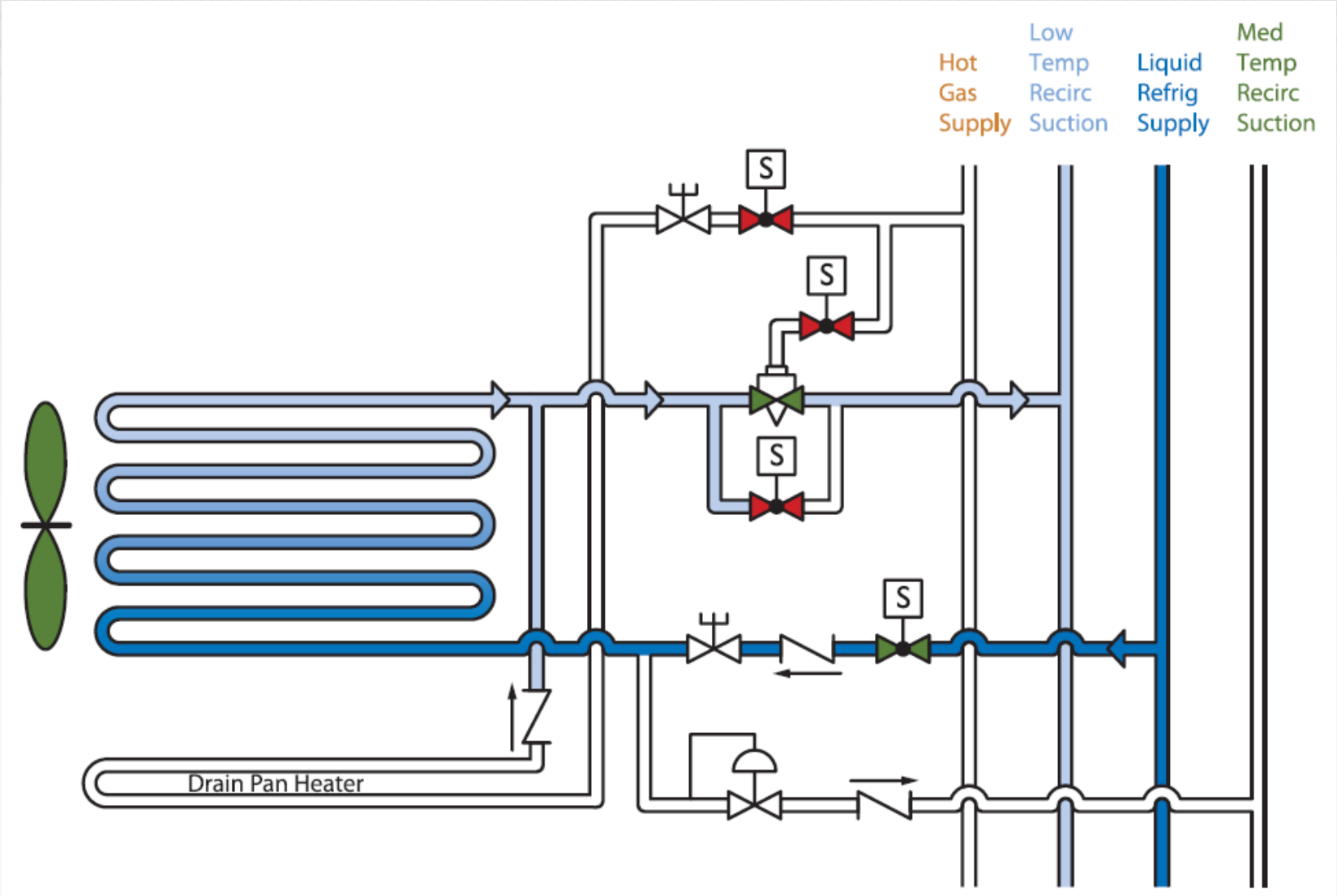
Usually there's a lot of them

SIMPLE AMMONIA OVERFEED SYSTEM



EVAPORATOR VALVE GROUPS ARE COMPLICATED

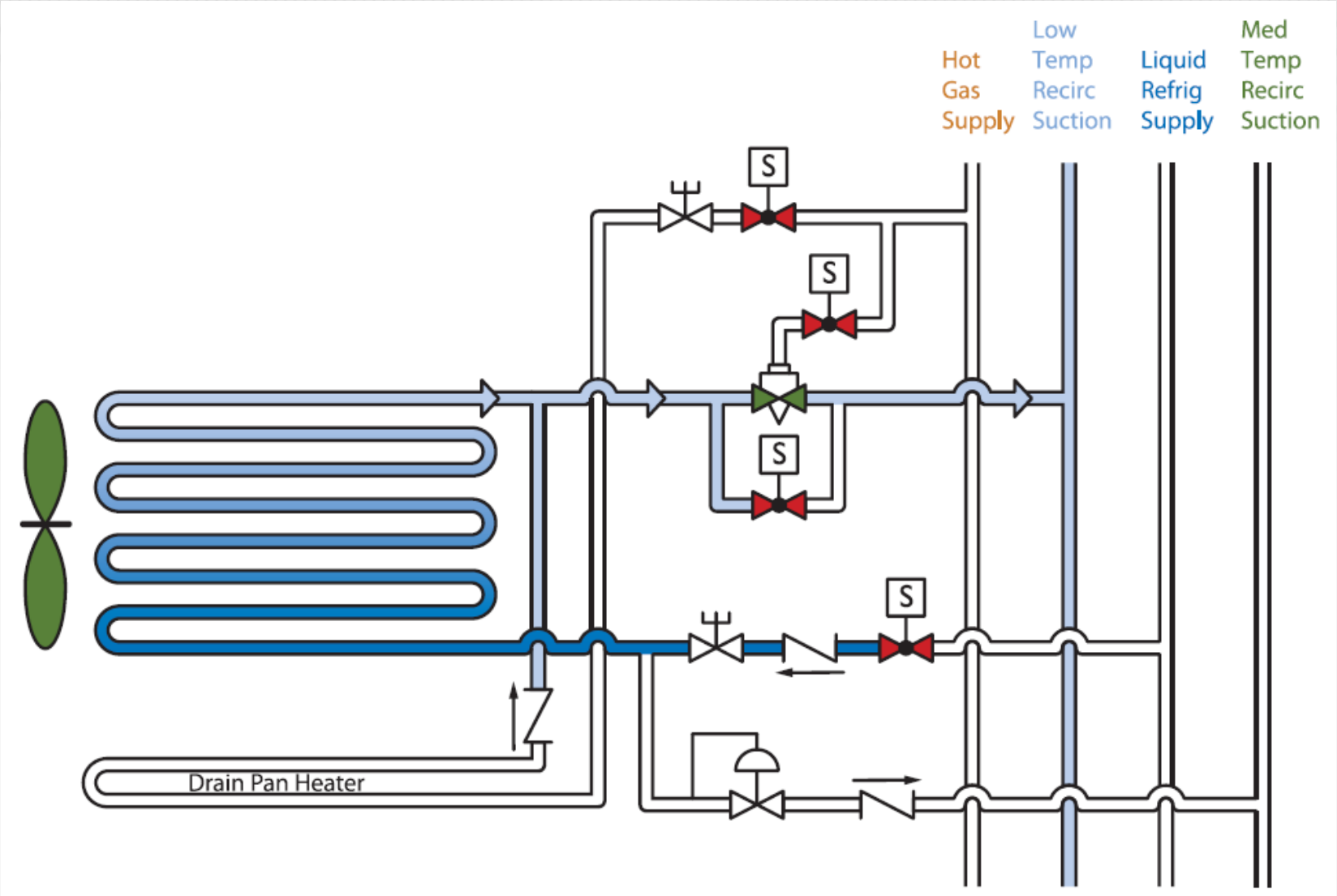
COOLING MODE



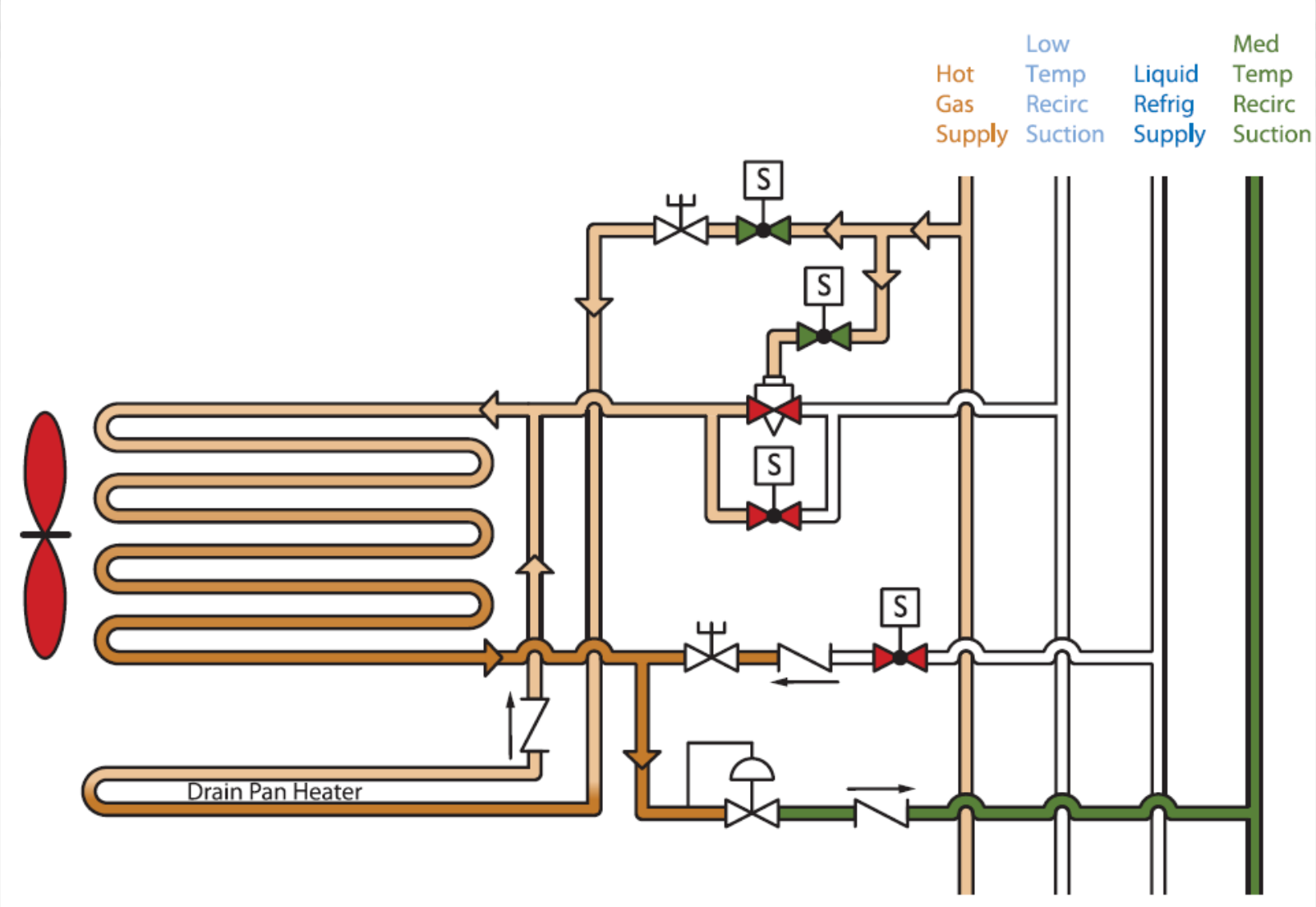
FROST HAPPENS

DEFROST TO THE RESCUE!

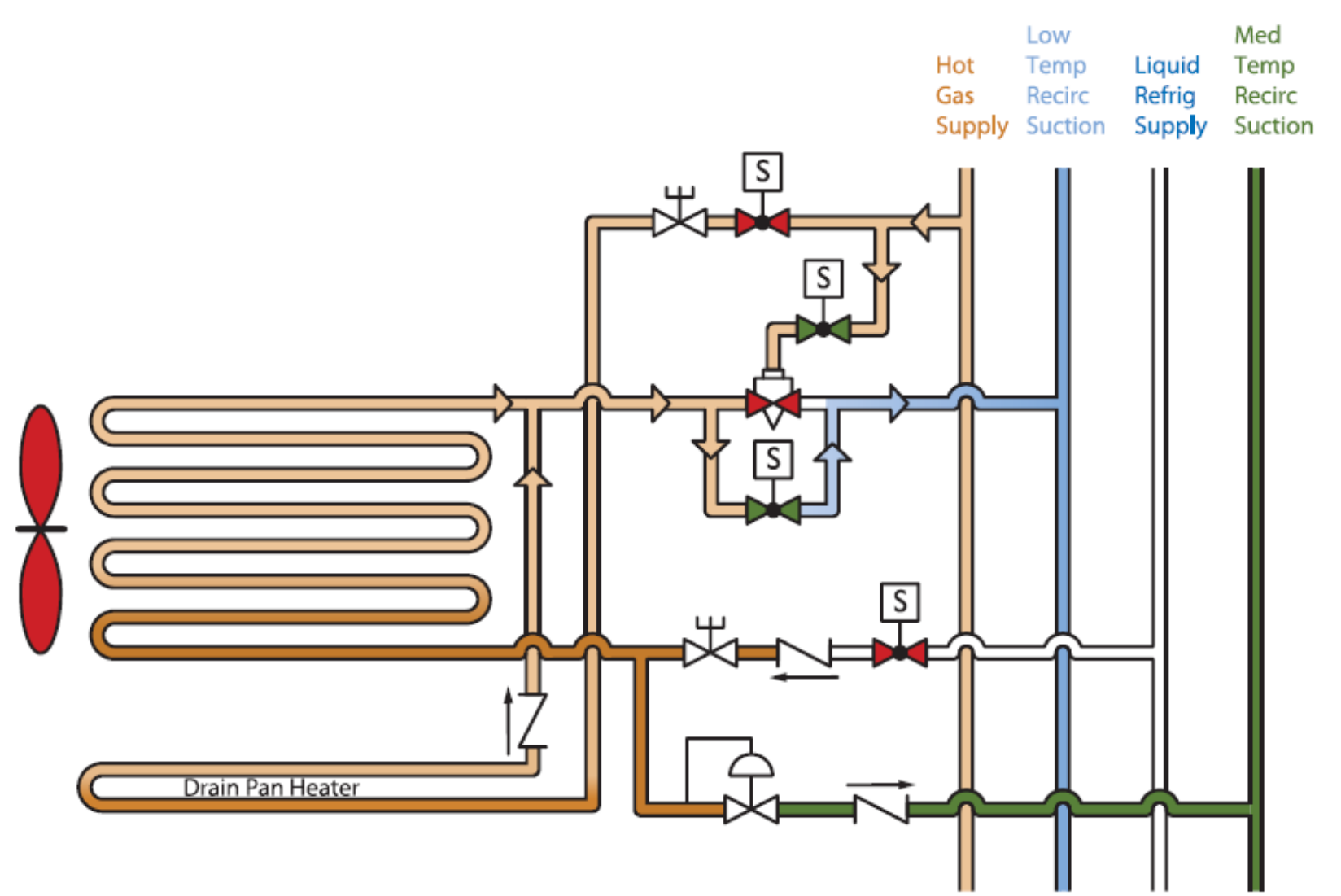
PUMP DOWN MODE (START OF DEFROST)



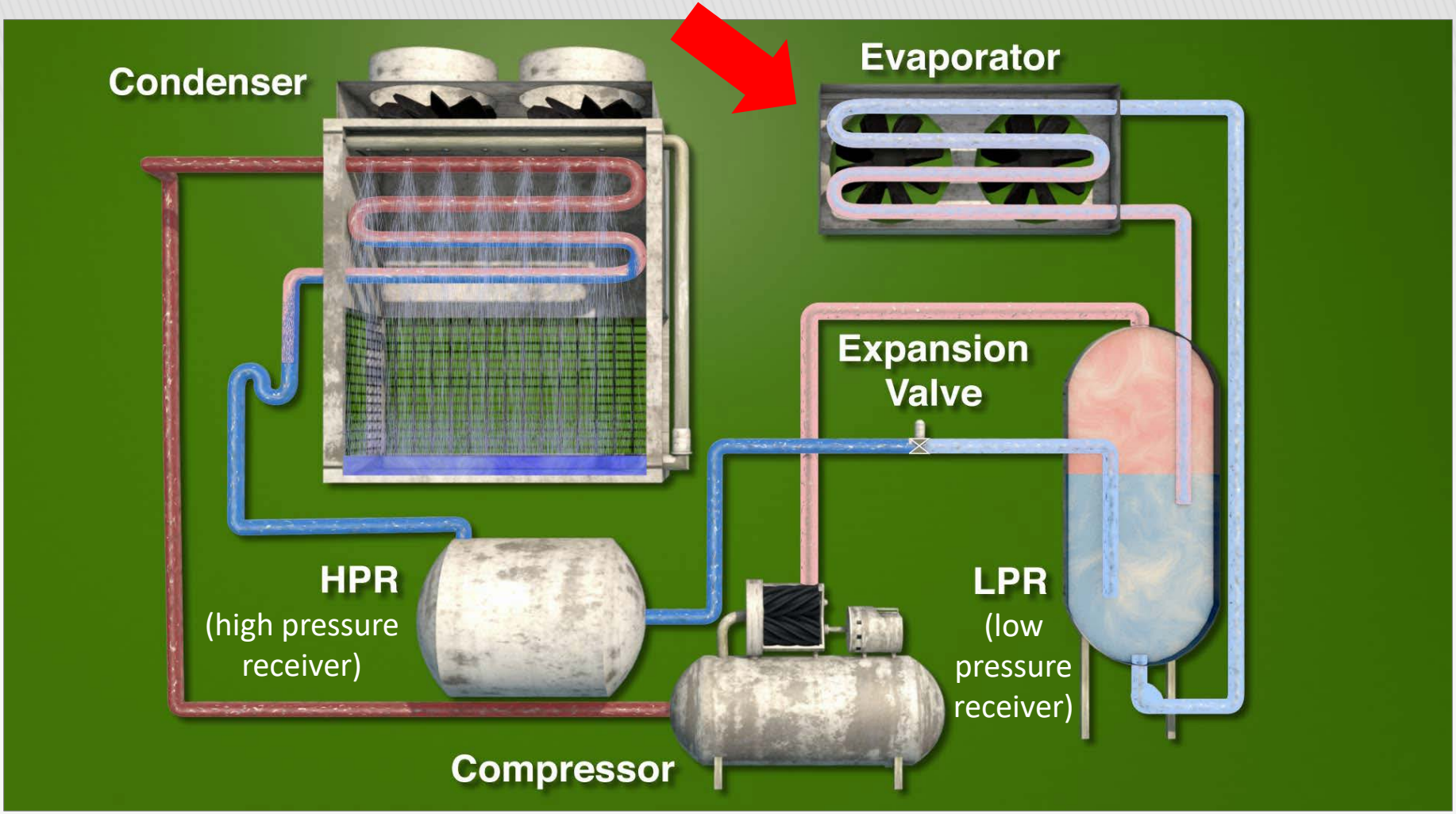
HOT GAS MODE



BLEED MODE (END OF DEFROST)

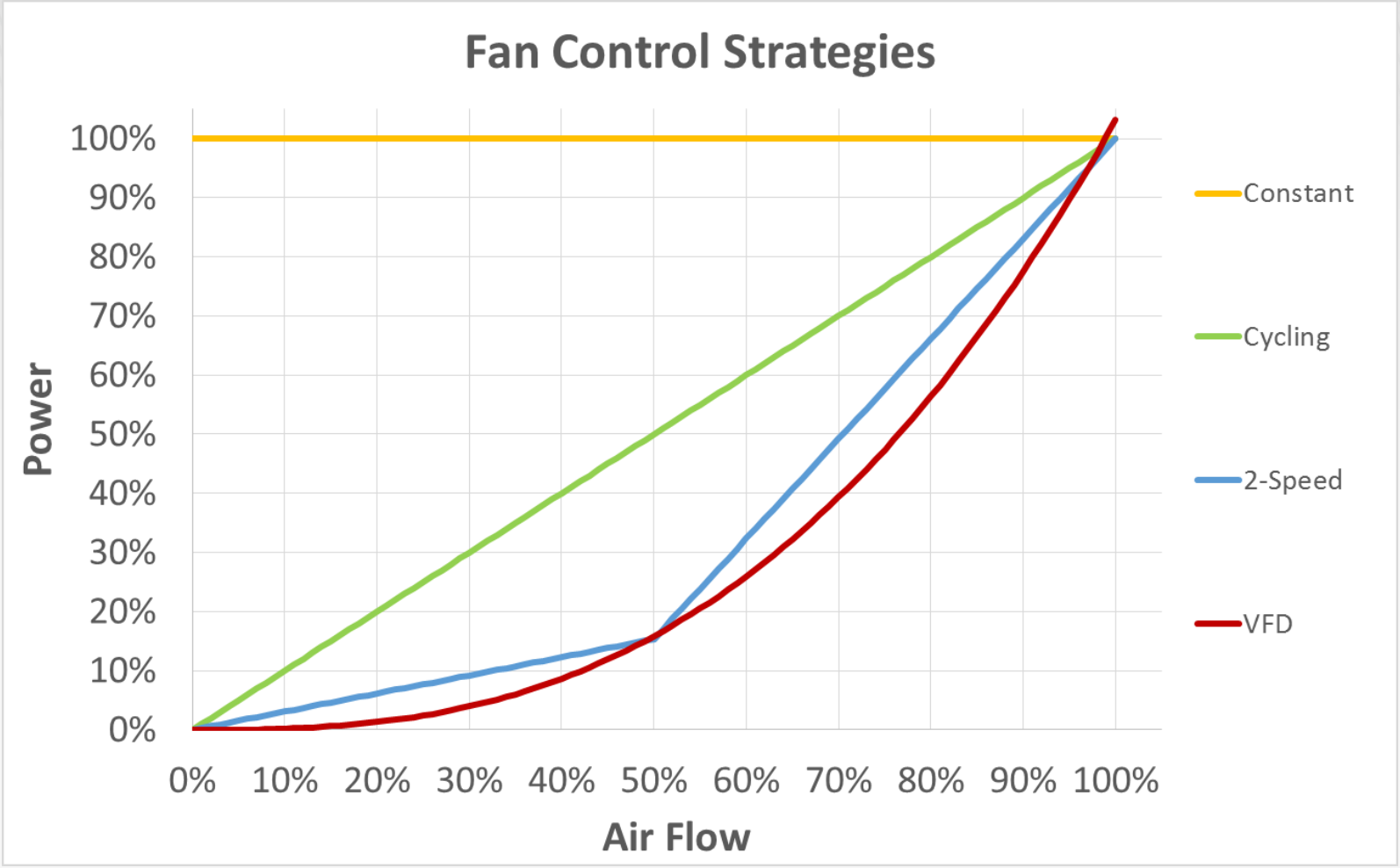


WHAT ARE SOME TYPICAL EE OPPORTUNITIES?

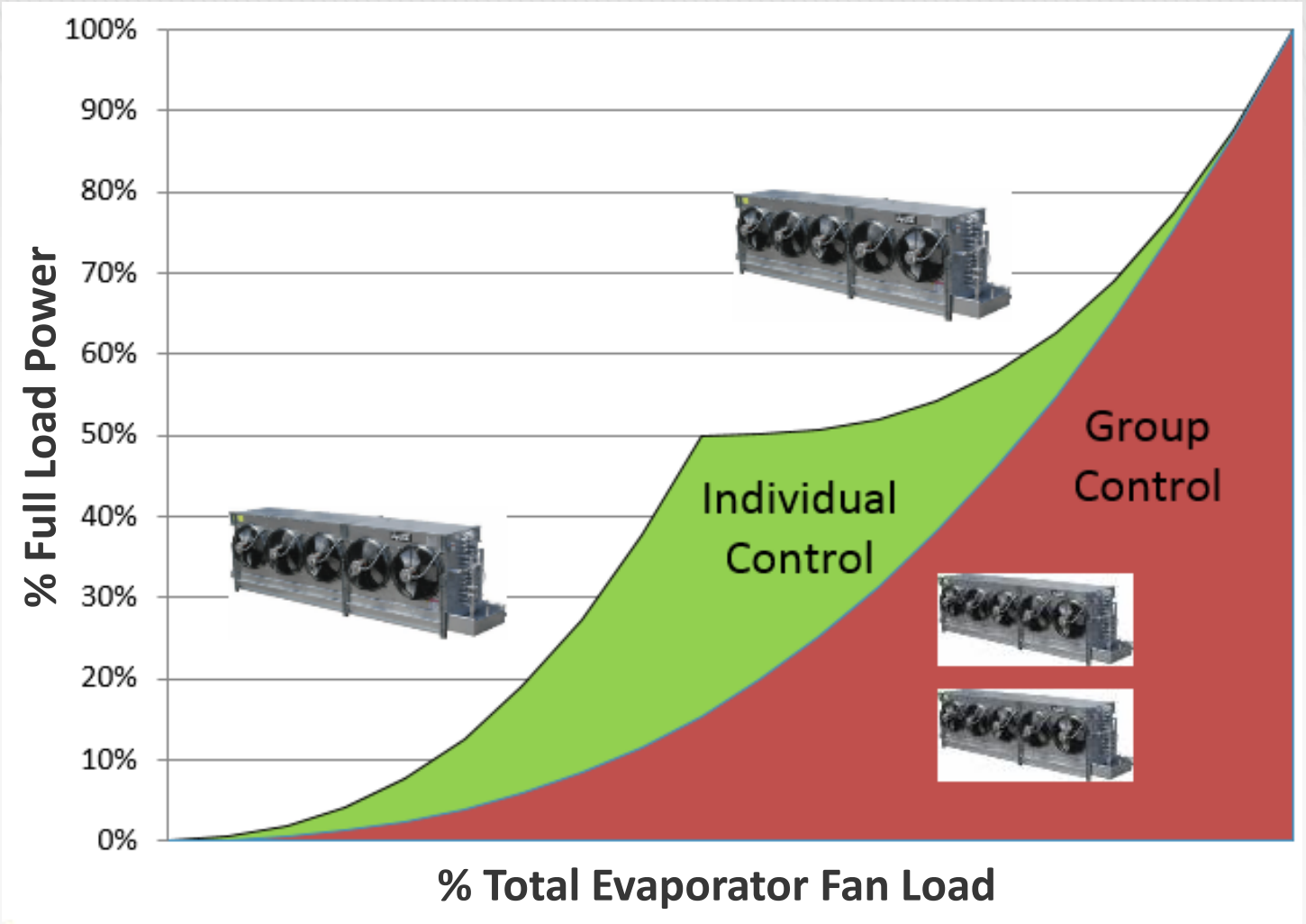


FIRST STEP: CLEAN THE COILS

EVAPORATOR FAN CONTROL



EVAPORATOR GROUP FAN CONTROL



EVAPORATOR CONTROL STRATEGIES

- Control fans first, then liquid
  - Cycle fans off when liquid is off
- Set minimum speed at 40-50%
- Set maximum speed at 80-90%
  - Only allow 100% if necessary

EVAPORATOR FAN/MOTOR/VFD ISSUES

- Burned-out fans (bypassing air)
- Fan blades installed backwards or turning in wrong direction
- VFD/motor problems (e.g., VFD bypasses)

ZONE TEMPERATURES AND SETPOINTS

- Are the temperature sensors reading accurately?
- Are the temperature setpoints appropriate?

ROOM	ZONE	SETPOINT GRP NUM	SETPOINT TEMP DEGF	ZONE TEMP DEGF
FRZR 3	8	G1	-2.0	-1.7
FRZR 4	9	G1	-2.0	-3.1
FRZR 2	5	G1	-2.0	-1.9
	6	G1	-1.5	
	7	G1	-2.0	
FRZR 1	14	G1	-1.0	-2.0
	15	G1	-1.5	
	16	G1	-2.0	
	17	G1	-1.5	

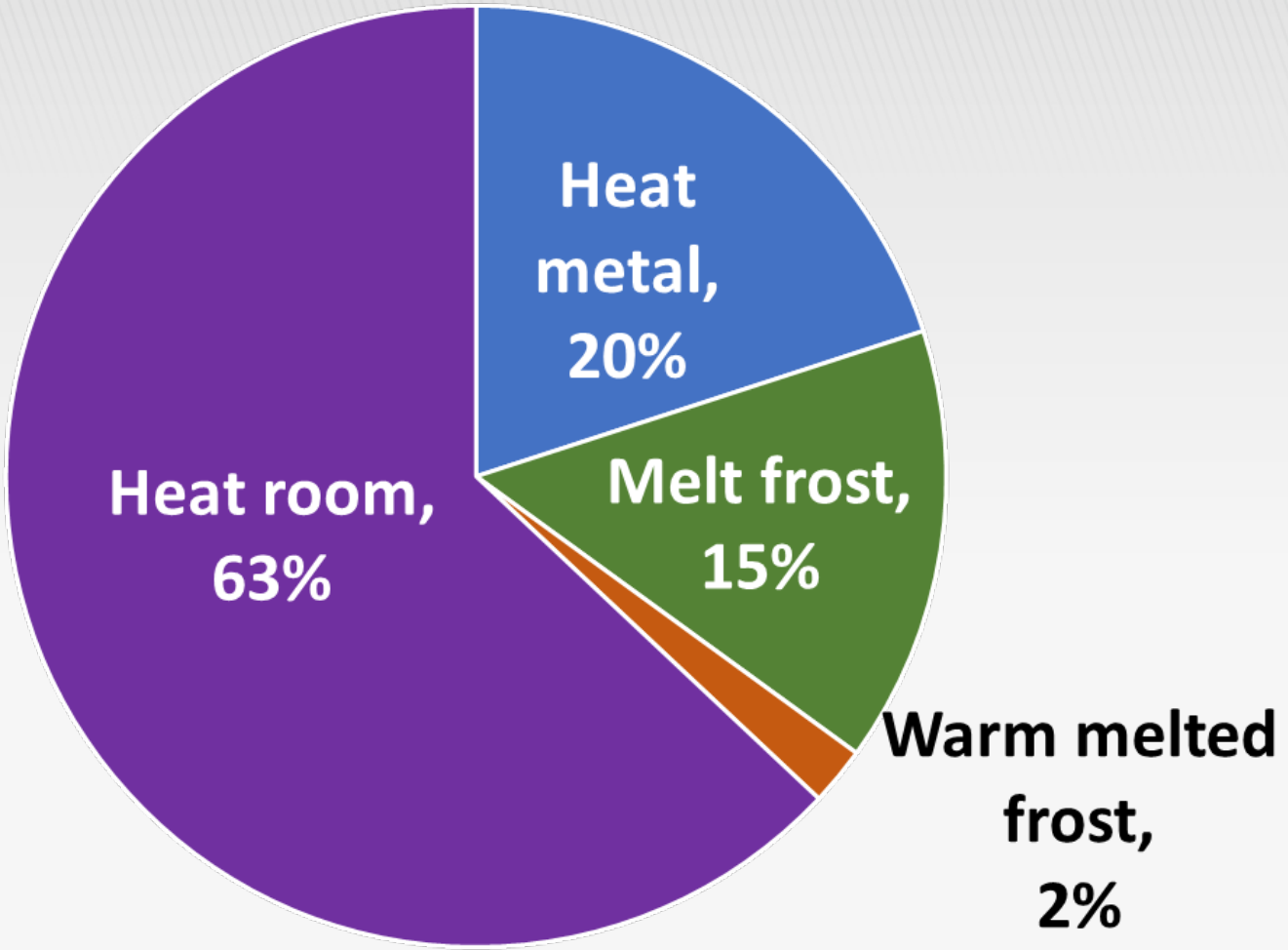
TOP LOW COST EVAPORATOR EE OPPORTUNITIES

- Clean evaporator coils
- Improve fan controls (cycling, VFDs)
- Re-commission valves & regulators
- Fix fan/motor/VFD issues
- Verify/increase temperature setpoints
- Calibrate temperature probes

TOP CAPITAL EVAPORATOR EE OPPORTUNITIES

- Add VFDs to evaporator fans
- Control evaporators from central control system
  - Group fan speed control
  - Better defrost management and scheduling

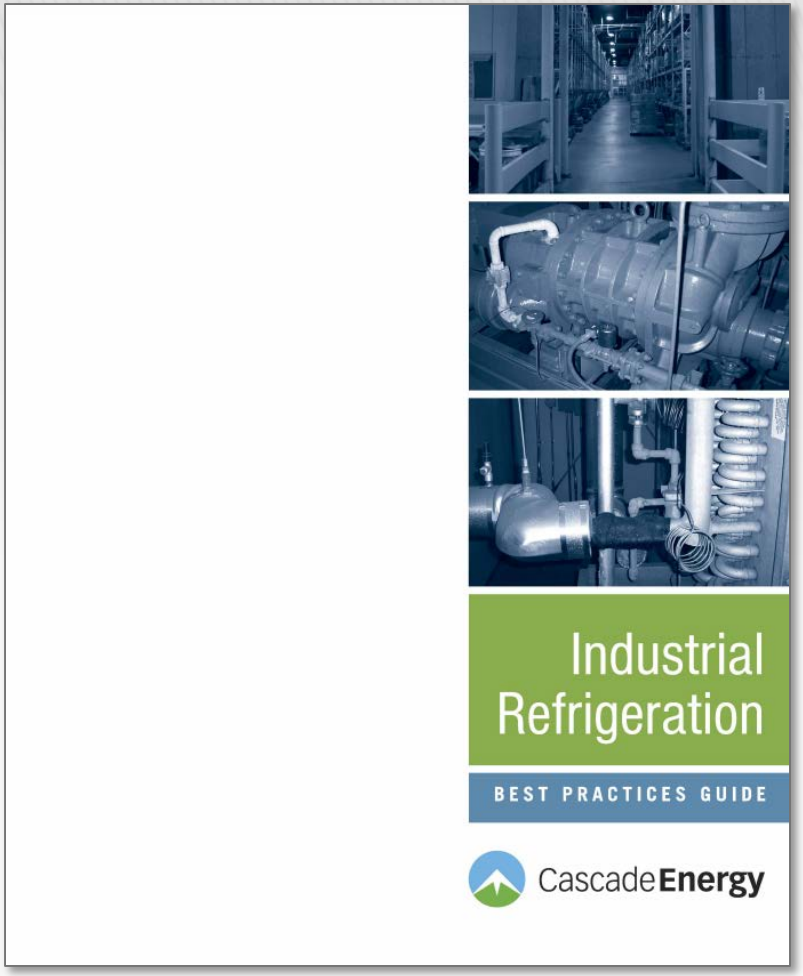
WHERE DOES DEFROST HEAT GO?

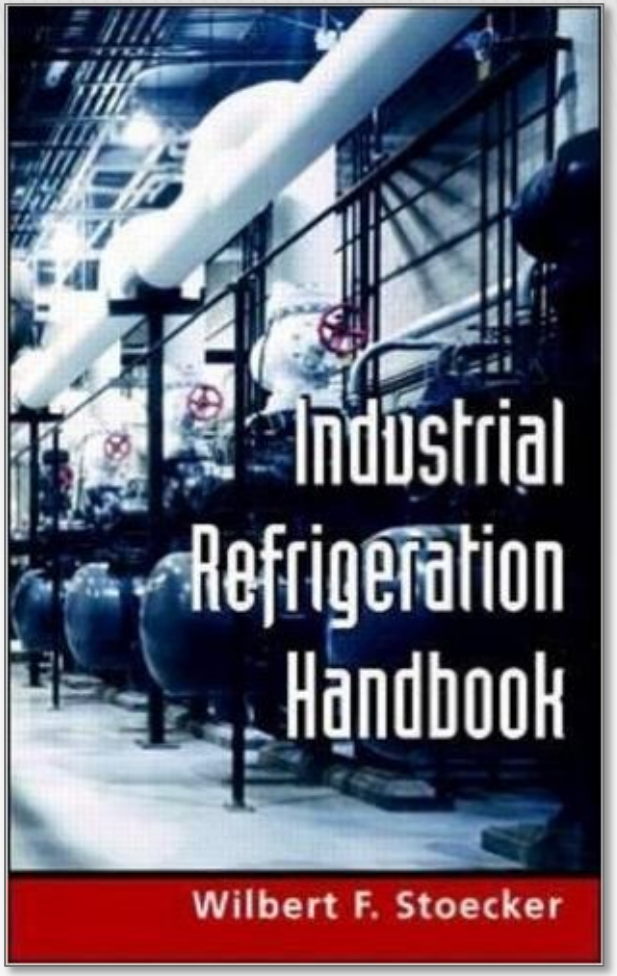


SYSTEMATIC DEFROST OPTIMIZATION

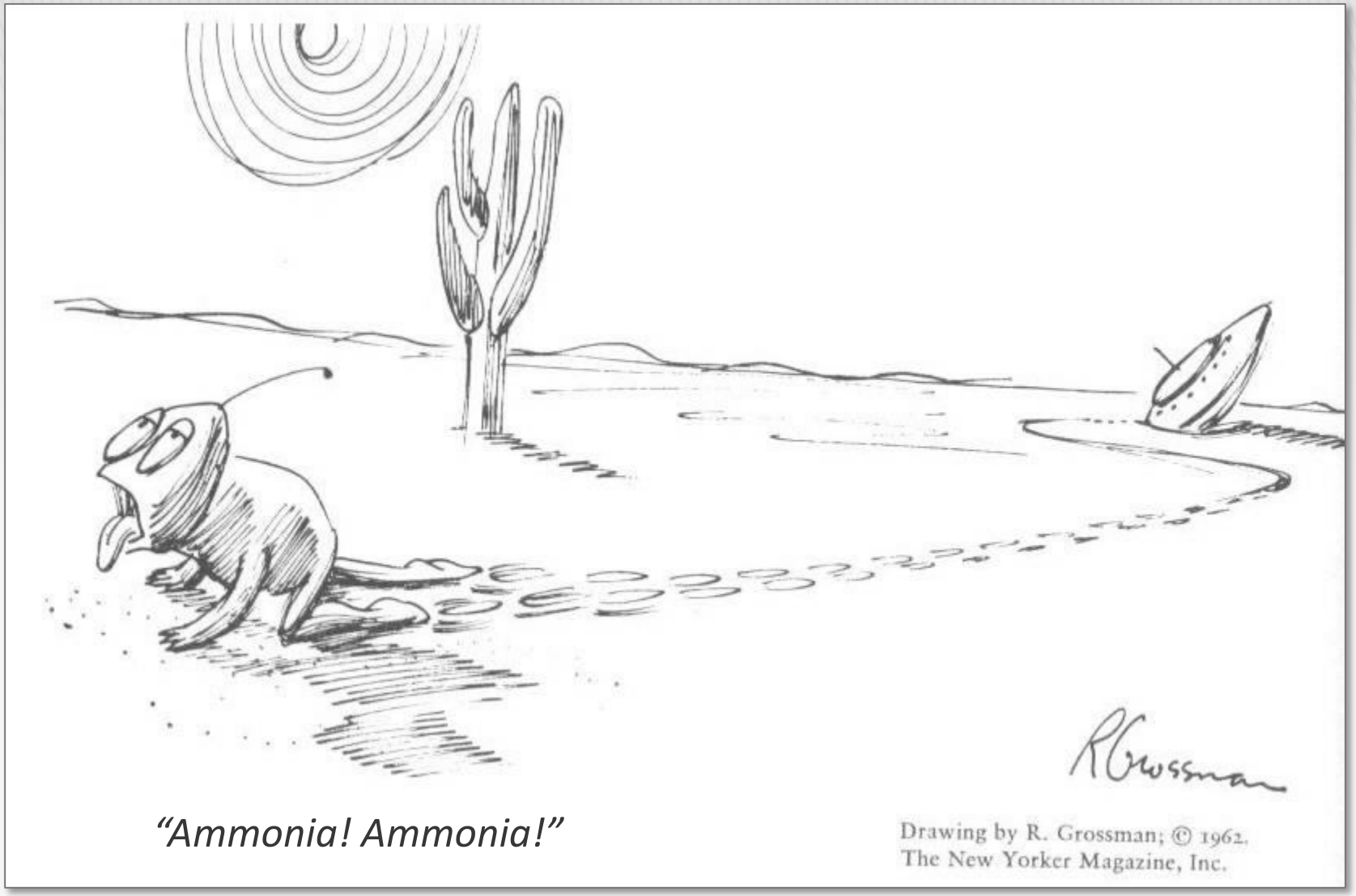
1. Keep frost out
2. Use the cheapest form of defrost
3. Start with clean coils, fix problem evaporators
4. Optimize (minimize) defrost frequency
5. Optimize pump down duration
6. Optimize defrost hot gas pressure
7. Optimize (minimize) defrost duration

FOR MORE INFO





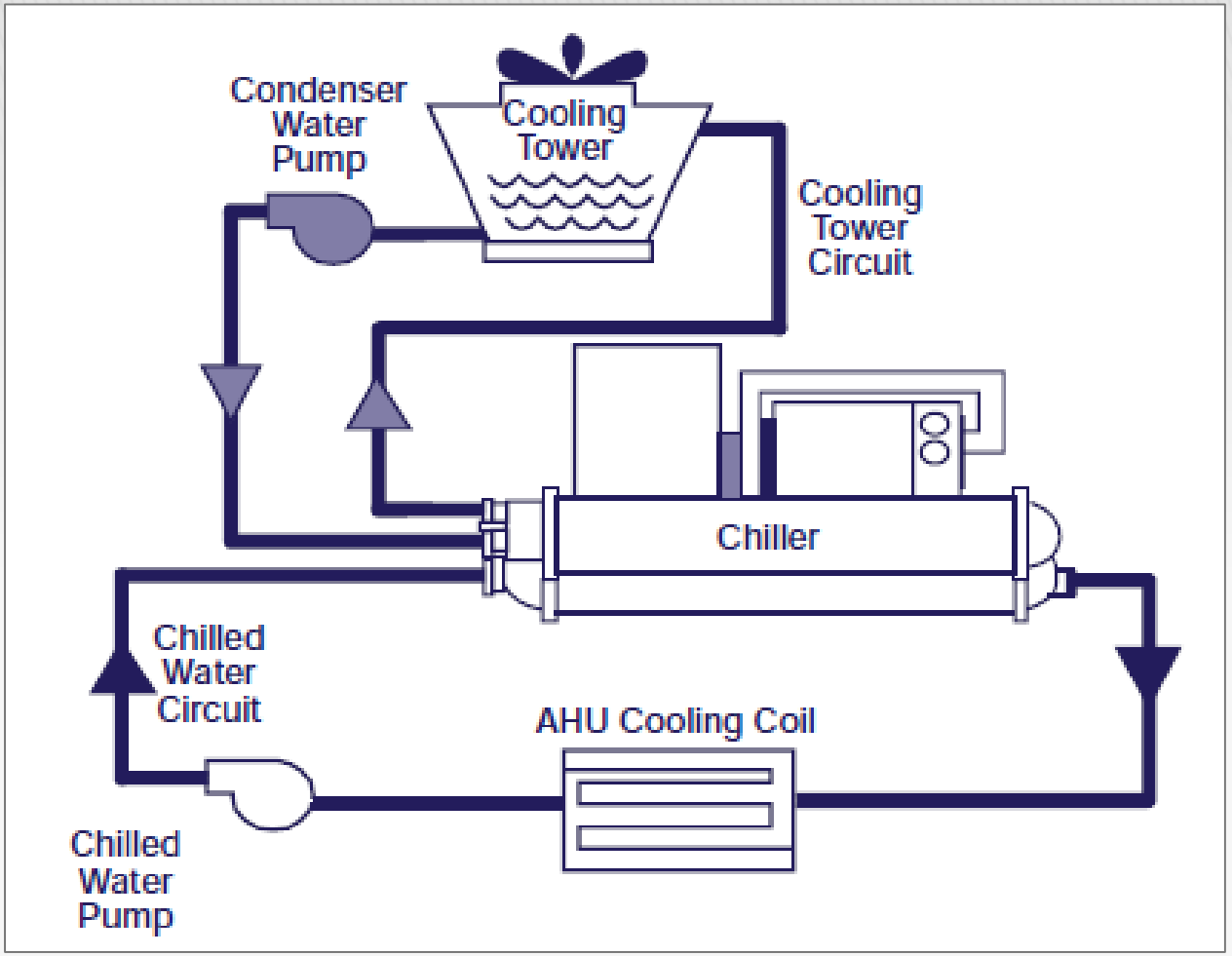
THE LAST WORD: SAFETY FIRST



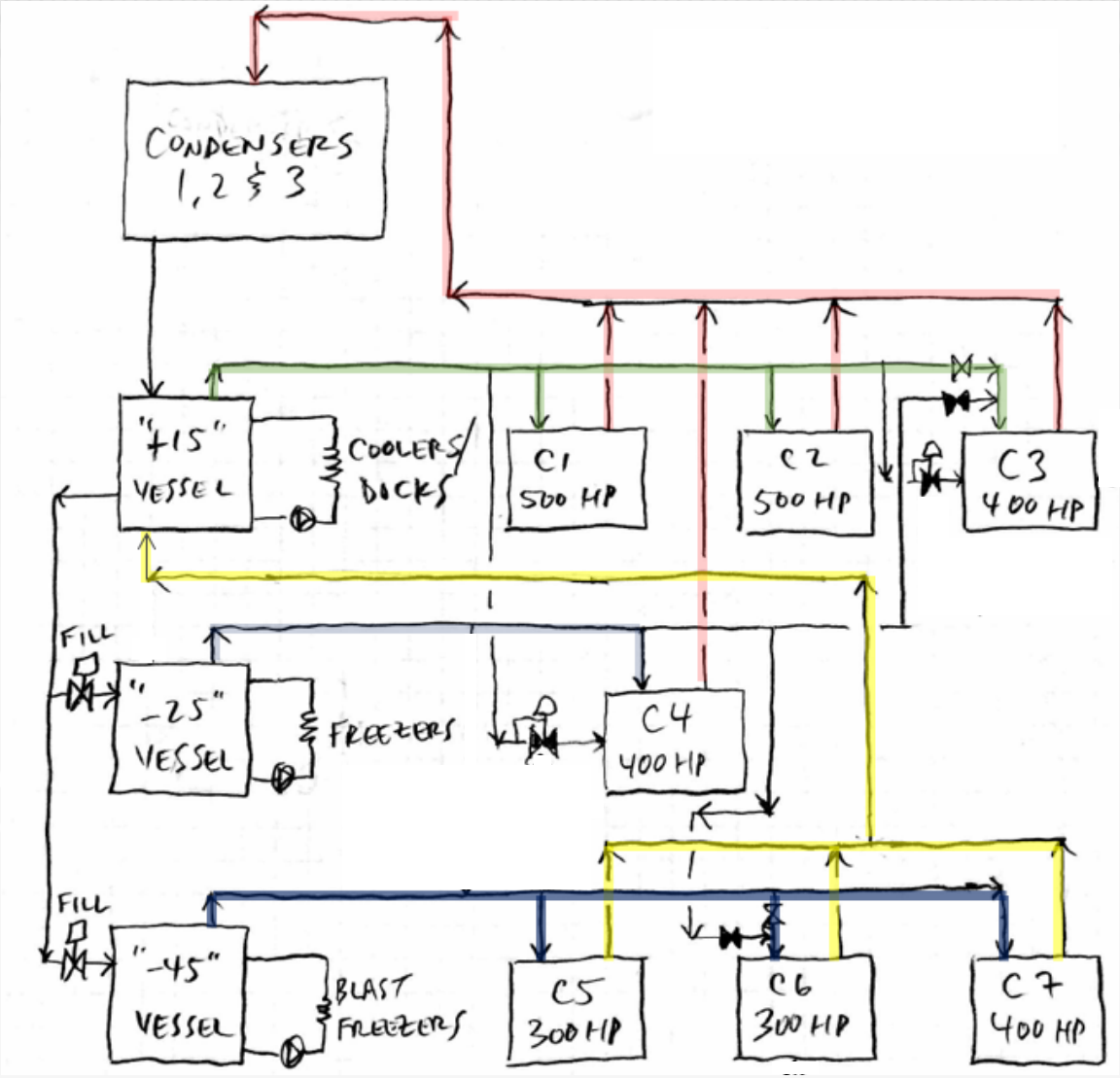
"Ammonia! Ammonia!"

QUESTIONS?

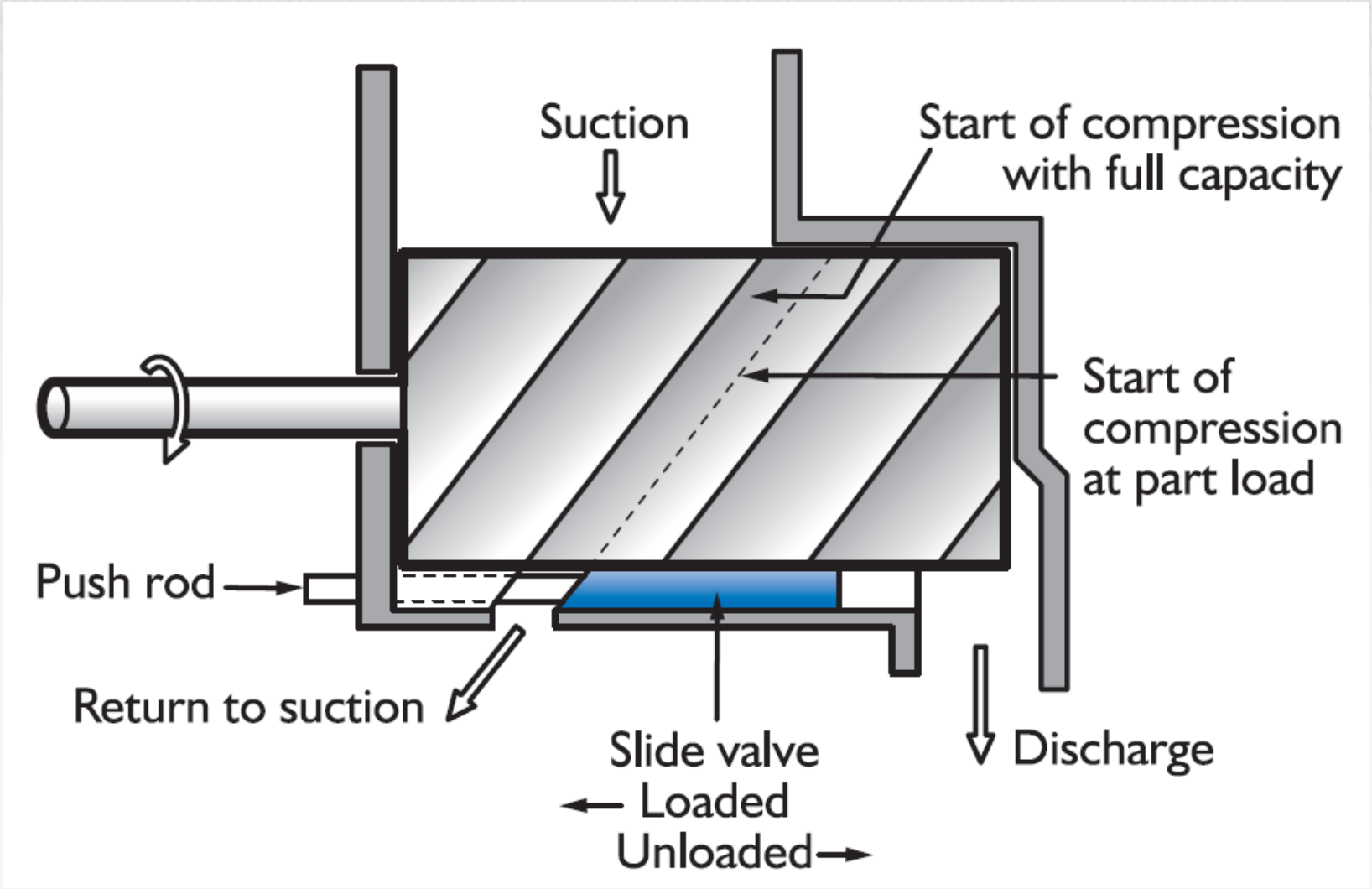
SIMPLE CHILLED WATER SYSTEM



A BIT MORE COMPLICATED



SCREW COMPRESSOR SLIDE VALVE CONTROL



SCREW COMPRESSOR VOLUME RATIO

Internal volume ratio, or VI (volume index)

- Initial gas volume / final gas volume
- Typically 2:1 to 5:1. Ideal VI varies by application.