

CONDENSING BOILER TECHNOLOGY



Presented by:

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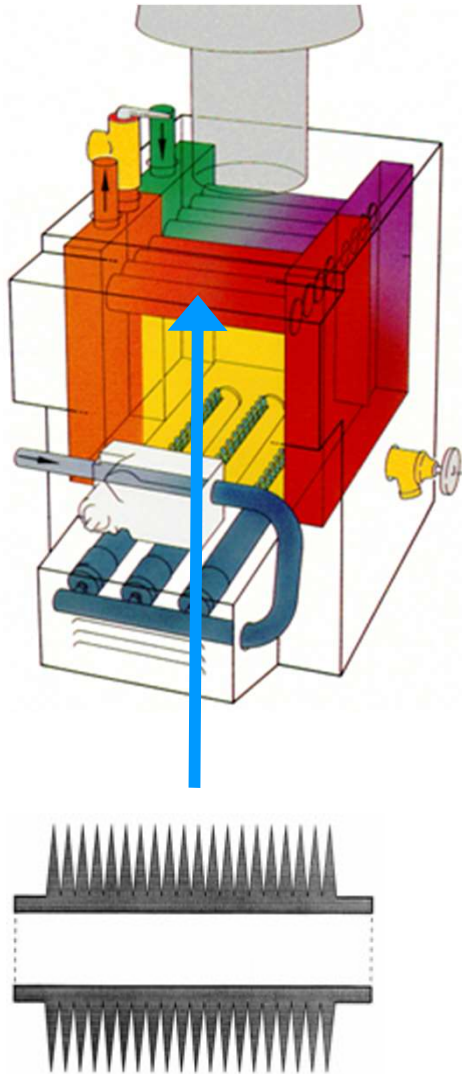


What is condensing boiler technology?

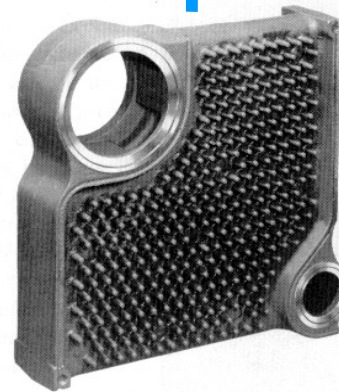


CONVENTIONAL BOILER TECHNOLOGY

Non-condensing construction



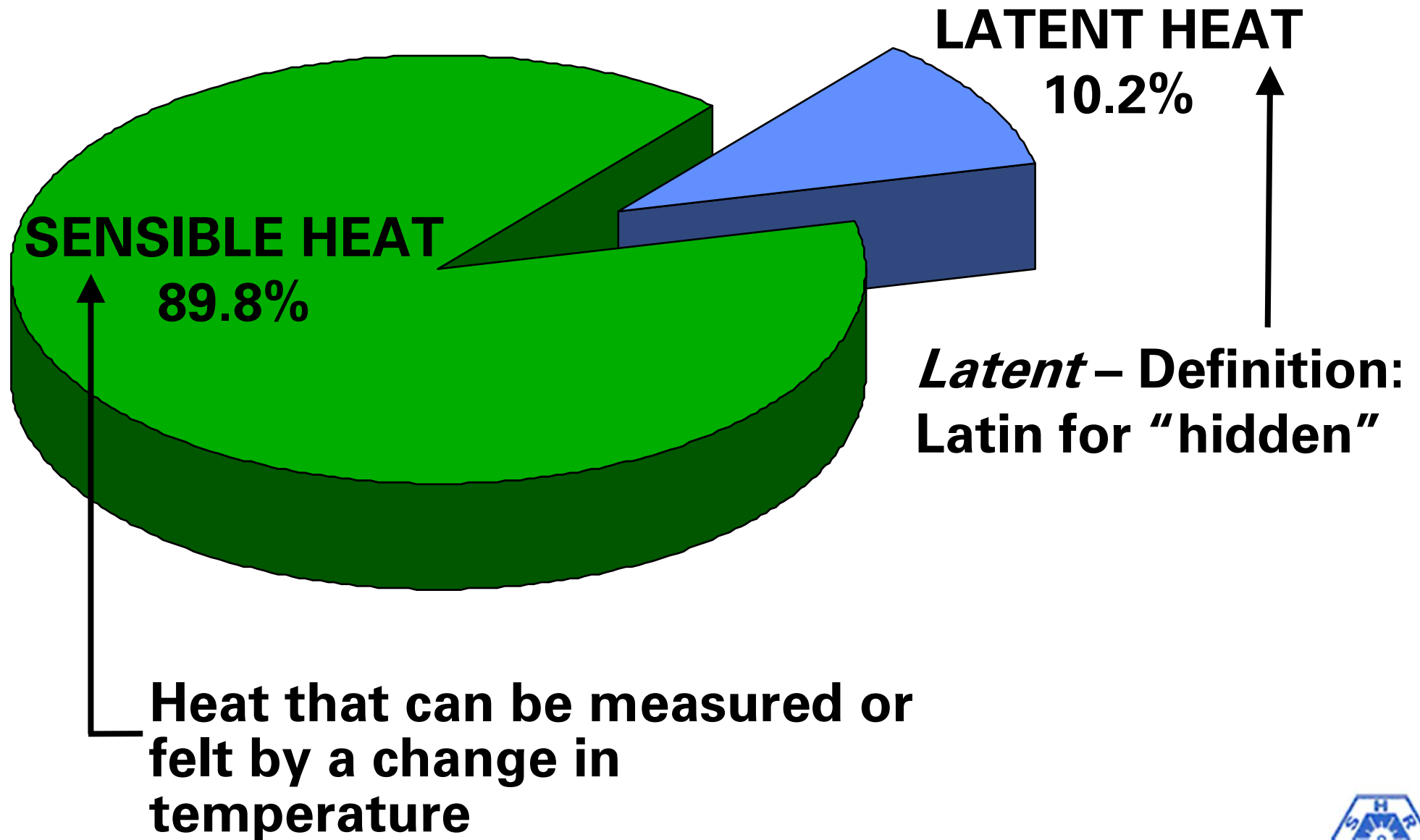
Fin tube boiler



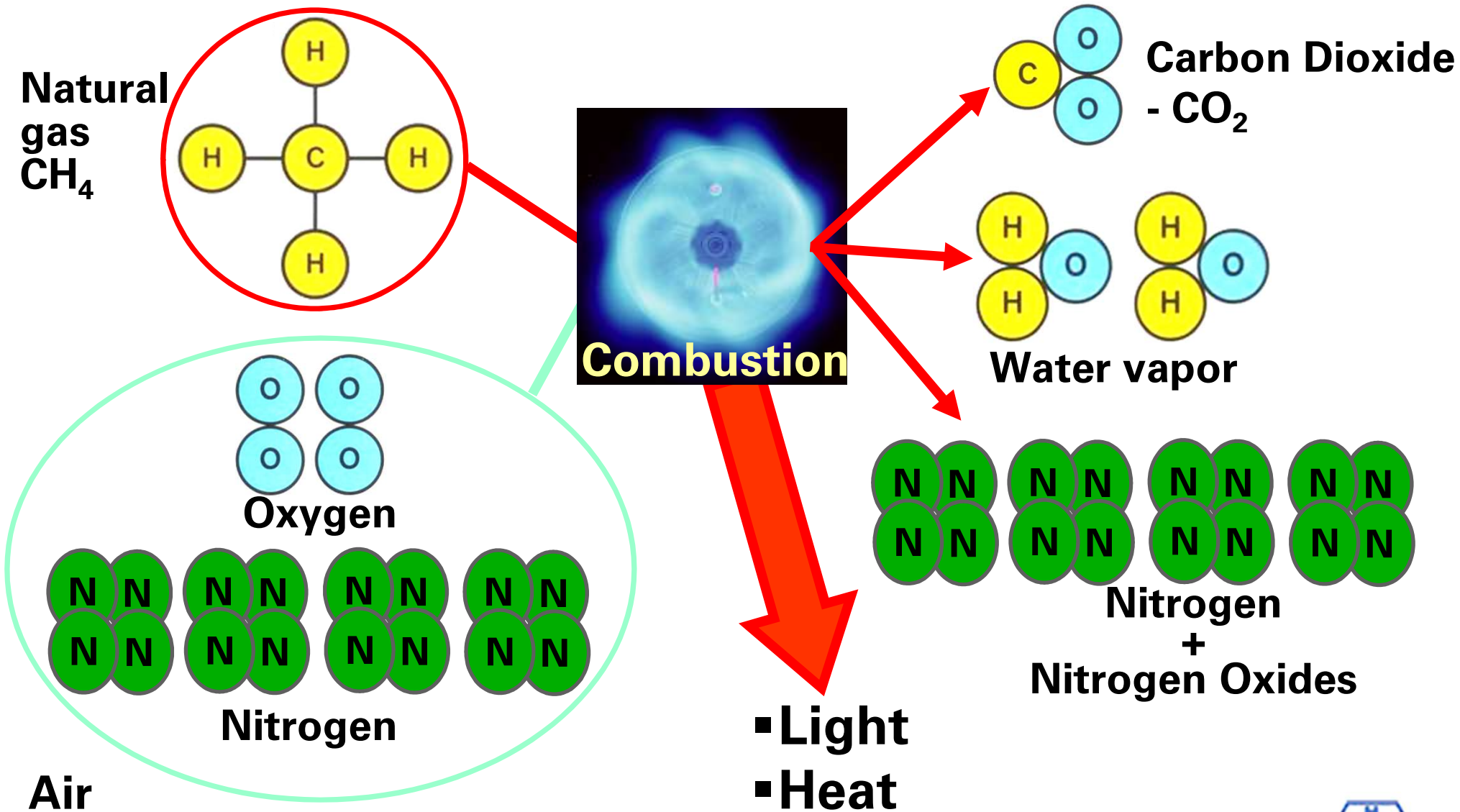
Cast-iron sectional boiler



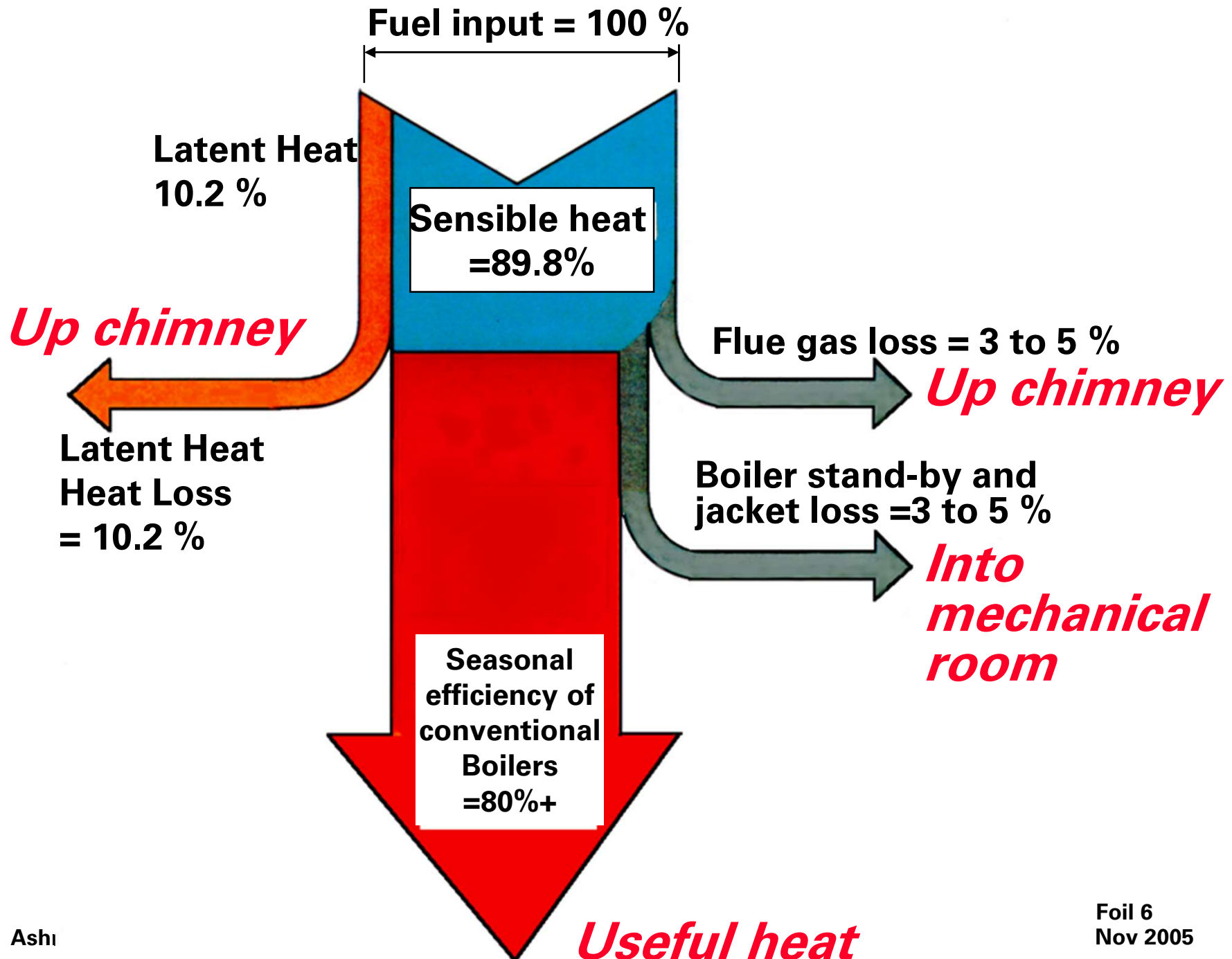
ENERGY CONTENT OF NATURAL GAS



NATURAL GAS COMBUSTION



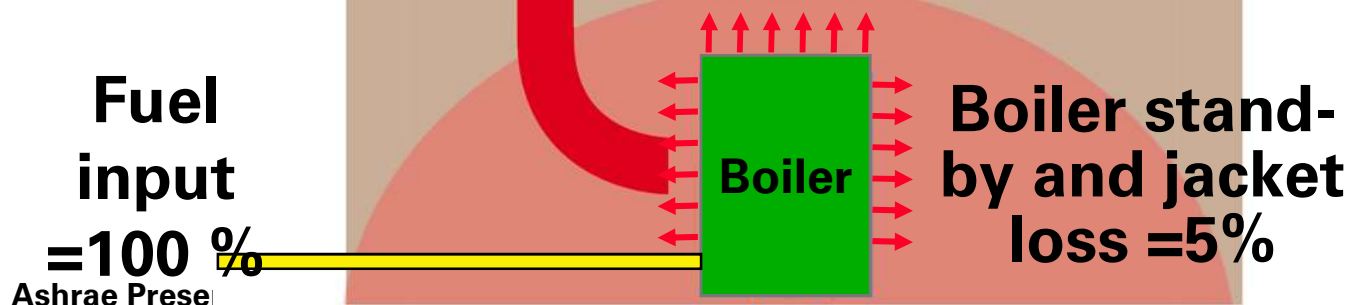
CONVENTIONAL BOILER HEAT FLOW



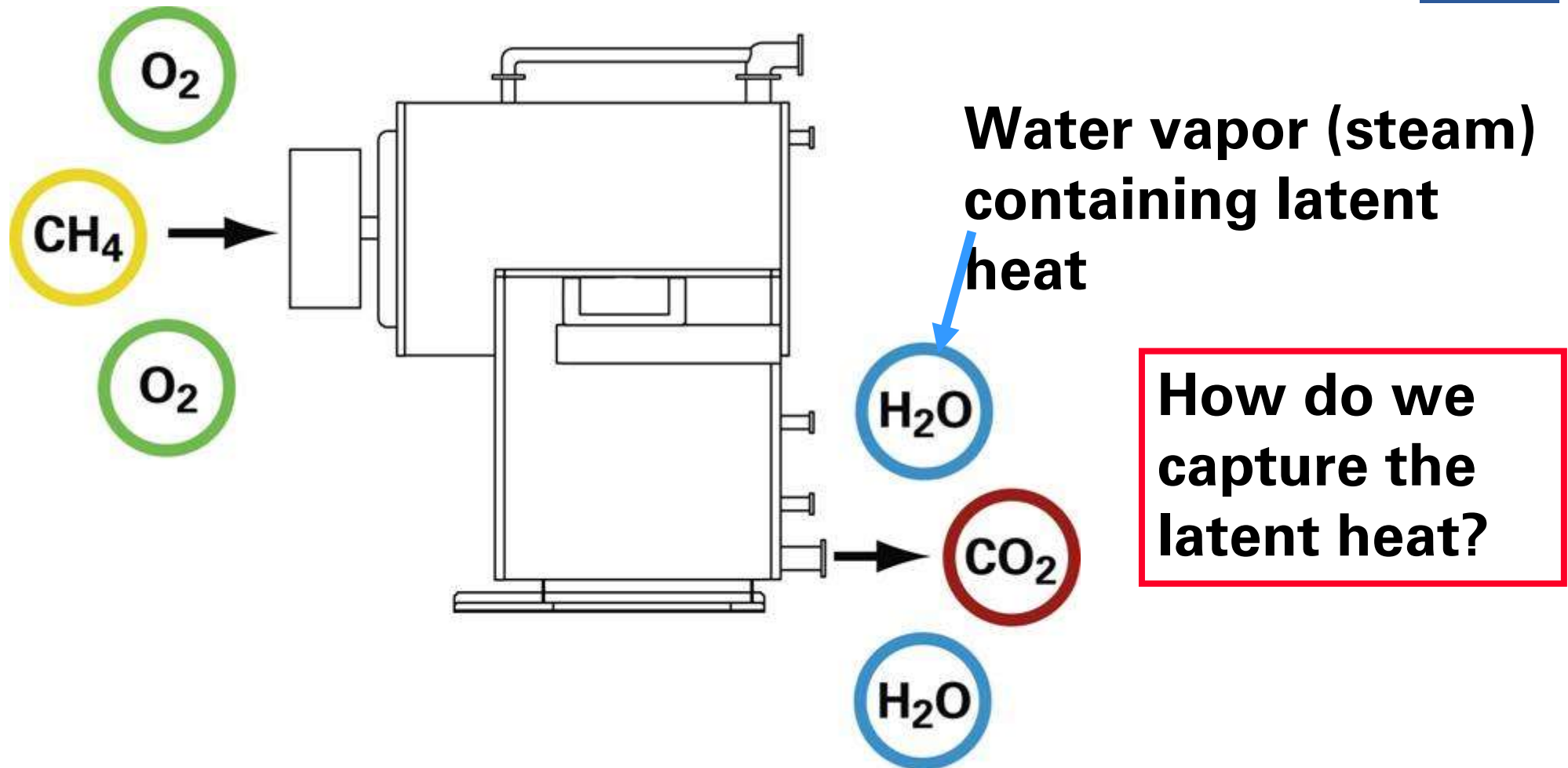
**Latent heat + Flue gas losses
=15%**



CONVENTIONAL BOILER HEAT FLOW



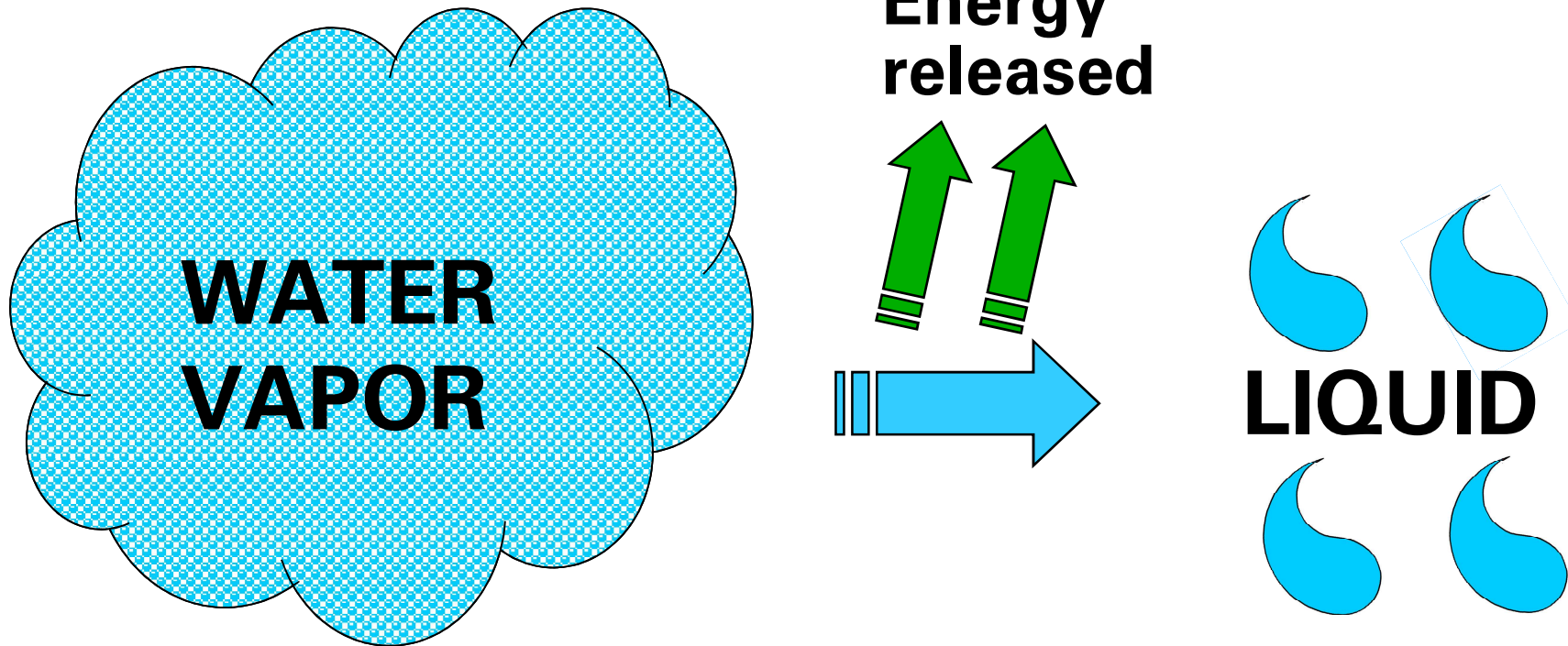
HEAT RECOVERY FROM FLUE GASES



- Simplified Chemical Combustion Formula:



LATENT HEAT RECOVERY

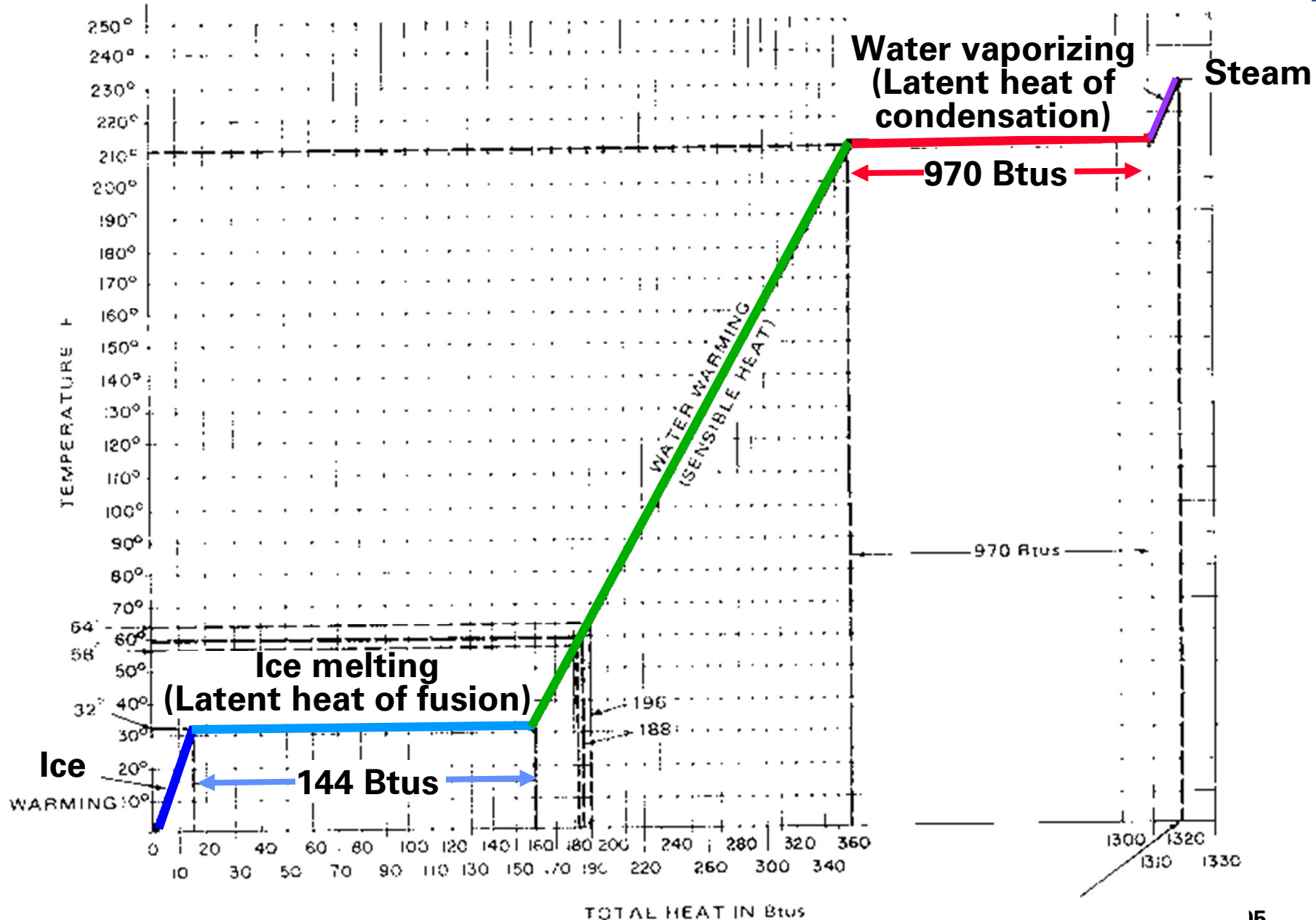


- **Water vapor turns to liquid when it is reduced in temperature.**
- **Energy is released when vapor turns to liquid**

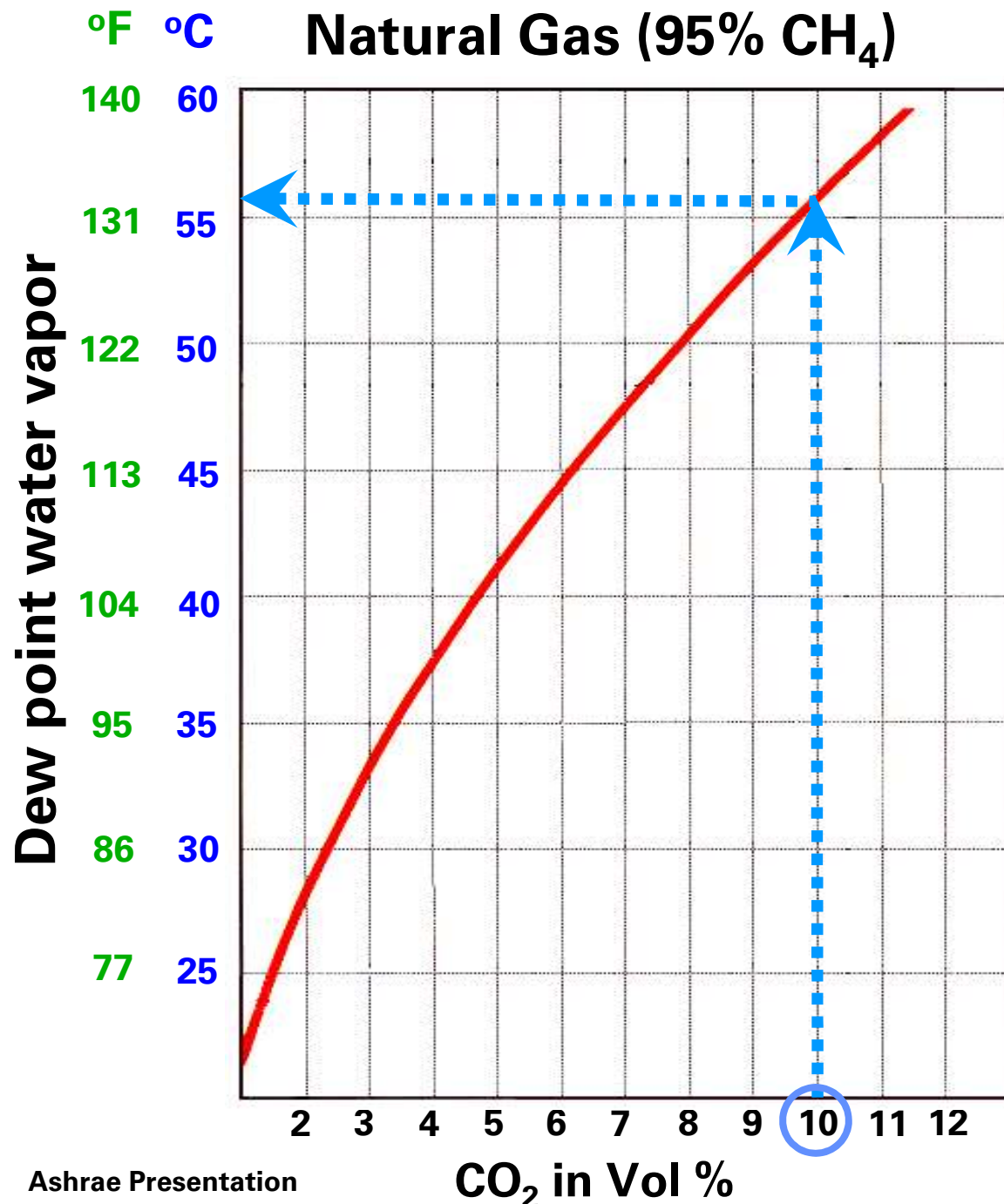


LATENT HEAT RECOVERY

1 pound of water



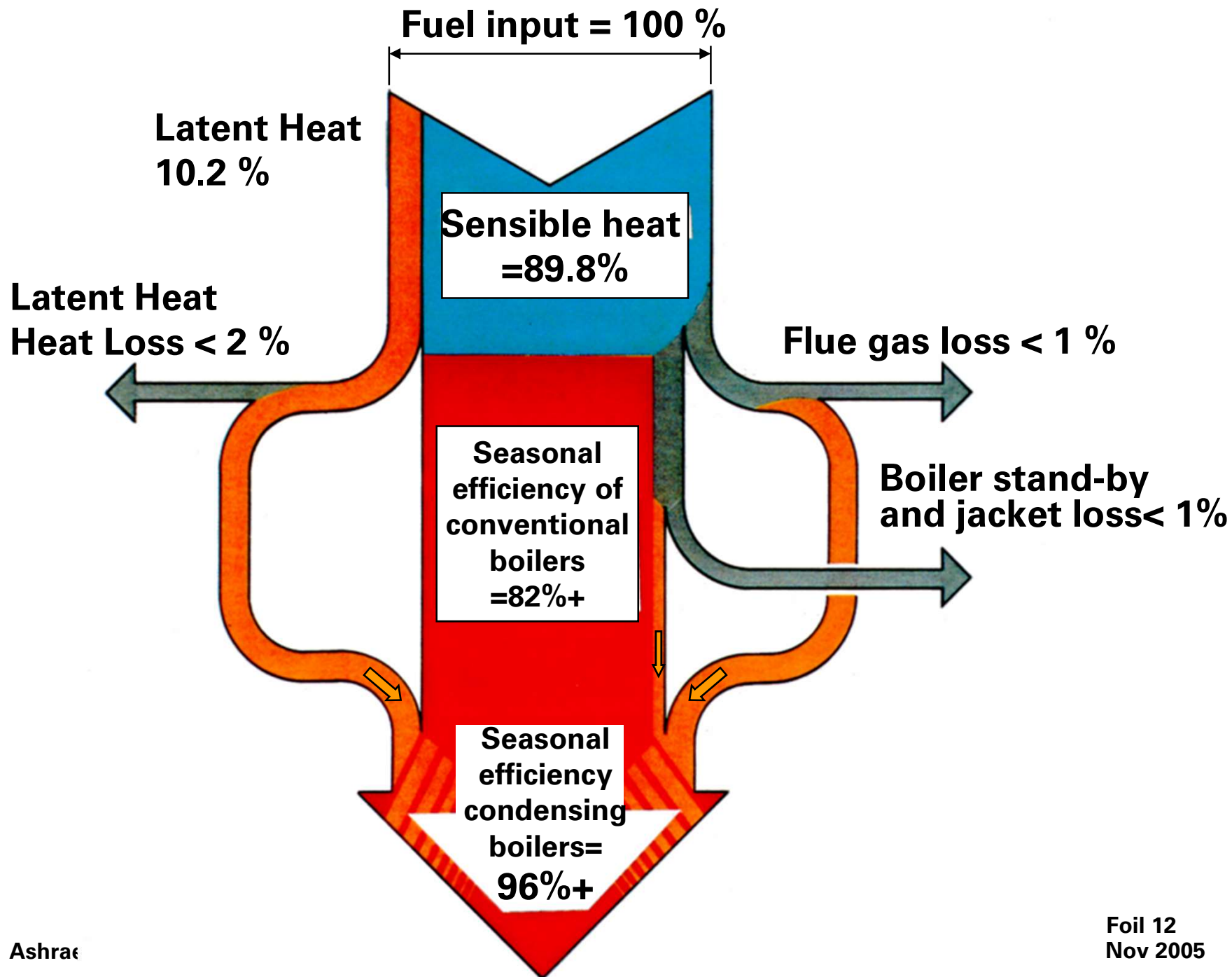
WATER VAPOR DEW POINT



- Water vapor condenses below the dew point temperature
- CO₂ % of flue gas influences dew point temperature



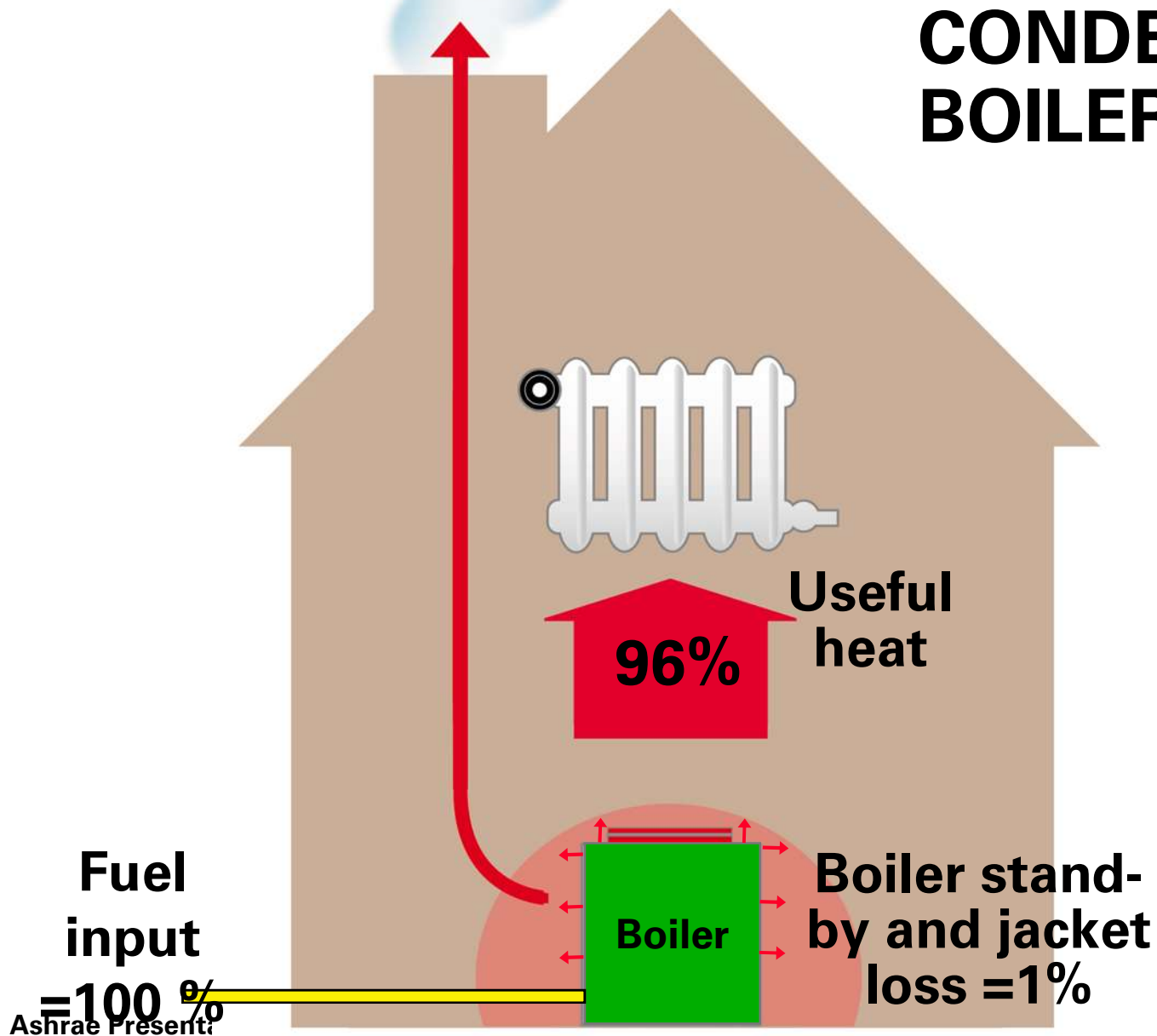
CONDENSING BOILER HEAT FLOW





**Latent heat + Flue gas losses
=3%**

CONDENSING BOILER HEAT FLOW



EFFICIENCY INCREASES DUE TO FLUE GAS CONDENSATION



Combines the following:

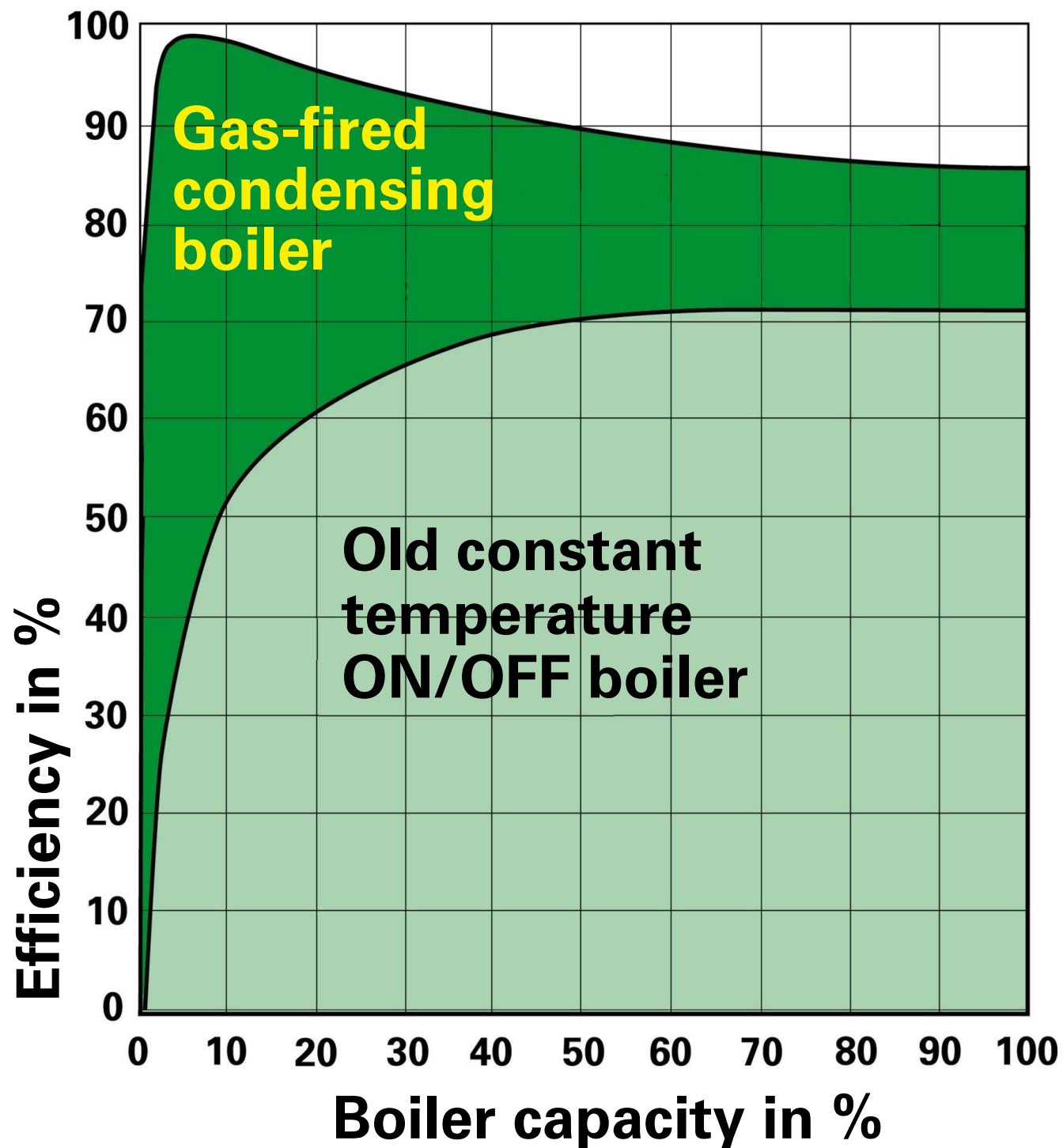
- 1. Additional latent heat gain from condensate**
- 2. Lower flue gas loss:**
 - **The flue gas temperature is lower because the sensible and latent heat is almost completely transferred to the boiler water**
- 3. Lower radiant standby losses:**
 - **Due to lower boiler water temperatures**





Why use condensing boiler technology?





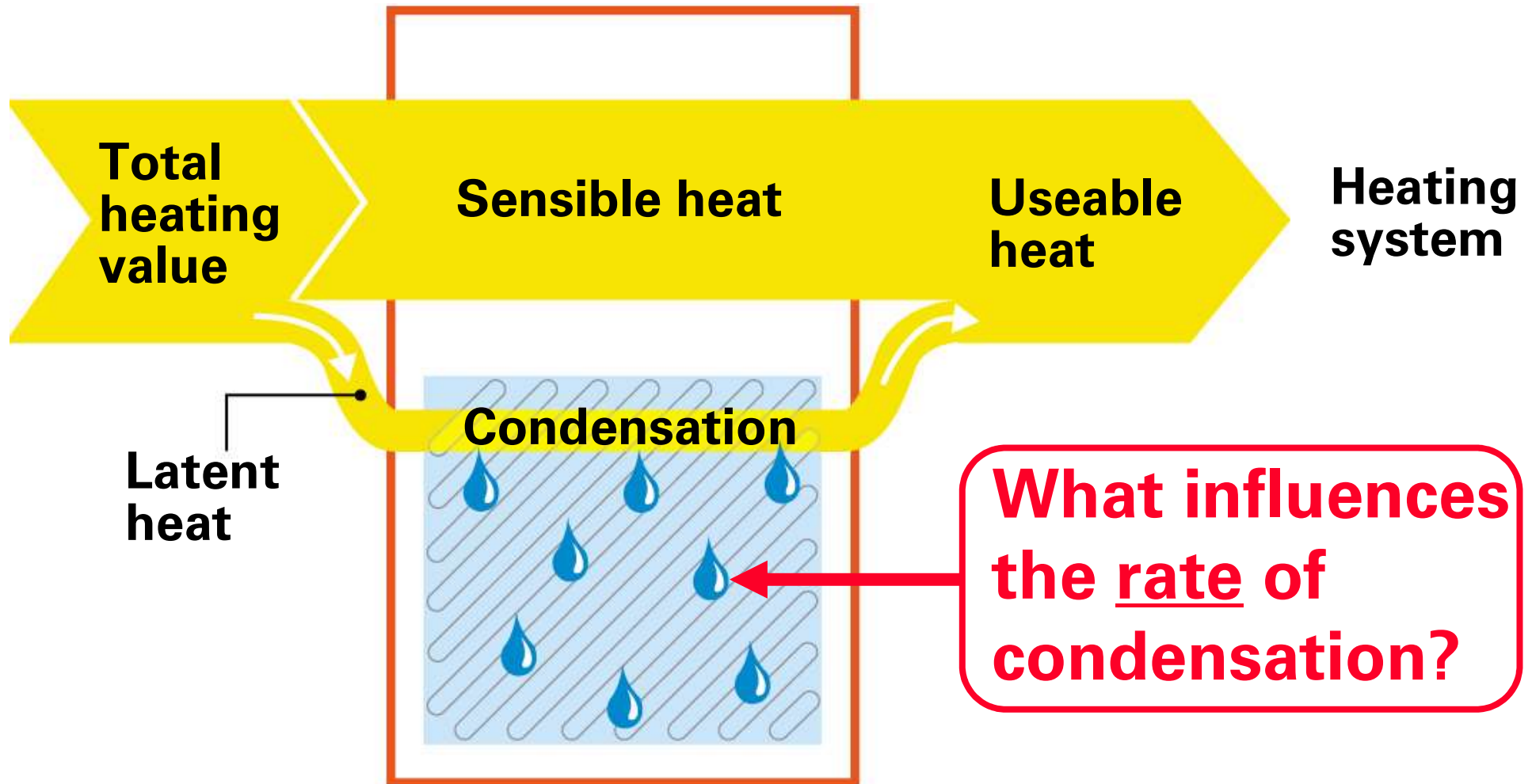
TYPICAL BOILER EFFICIENCIES



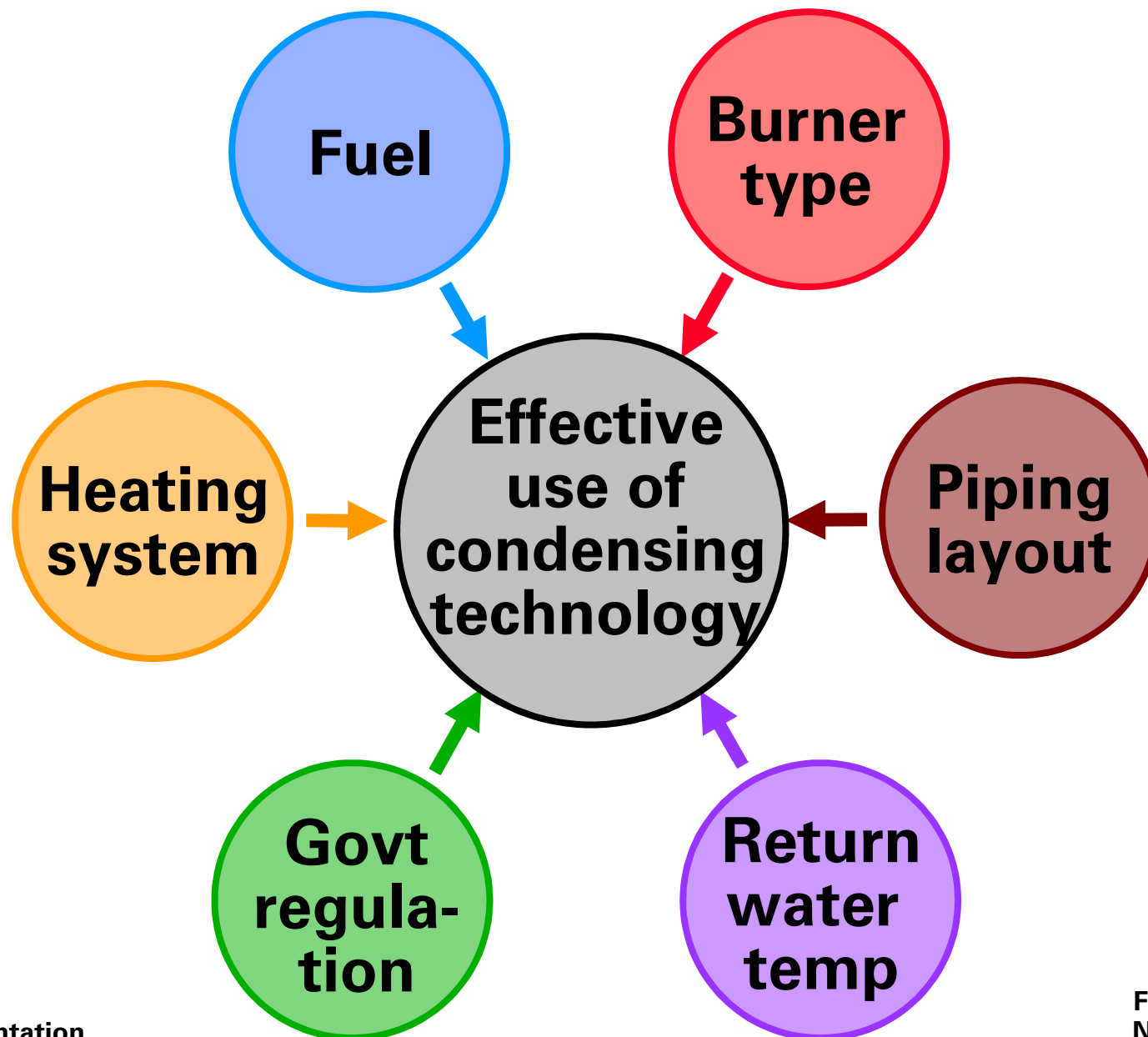
MORE USABLE HEAT THROUGH CONDENSATION



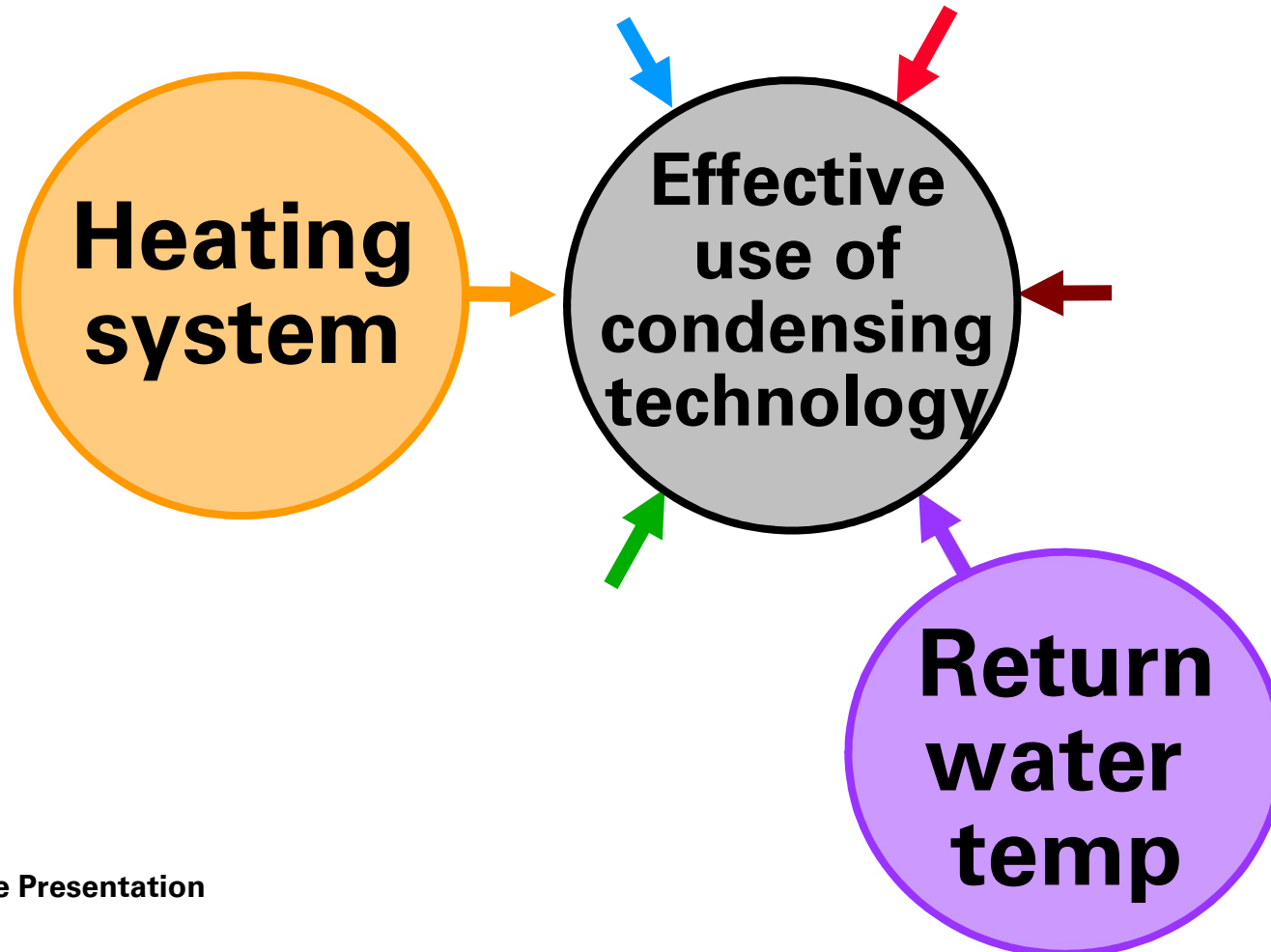
Condensing boiler



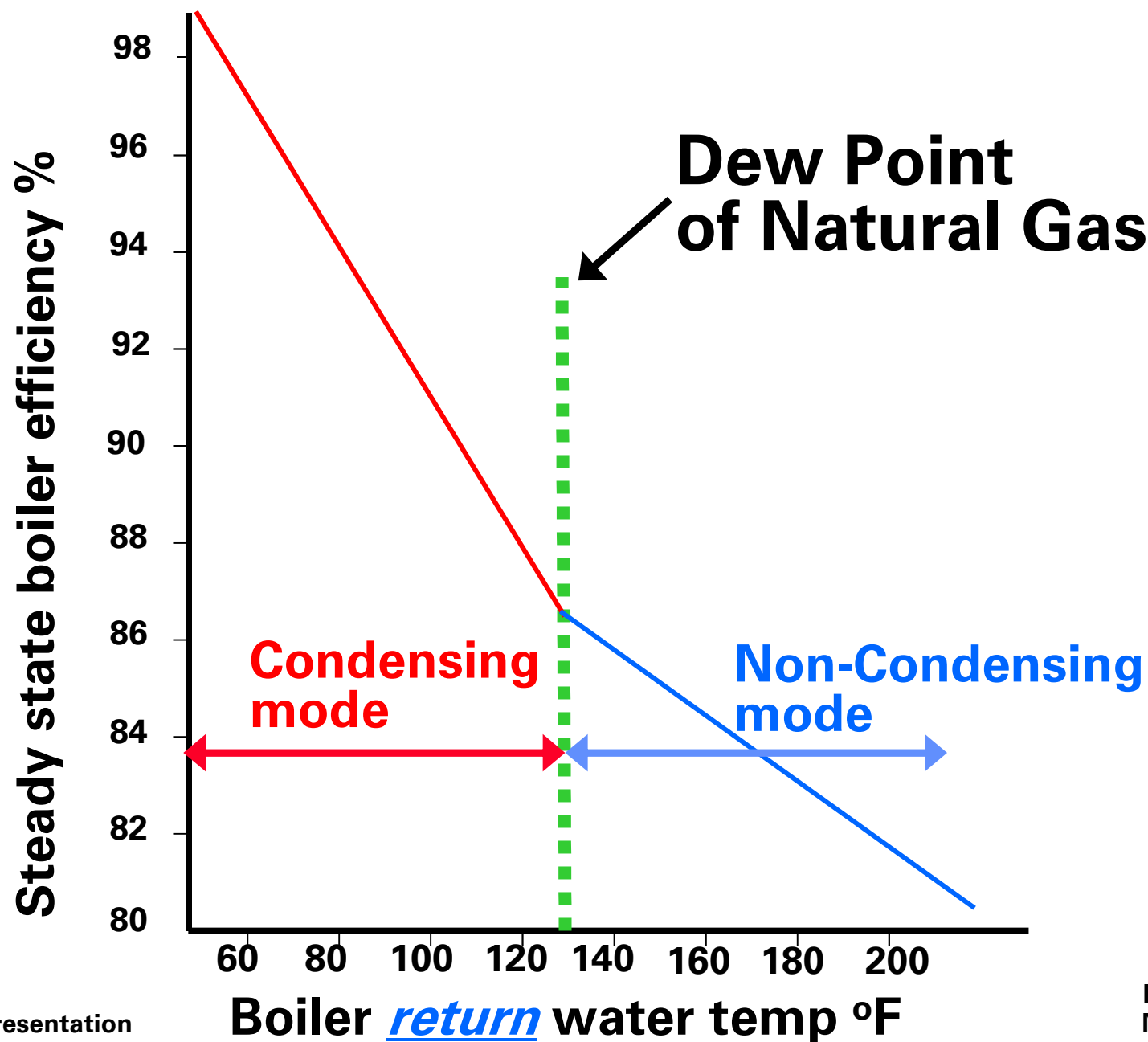
FACTORS INFLUENCING EFFECTIVENESS OF CONDENSING TECHNOLOGY



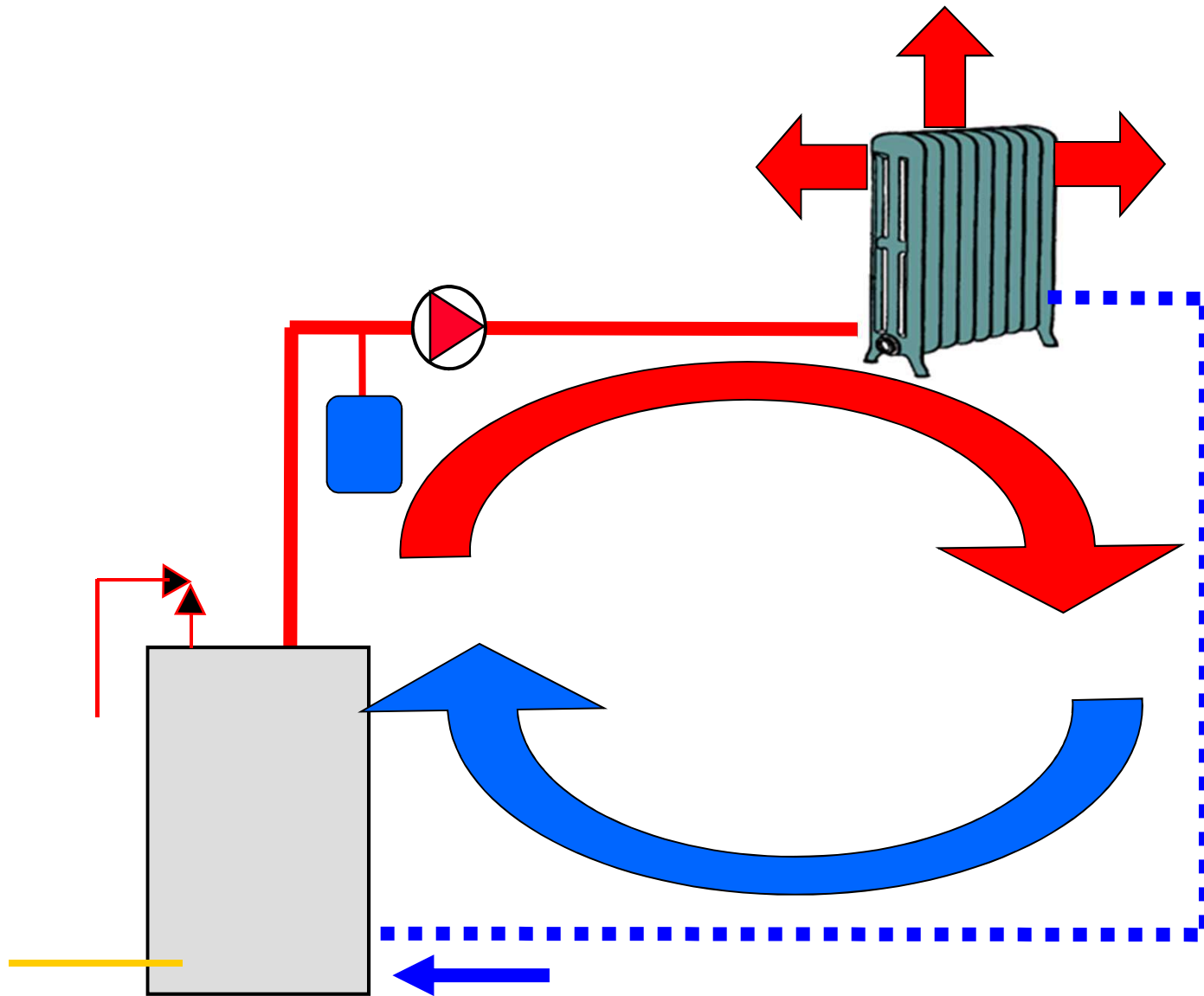
FACTORS INFLUENCING EFFECTIVENESS OF CONDENSING TECHNOLOGY



SIMPLIFIED CONDENSING BOILER OPERATION



RETURN WATER TEMPERATURE



Boiler return water
temperature determines
condensing operation

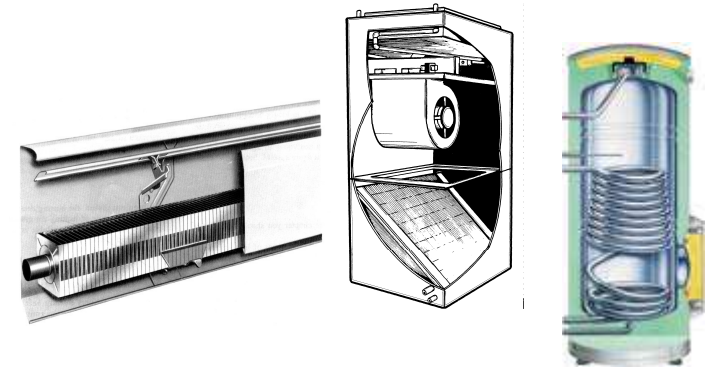


TYPICAL HYDRONIC WATER TEMPERATURE REQUIREMENTS:



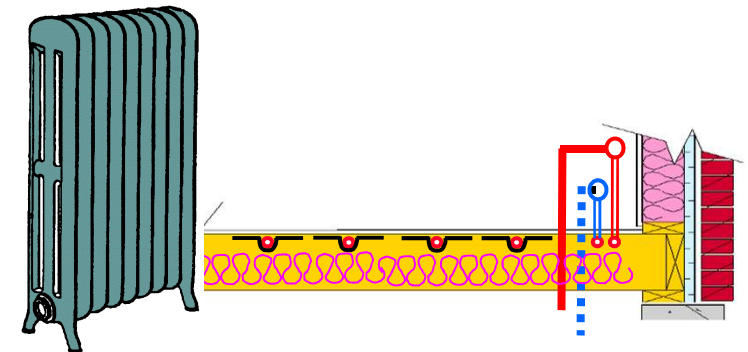
High temperature:

- Finned tube baseboard 140 - 190 °F
- Air heat fancoils 140 - 180 °F
- Pool/spa heat exchangers 160 - 180 °F
- DHW production 150 - 190 °F



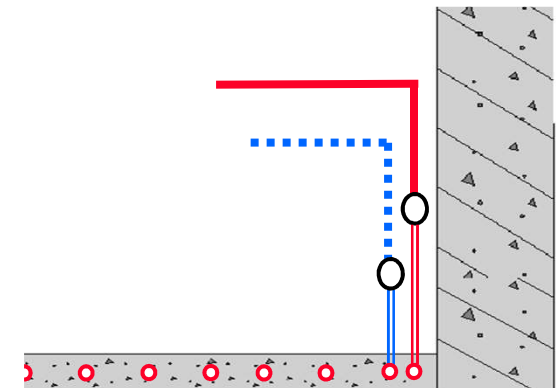
Medium temperature:

- Cast iron radiators 100 - 140 °F
- Low mass radiant floor
ie: wood joist floors 100 - 150 °F

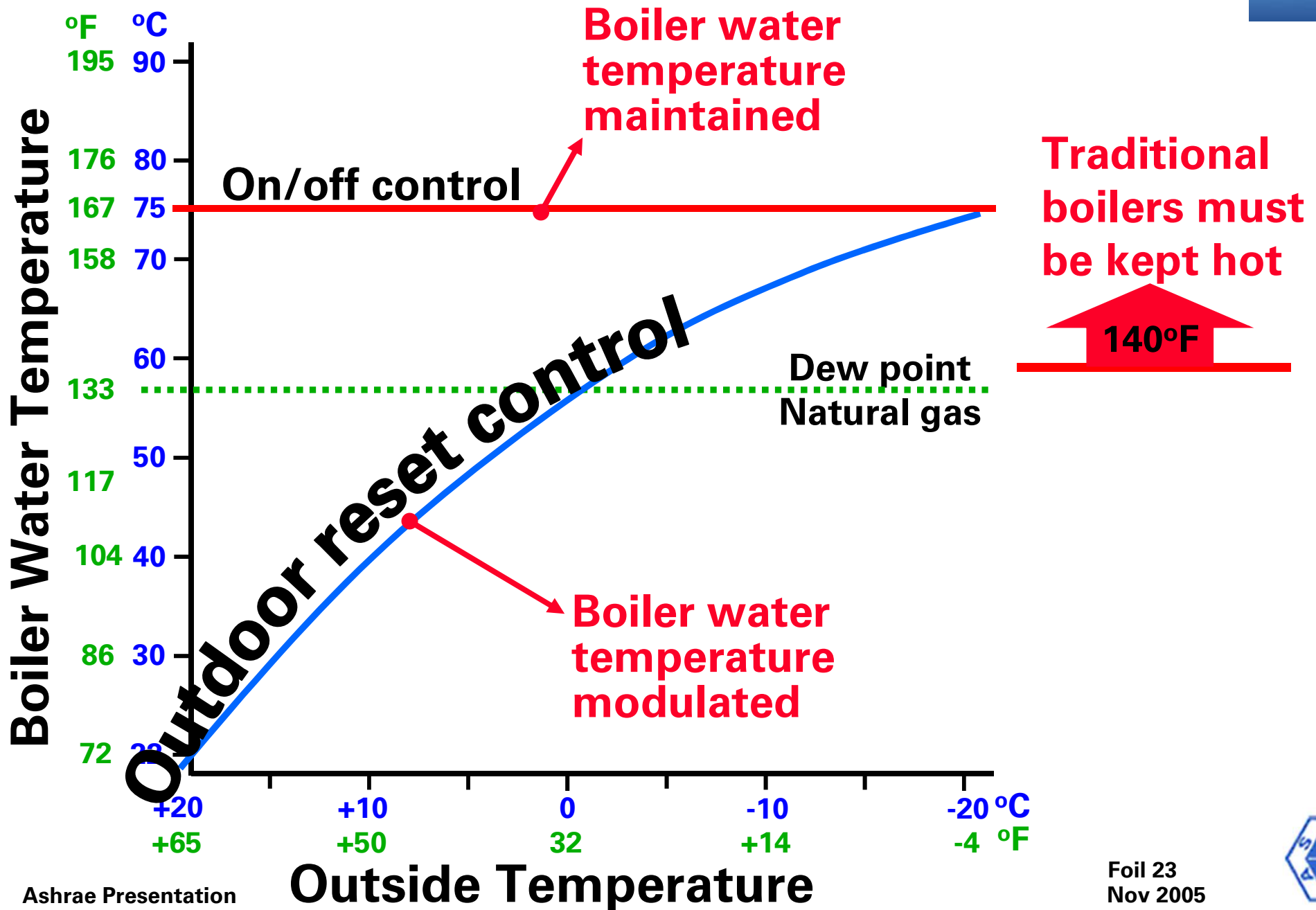


Low temperature:

- High mass radiant floor
ie: concrete floors 80 - 120 °F
- Snowmelting systems 80 - 120 °F



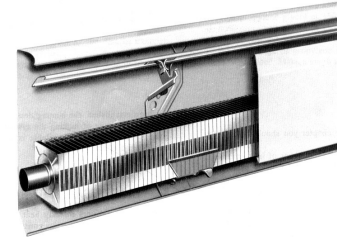
HYDRONIC WATER TEMPERATURES



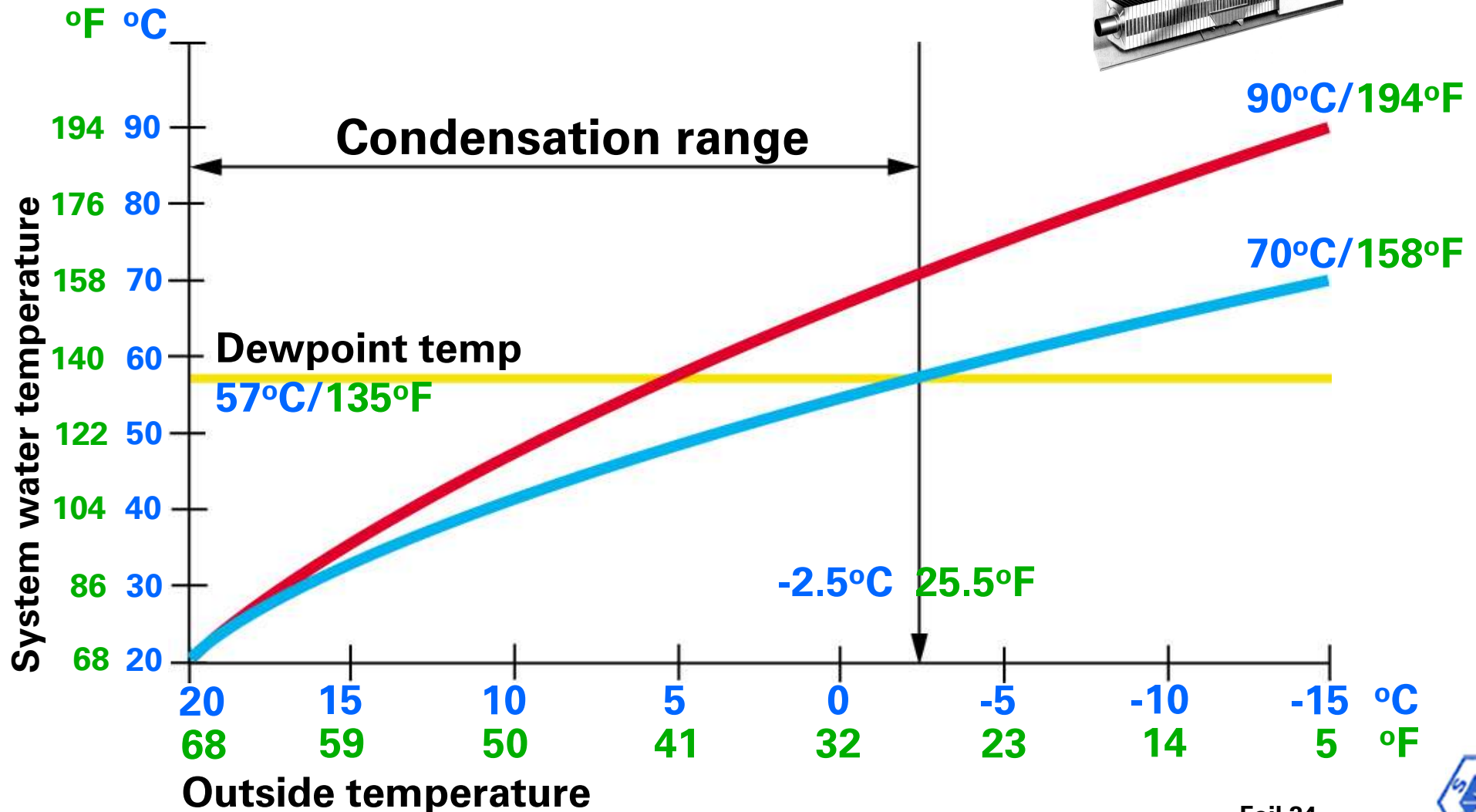
IMPACT OF SYSTEM TEMPERATURES ON CONDENSATION

Example 1: Supply/return temperature:

90/70°C, 194/158°F



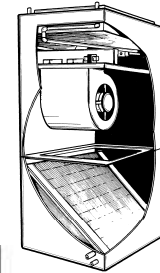
Fin tube



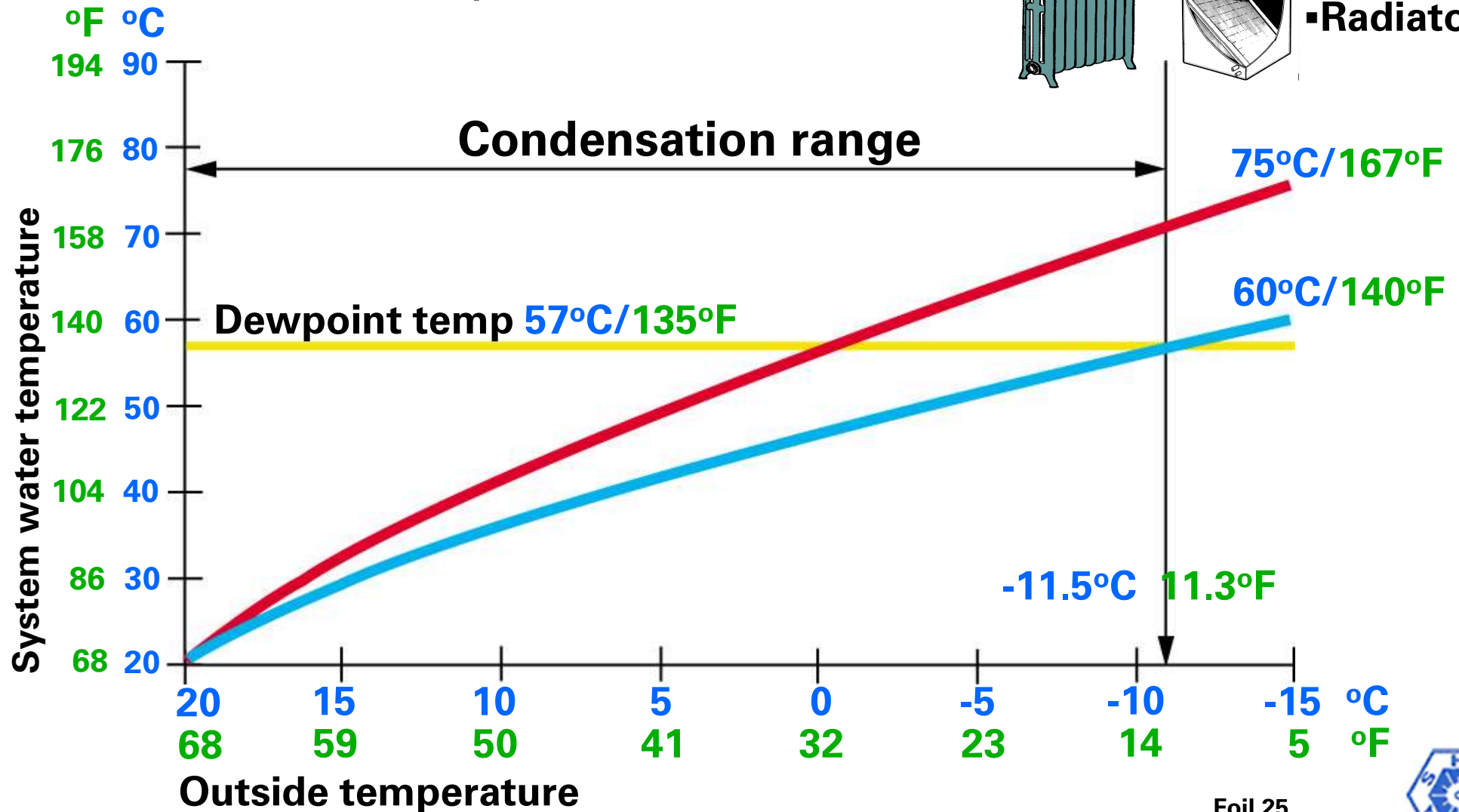
IMPACT OF SYSTEM TEMPERATURES ON CONDENSATION

Example 2: Supply/return temperature:

75/60°C, 167/140°F



▪ Hydro-Air
▪ Radiators



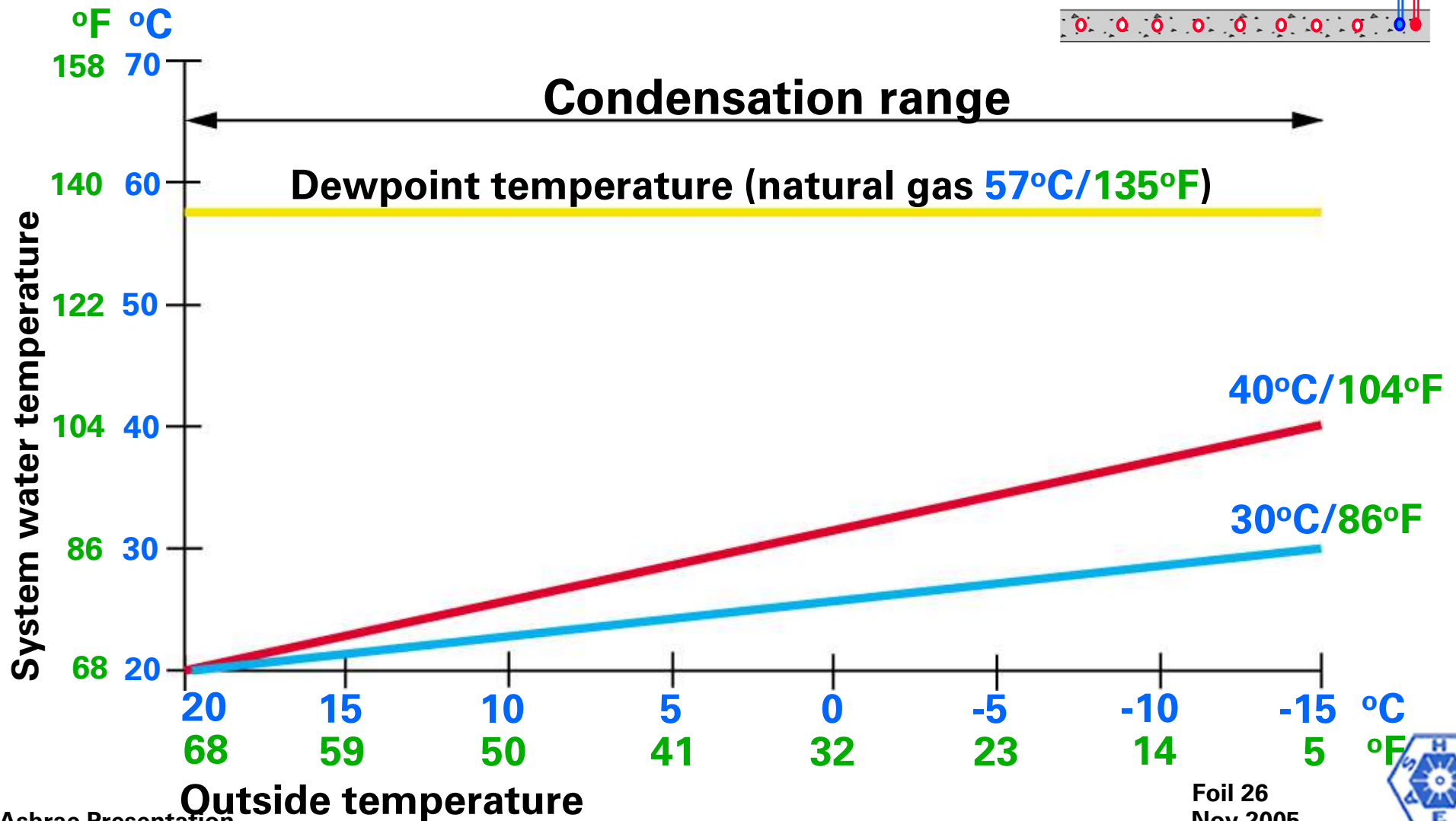
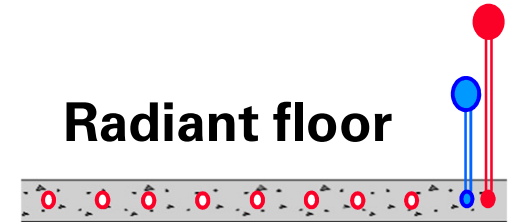
IMPACT OF SYSTEM TEMPERATURES ON CONDENSATION

Example 3: Supply/return temperature:

40/30°C, 104/86°F

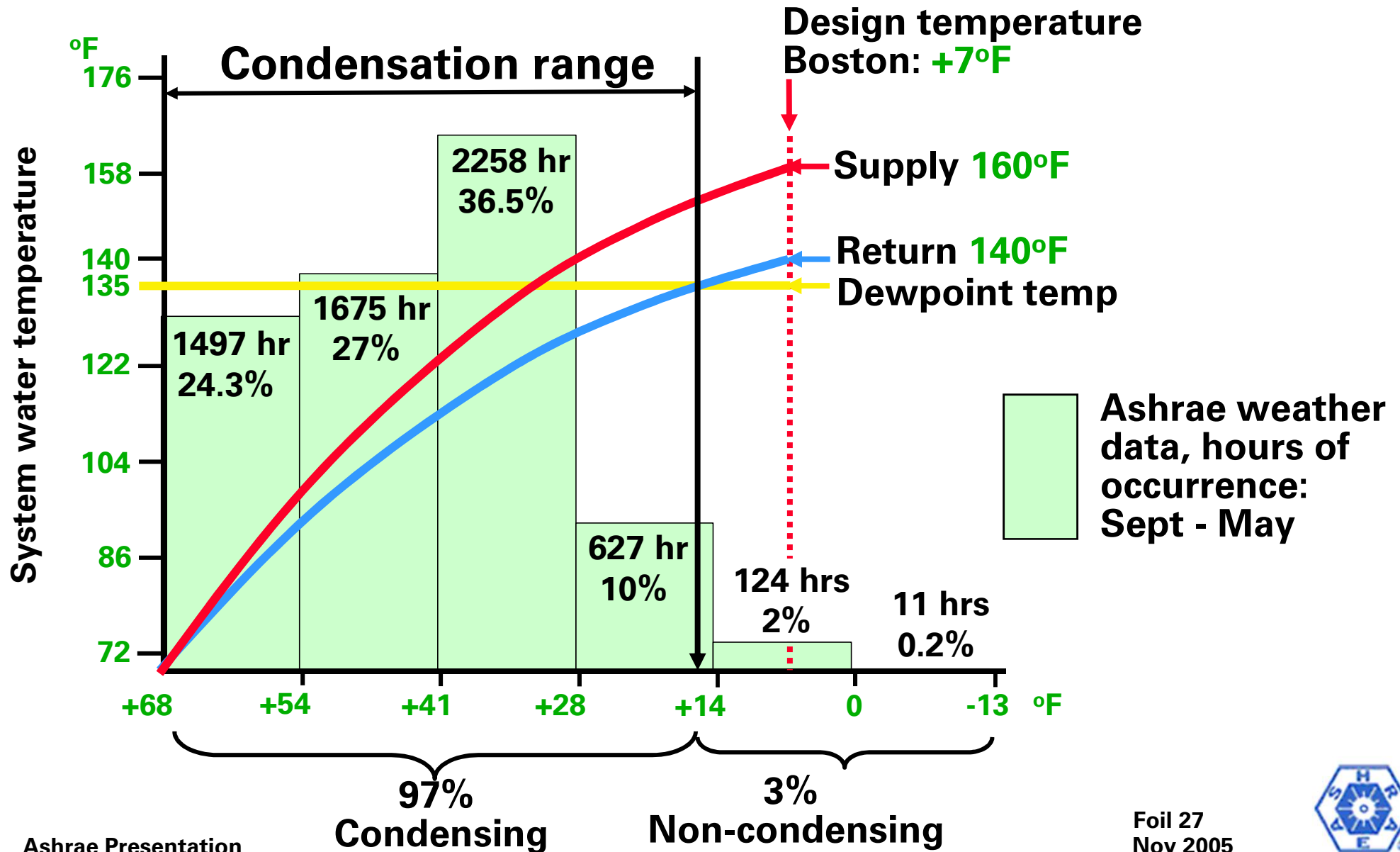


Radiant floor



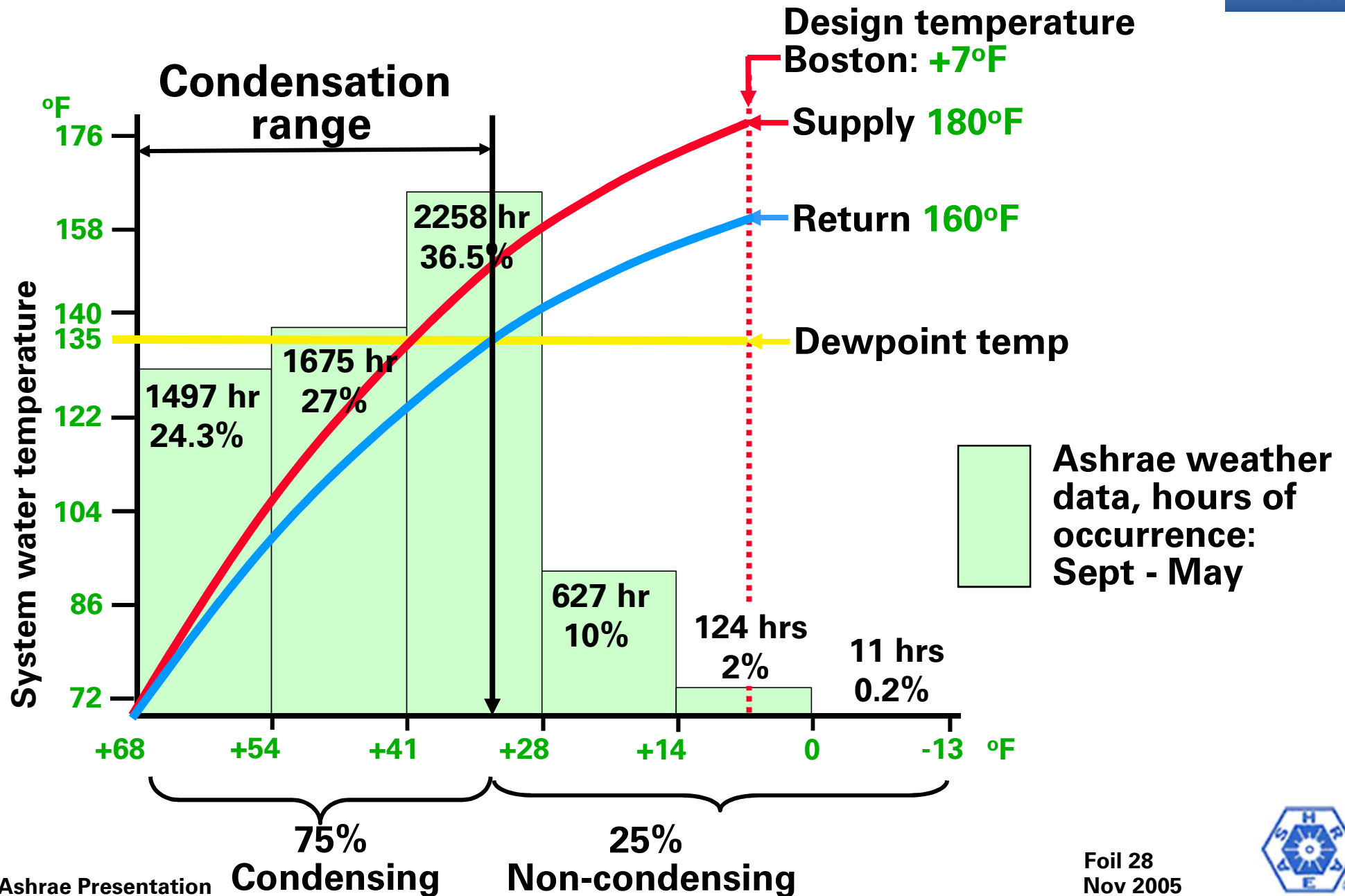
CONDENSING / NON CONDENSING RATIO

ASHRAE weather data for Boston, MA

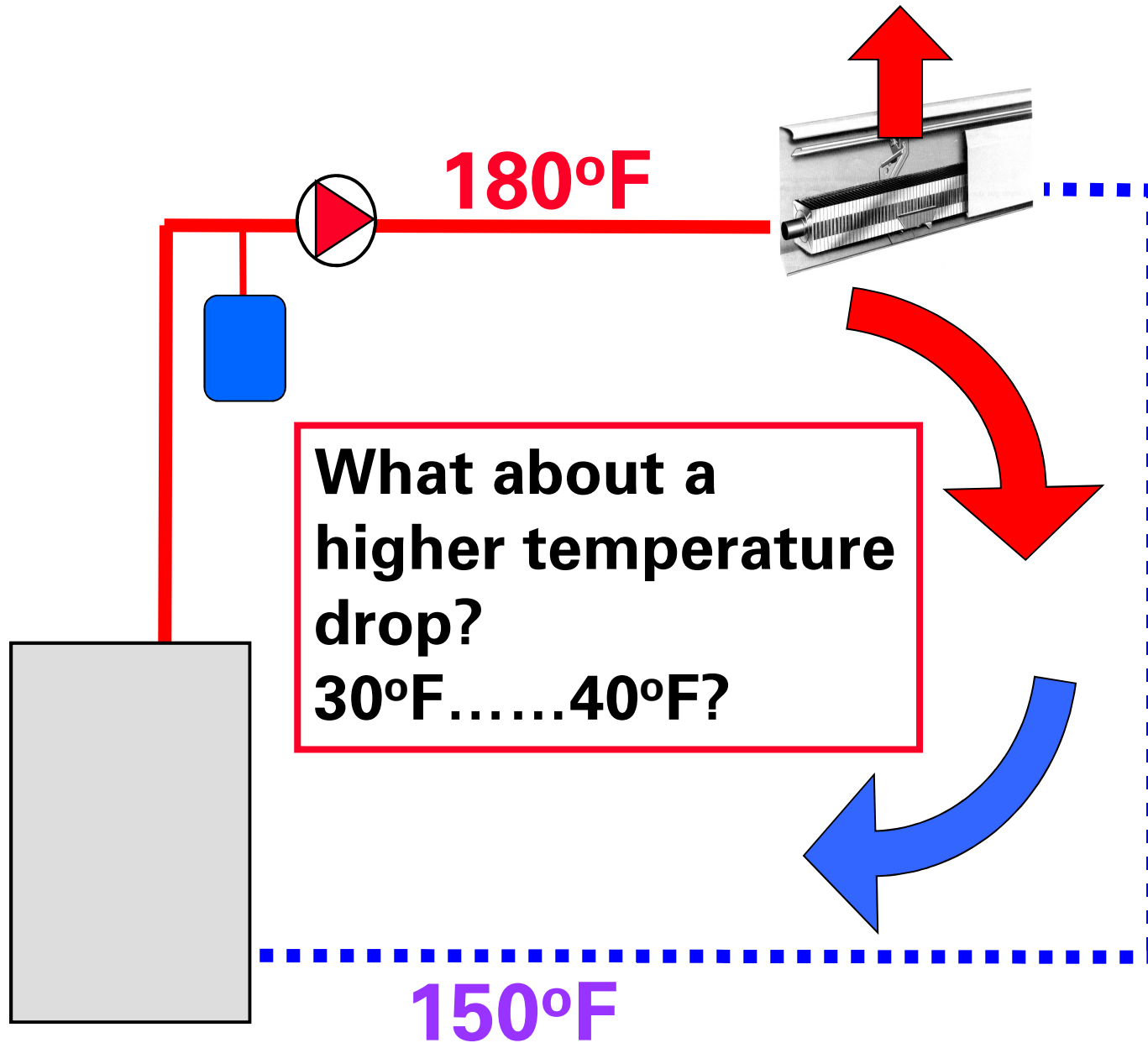


CONDENSING / NON CONDENSING RATIO

ASHRAE weather data for Boston, MA



SYSTEM WATER TEMPERATURE DROP

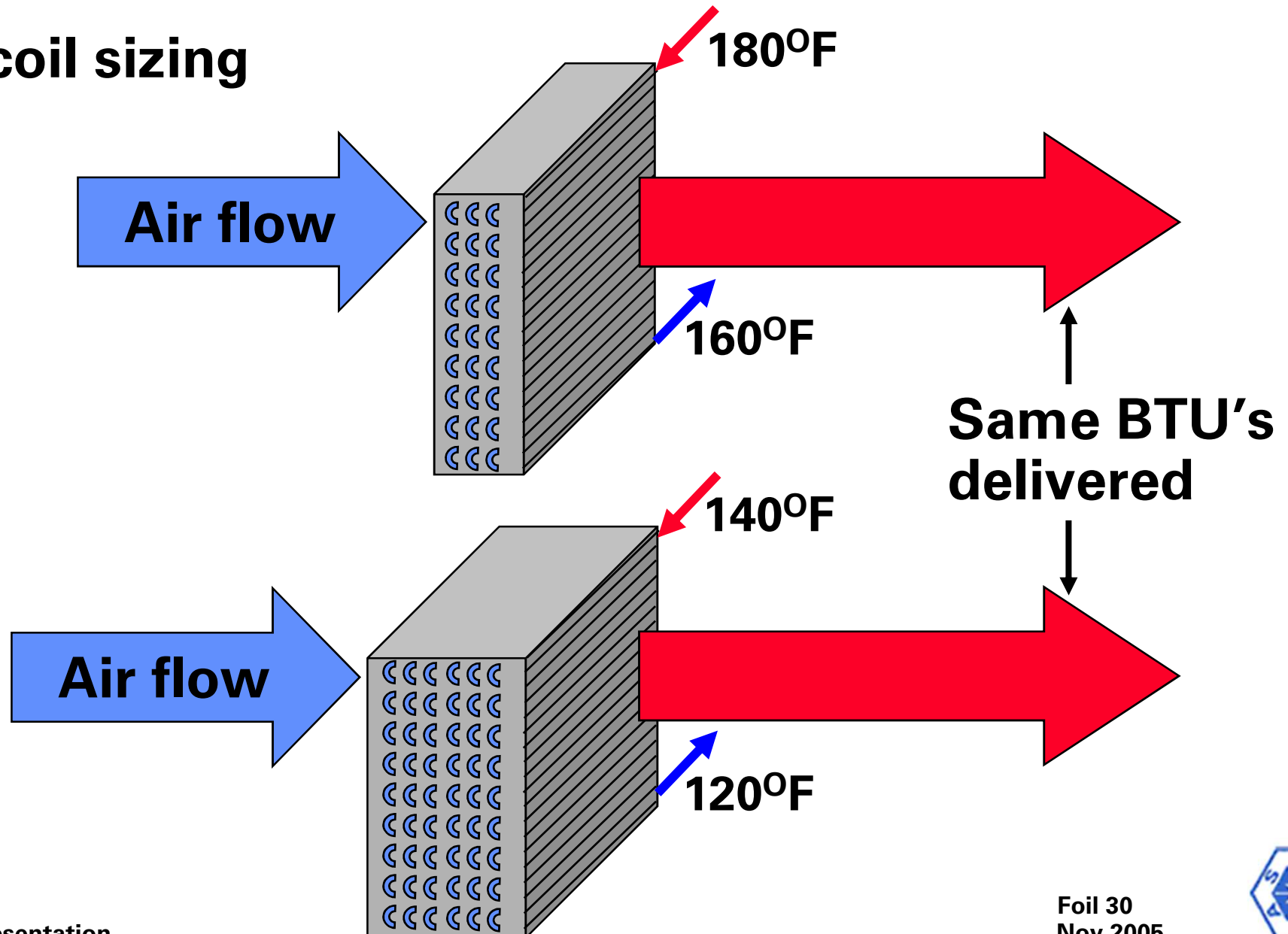


TRUE SYSTEM EFFICIENCY

System Components

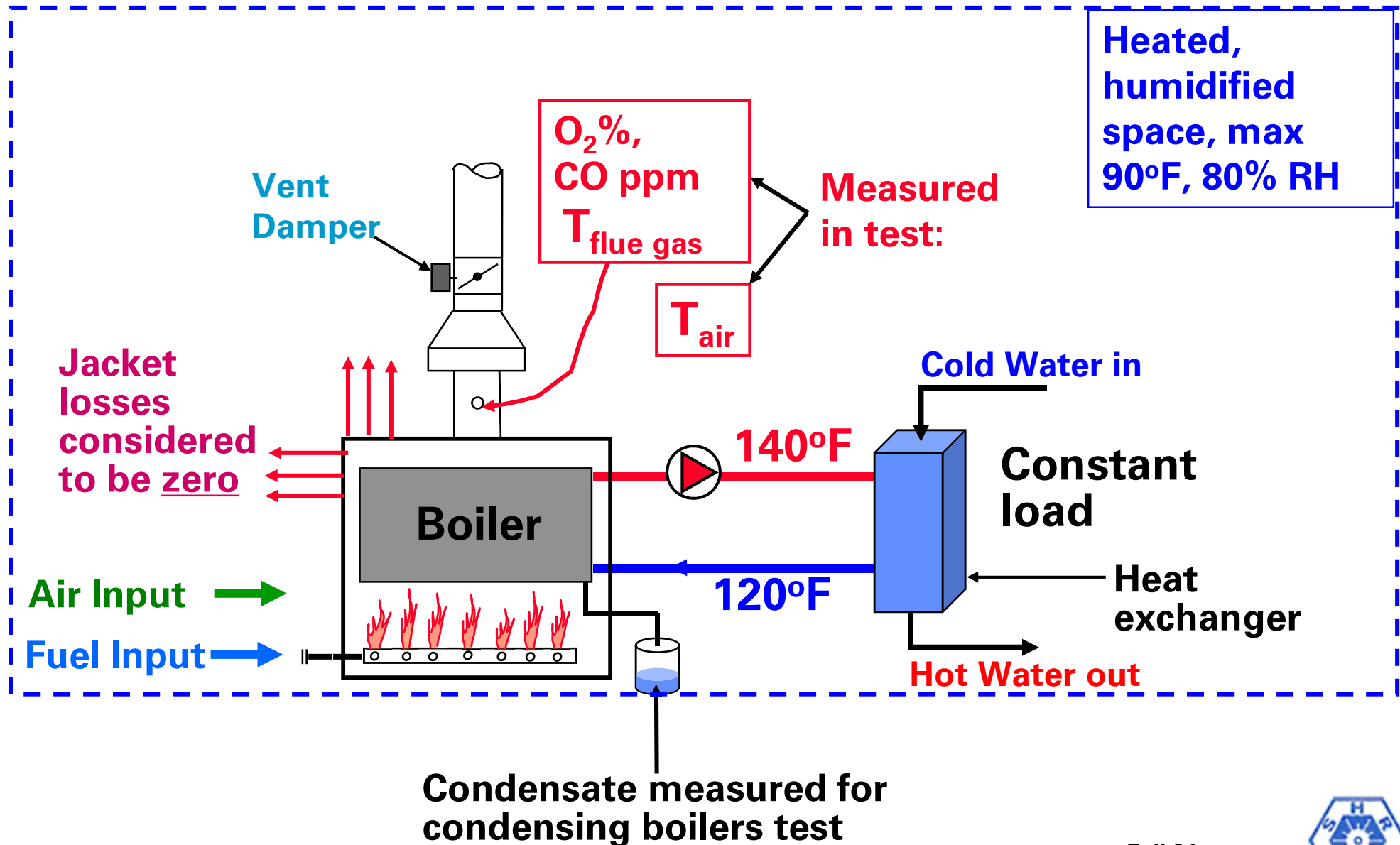


Fan coil sizing



ANNUAL FUEL UTILIZATION EFFICIENCY

For residential boilers < 300 MBH

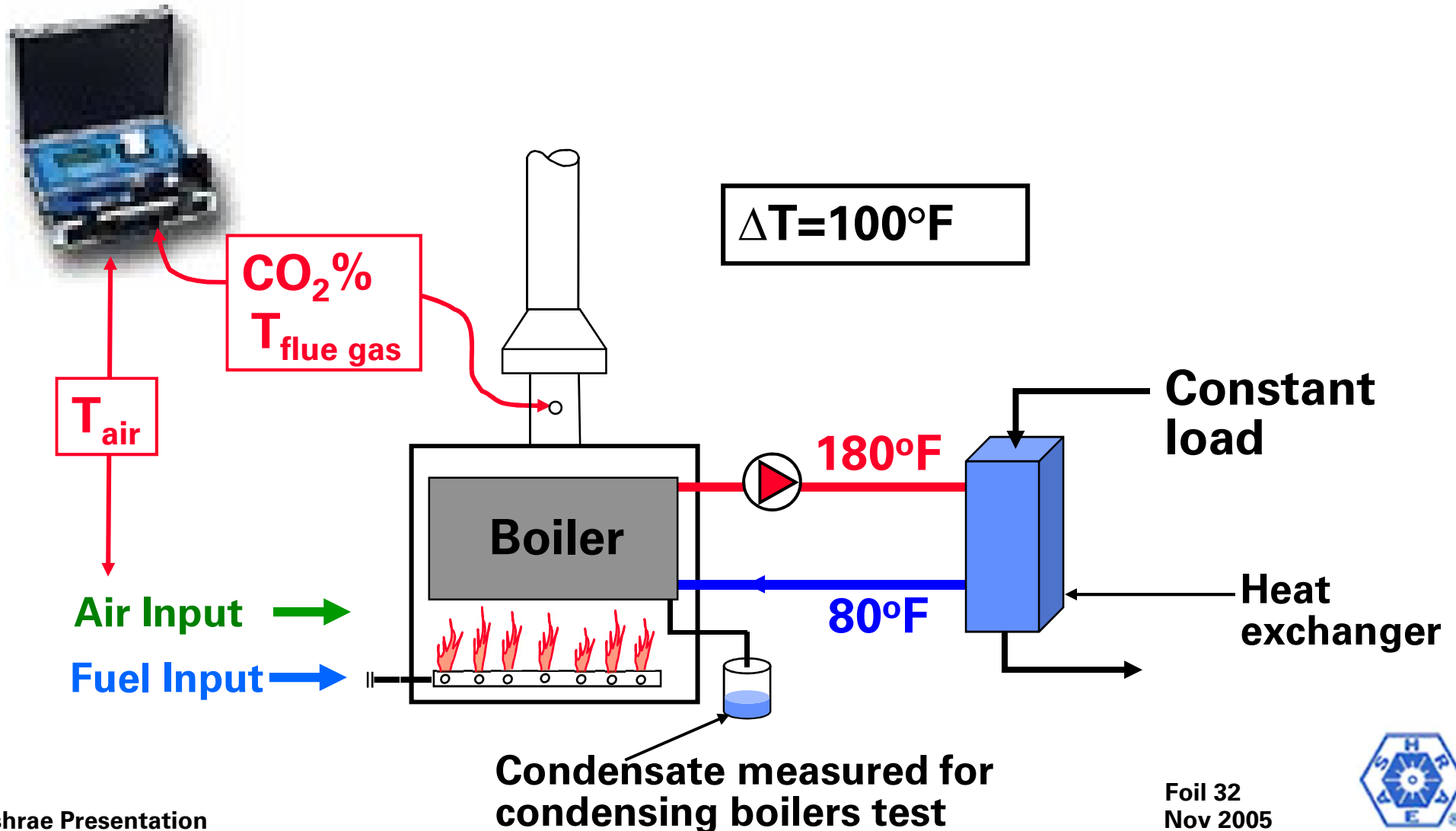


COMBUSTION EFFICIENCY

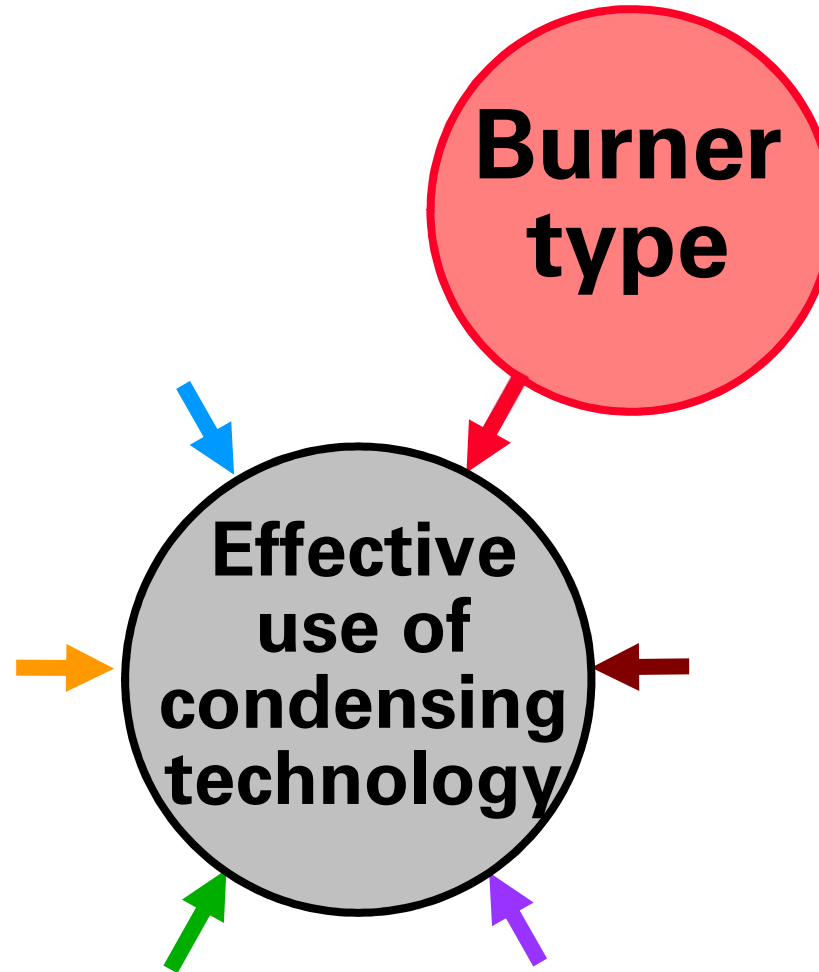
Testing for non-condensing gas commercial boilers



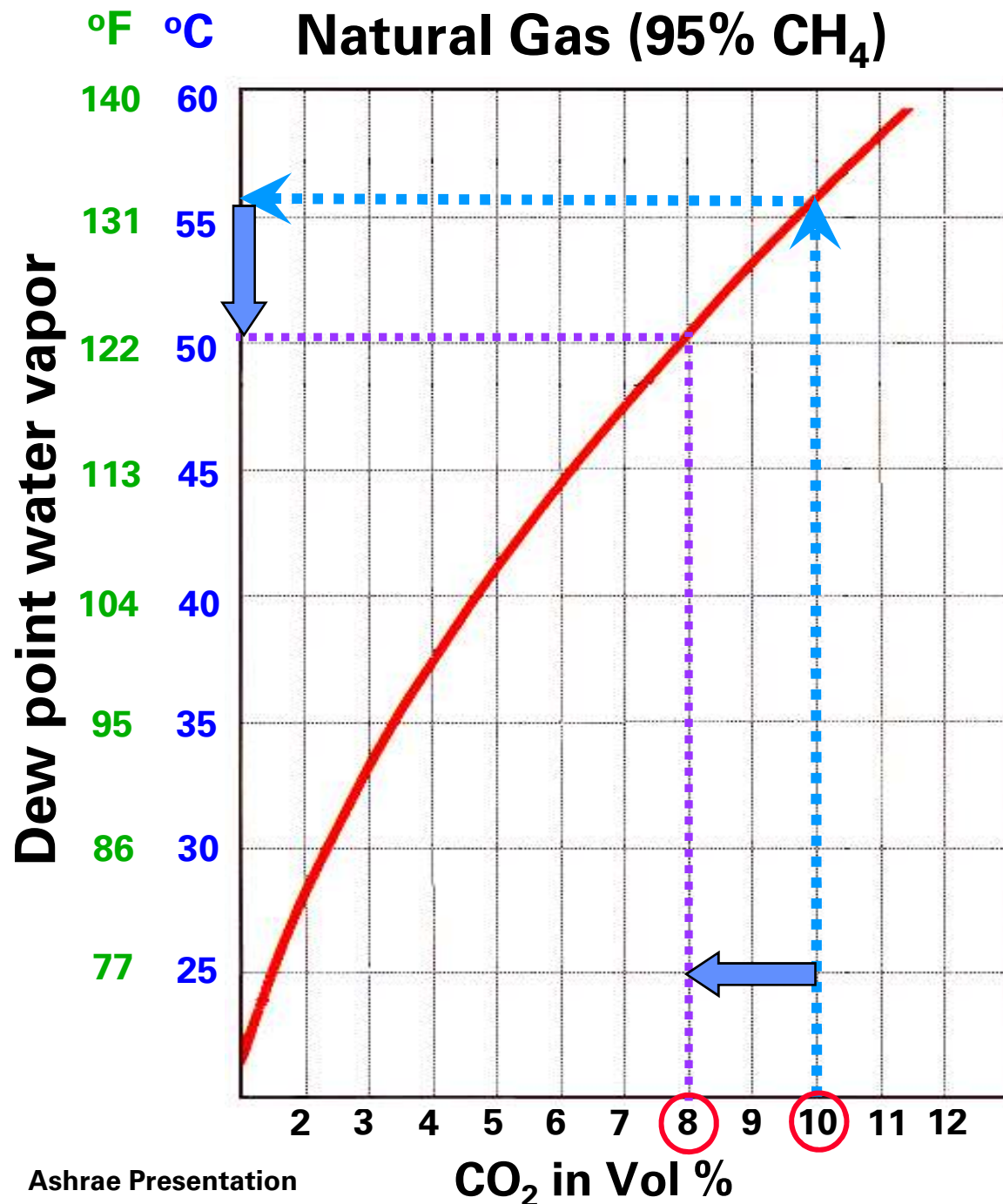
ANSI Z21.13 / CSA 4.9-2000



FACTORS INFLUENCING EFFECTIVENESS OF CONDENSING TECHNOLOGY

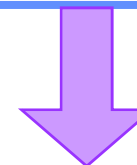


WATER VAPOR DEW POINT



CO₂% of flue gas influences dew point temperature

Higher CO₂
=Higher Dew point
=More Condensation



Lower CO₂
=Lower Dew point
=Less Condensation



CONDENSING BOILER TECHNOLOGY

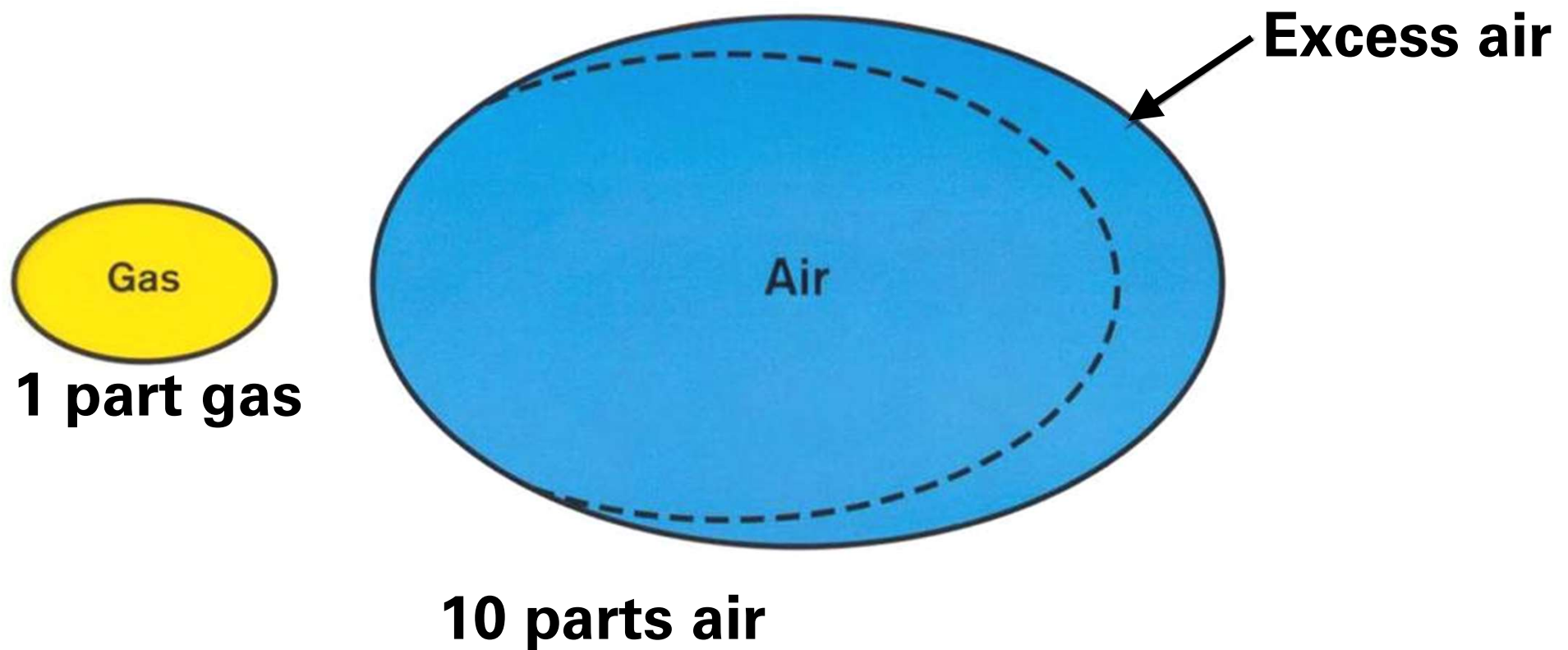


What influences the CO₂% ?

THE BURNER!

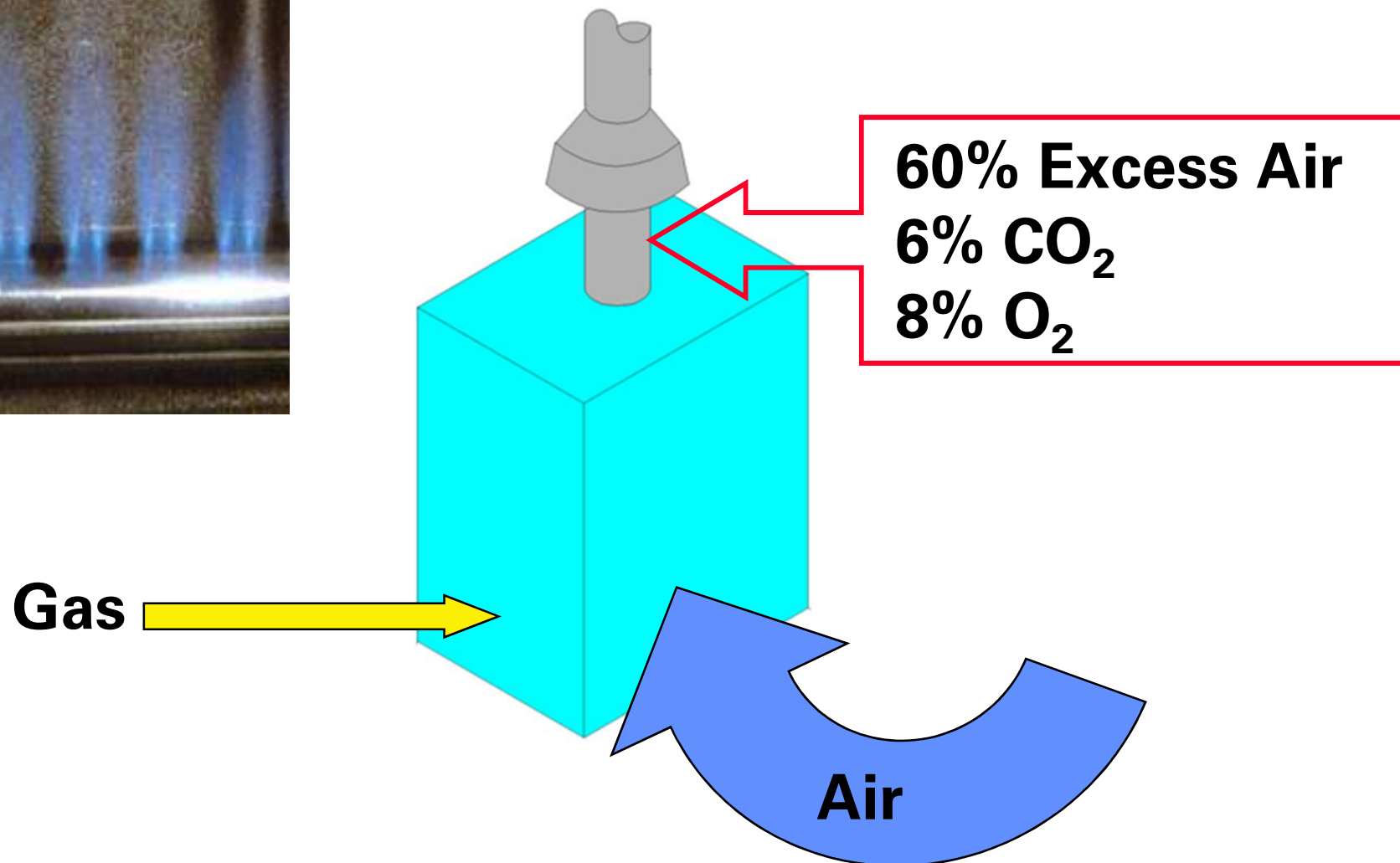


NATURAL GAS COMBUSTION



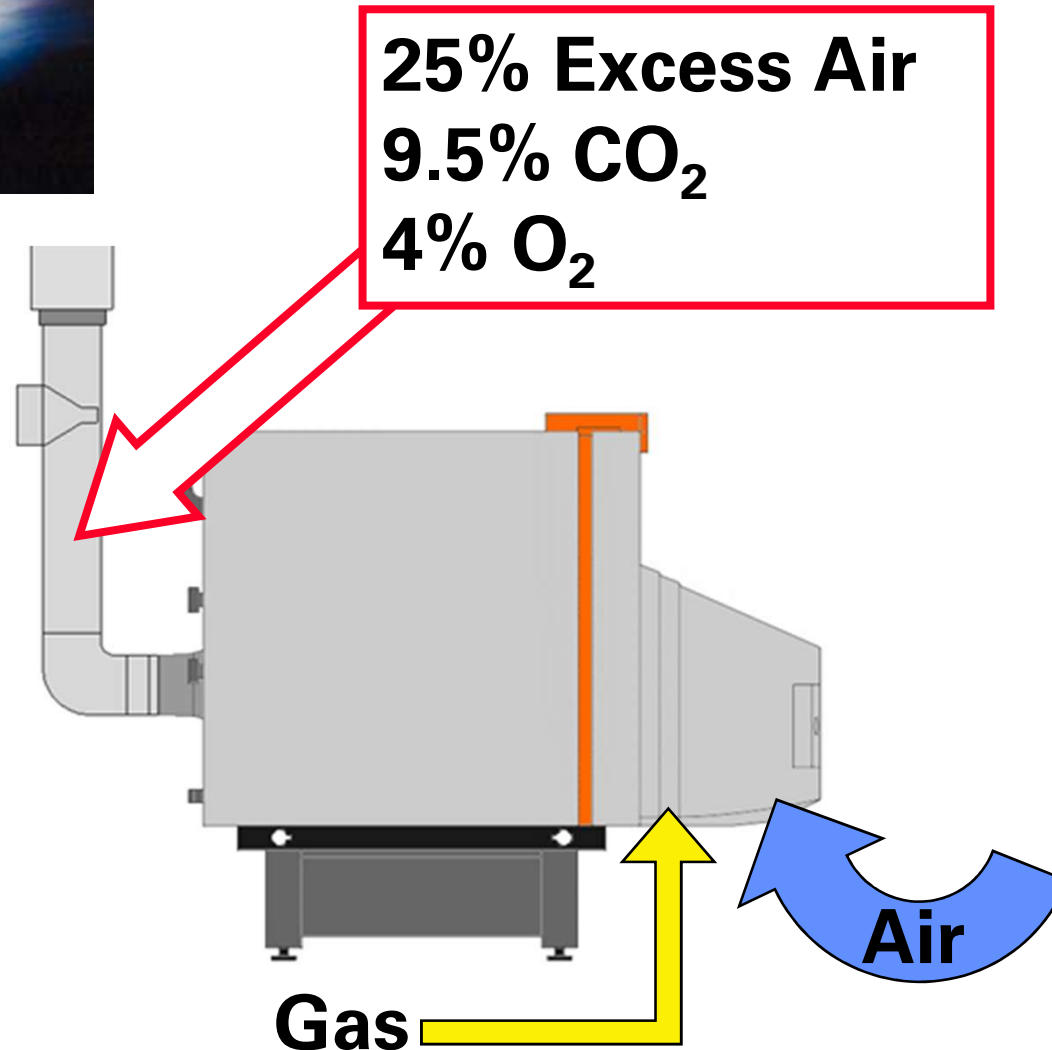
NATURAL GAS COMBUSTION

Atmospheric Burner technology



NATURAL GAS COMBUSTION

Power-fired burner technology



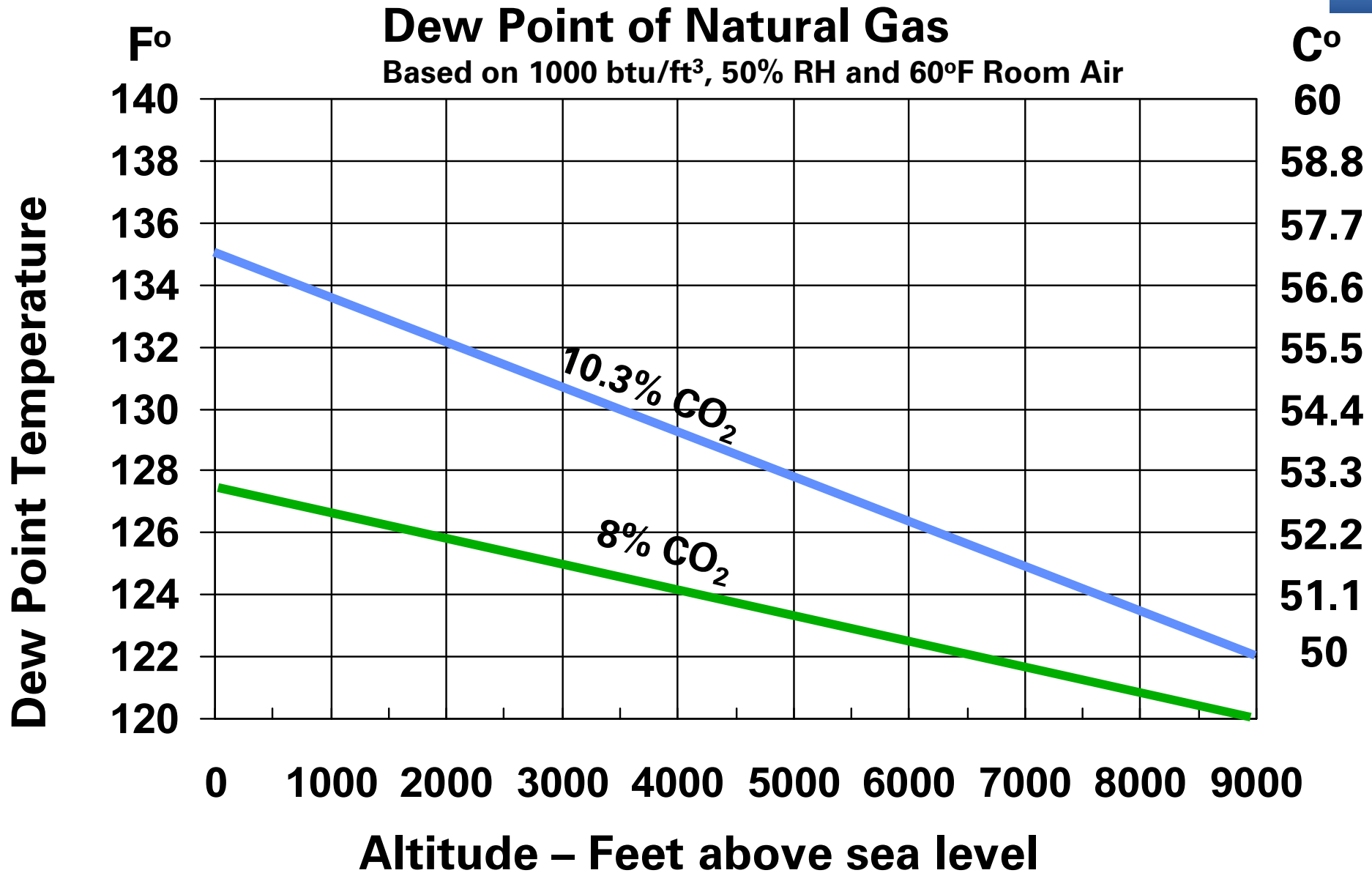
BURNER REQUIREMENTS FOR CONDENSING BOILERS



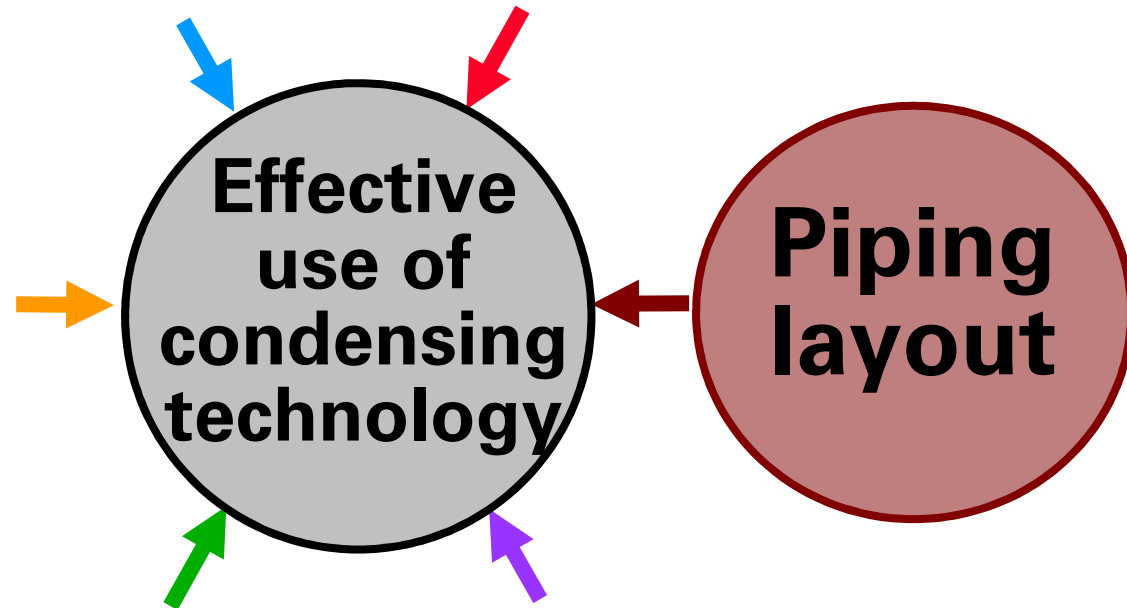
- **Combustion with minimal excess air**
 - **CO₂: 9.5 to 10%**
 - **Excess air: 20 – 25%**
- **Fully modulating input**
- **Precise calibration thru entire firing range**
- **Low NO_x and CO emissions**



DEW POINT AND ALTITUDE

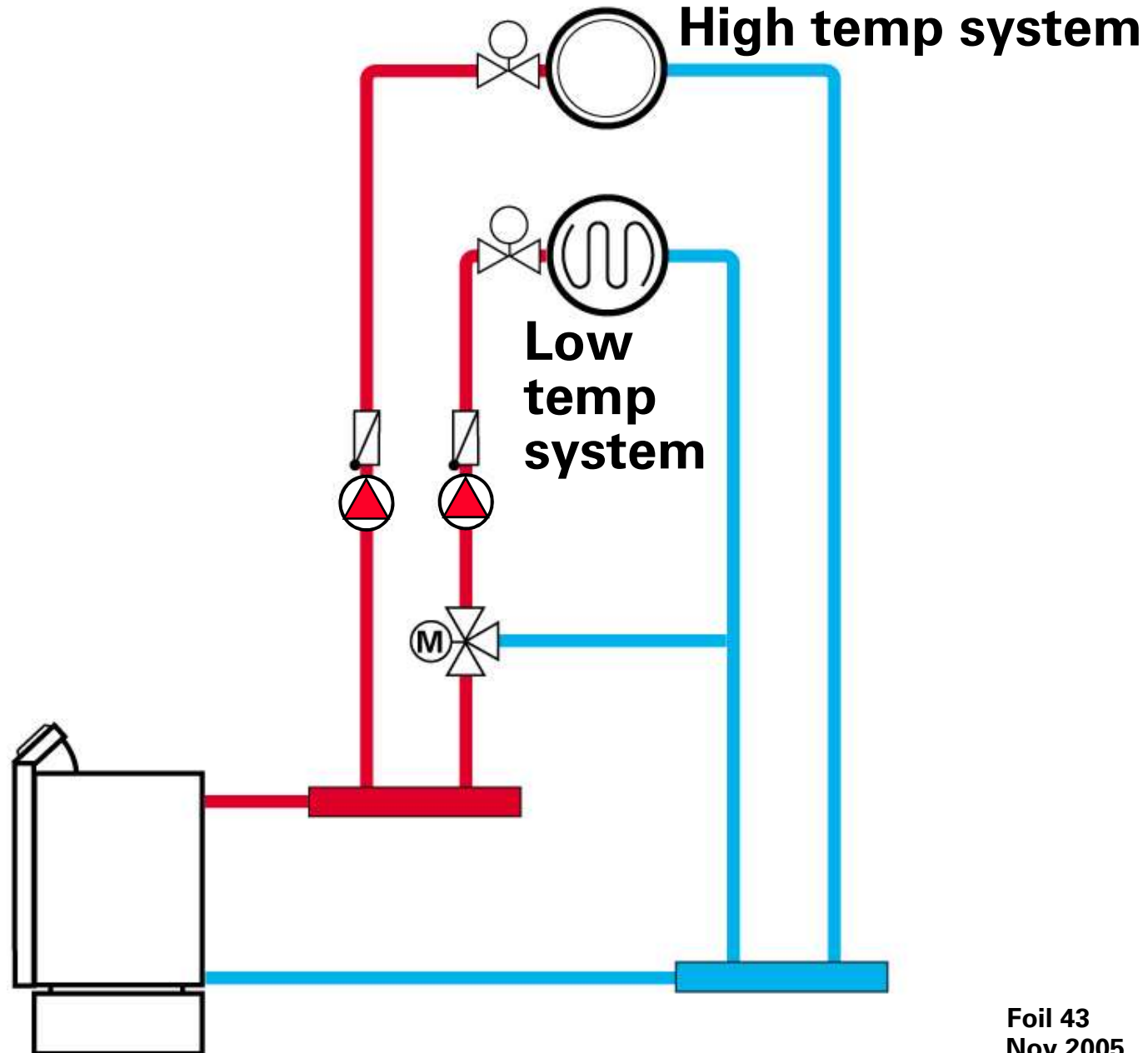


FACTORS INFLUENCING EFFECTIVENESS OF CONDENSING TECHNOLOGY

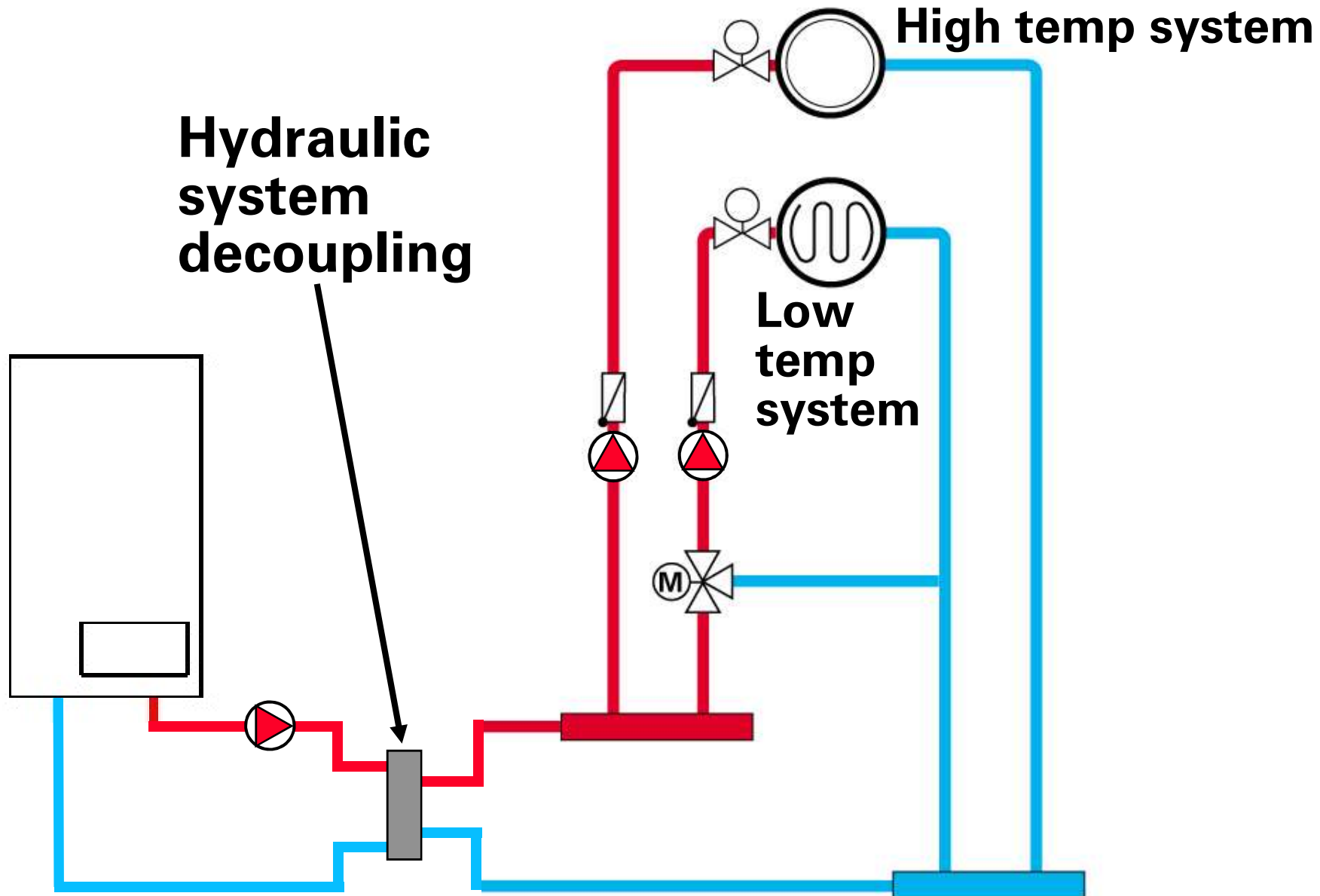




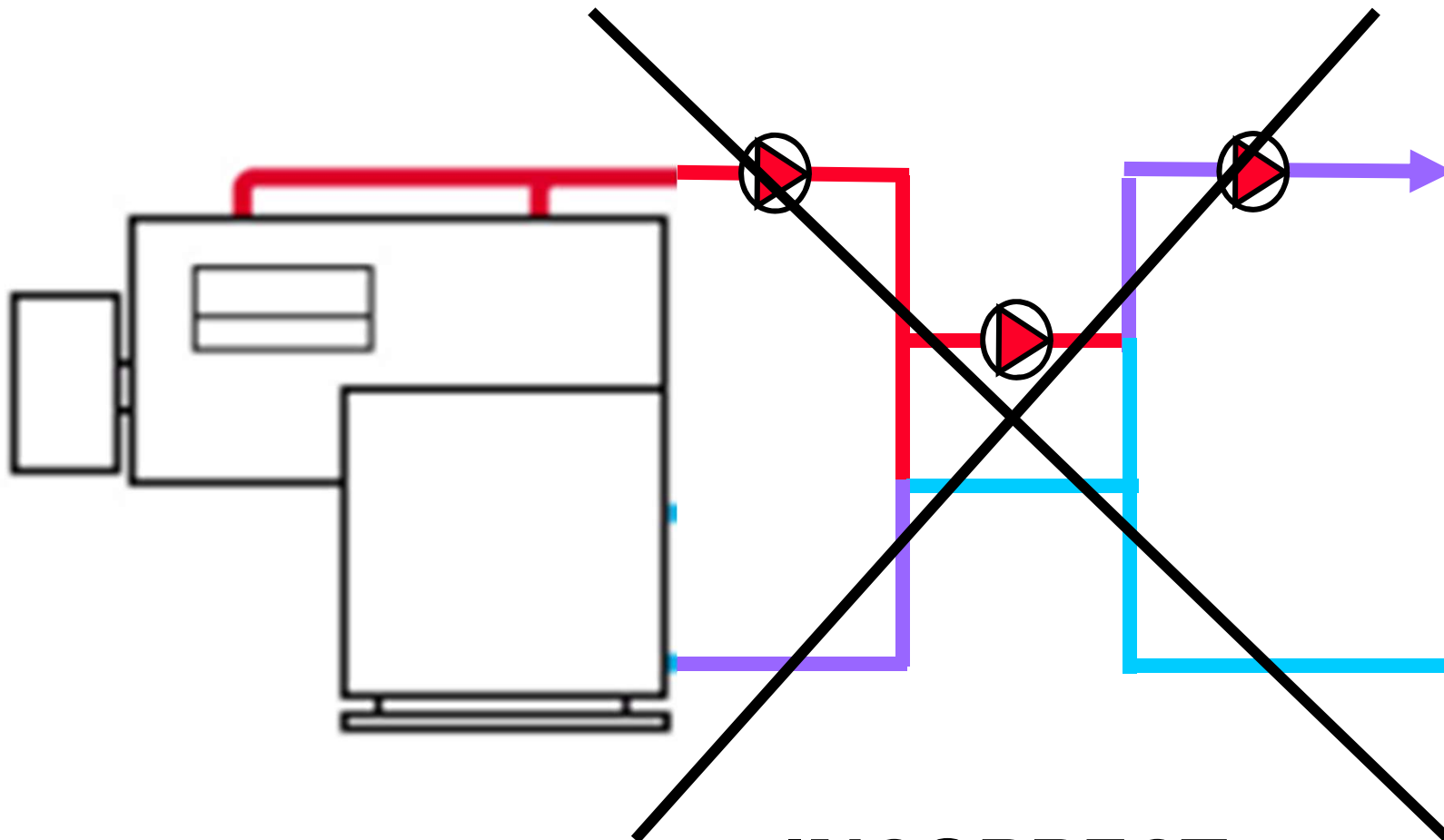
CONDENSING BOILERS IN TWO TEMPERATURE SYSTEMS



CONDENSING BOILERS IN HIGH FLOW SYSTEMS



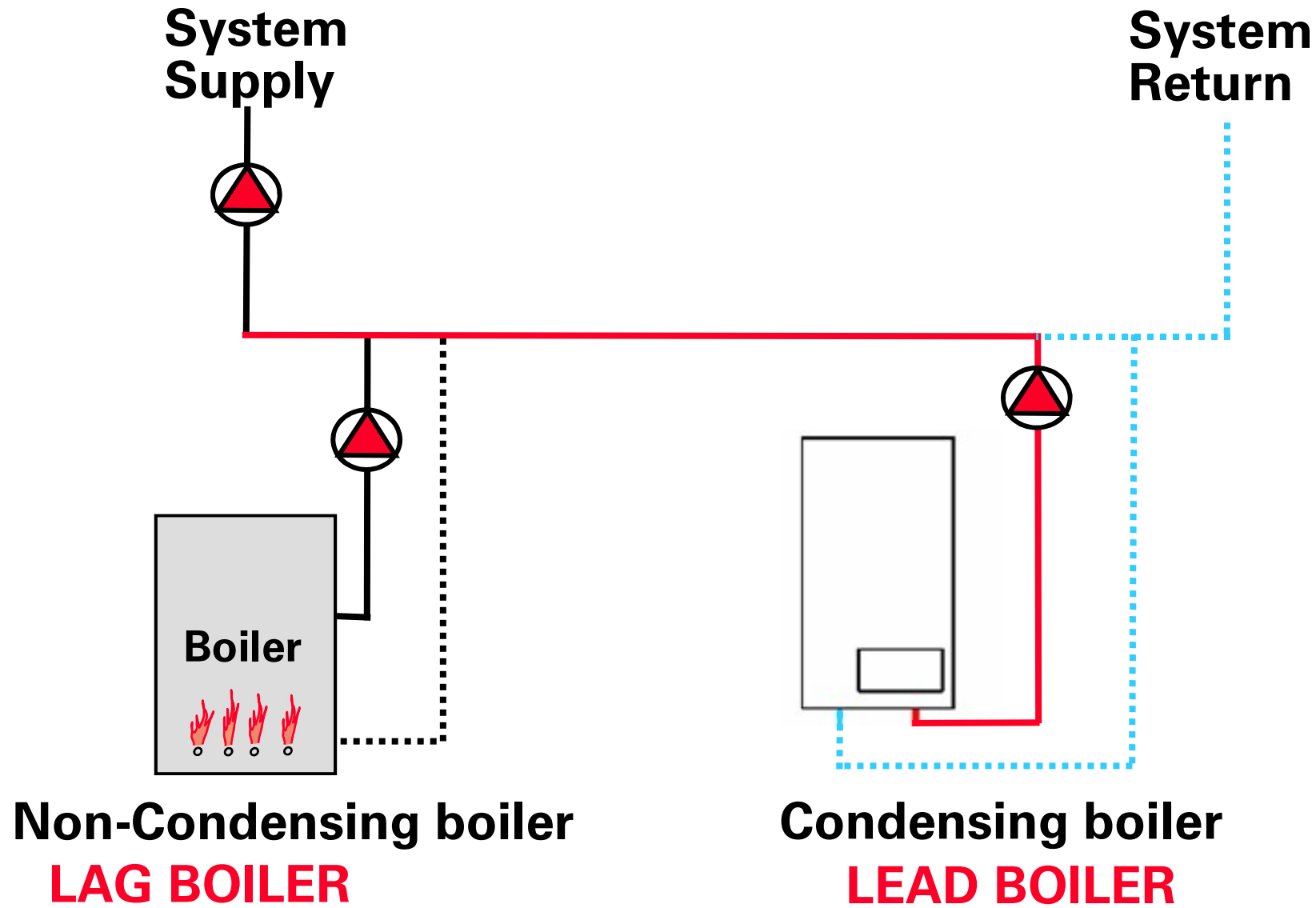
INJECTION PUMPING WITH CONDENSING BOILERS



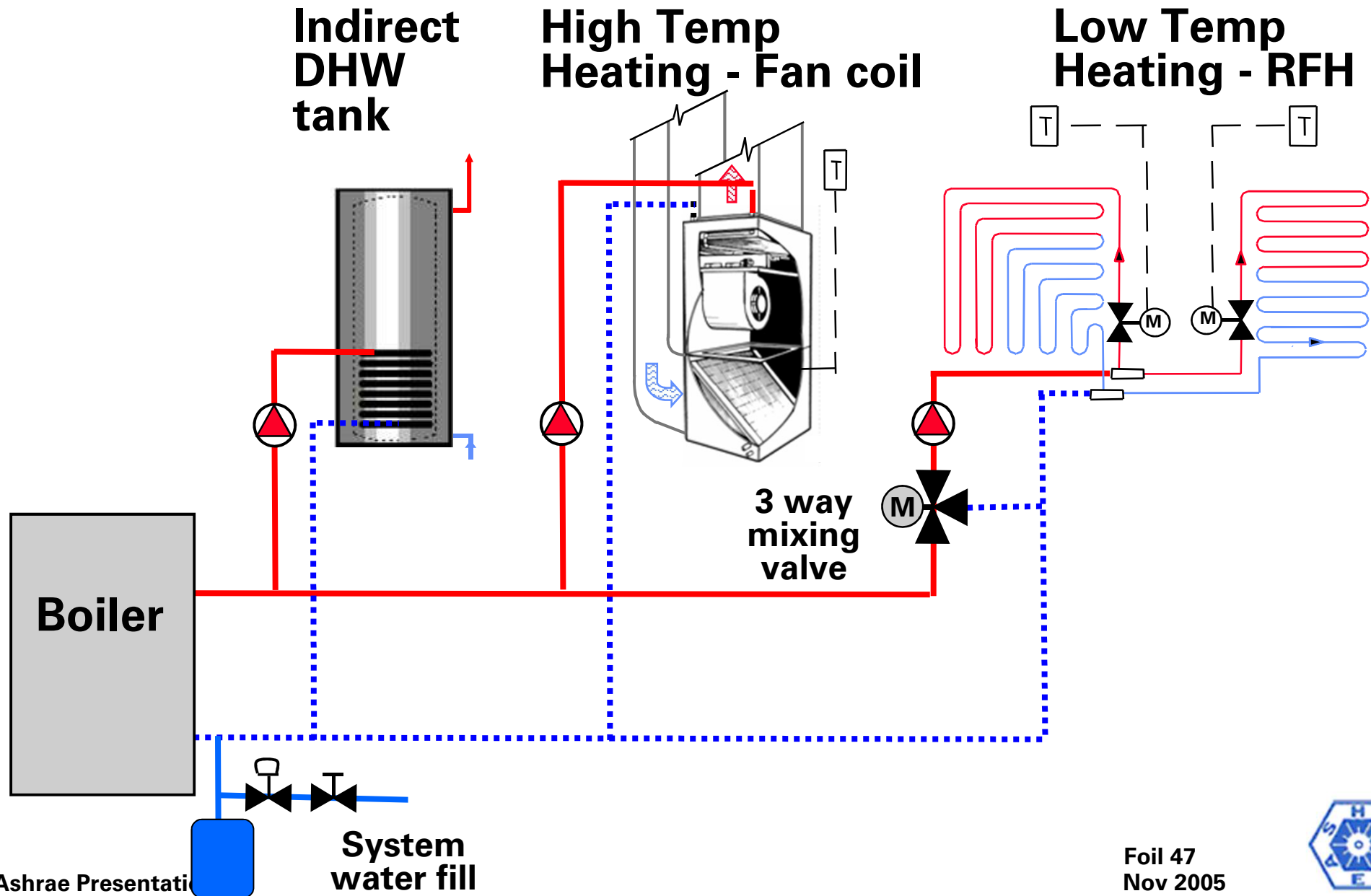
INCORRECT



COMBINATION OF BOILERS



MULTIPLE FUNCTION, MULTIPLE TEMPERATURE SYSTEM

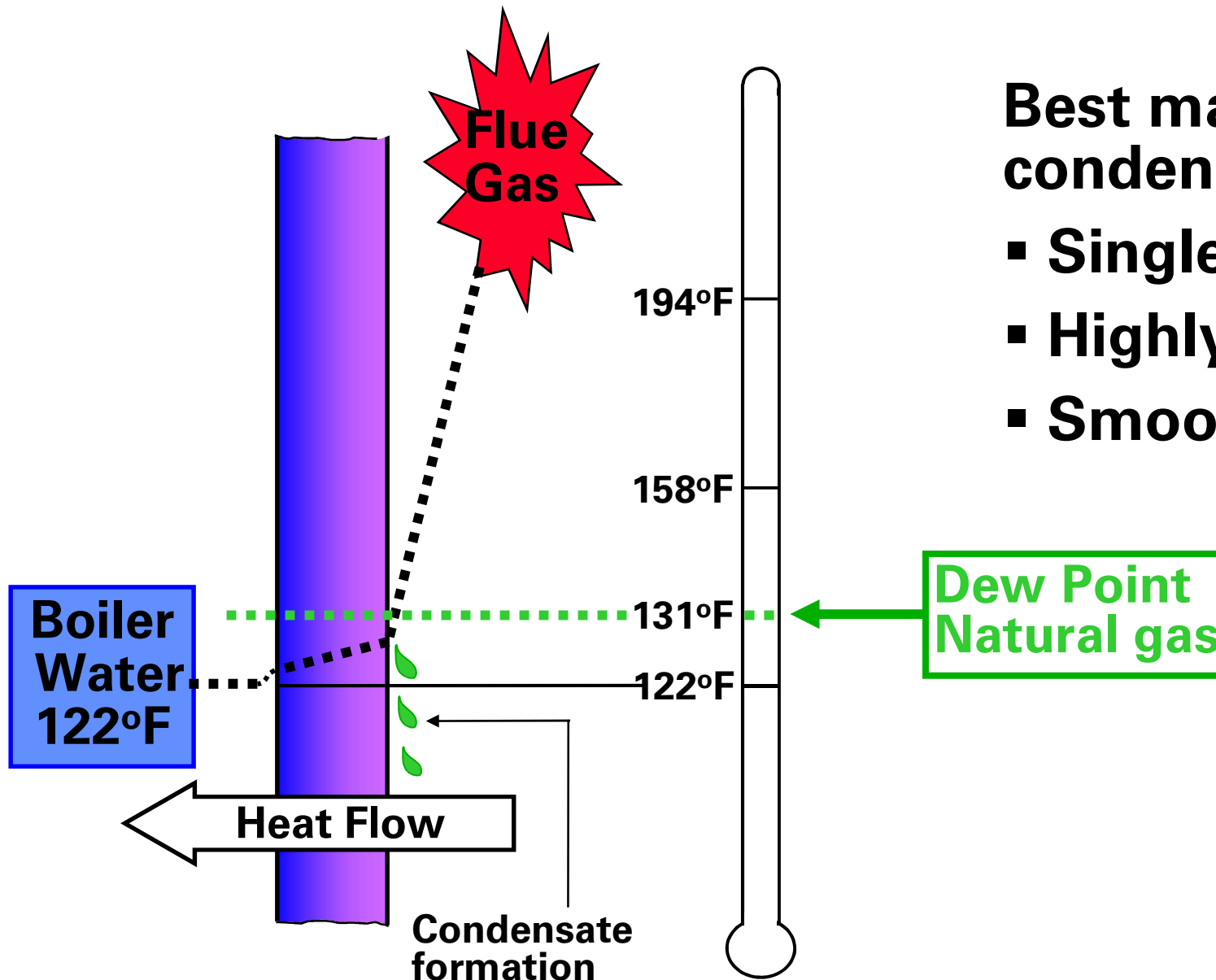




Construction requirements of condensing boiler technology



PHYSICAL REQUIREMENTS OF THE HEAT EXCHANGER SURFACES

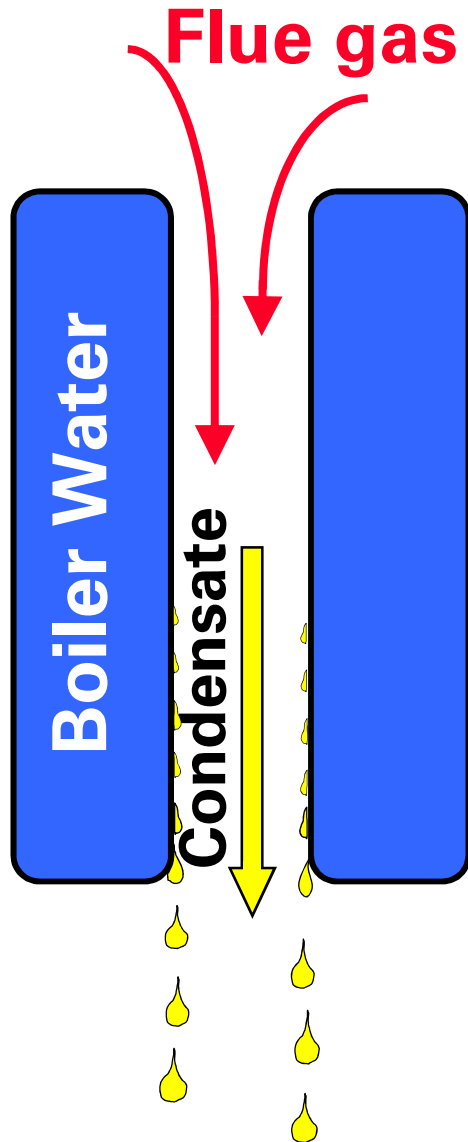


Best material for condensing boilers:

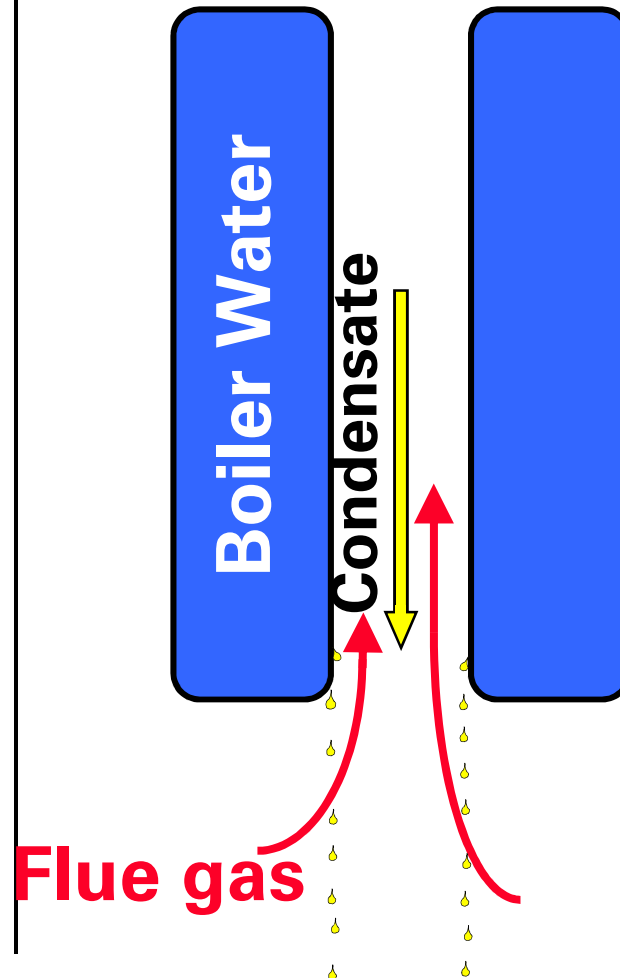
- Single wall
- Highly conductive
- Smooth surface



PHYSICAL REQUIREMENTS OF THE FLUE GAS AND CONDENSATE PASSAGE WAYS



CORRECT



INCORRECT

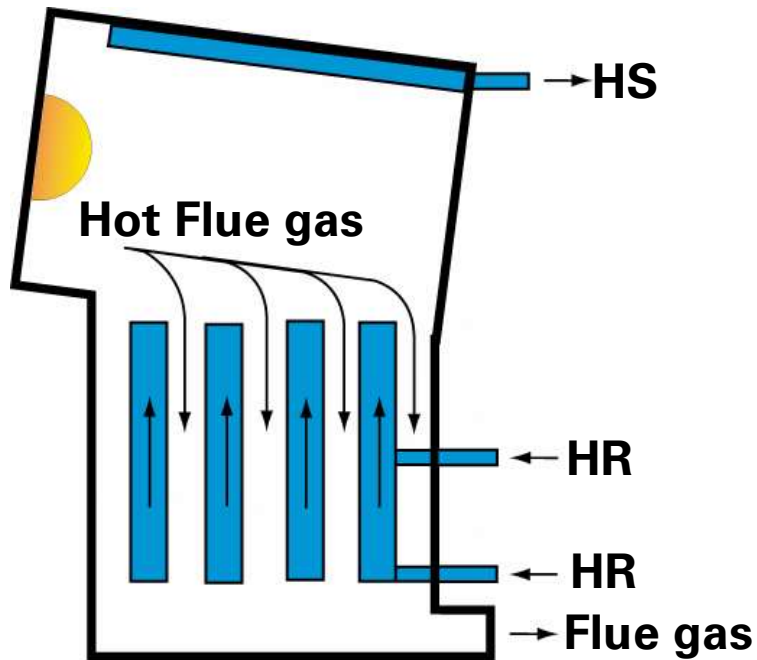
Flue gas and condensate must flow in the same direction (parallel flow)



CONDENSING BOILER CONSTRUCTION



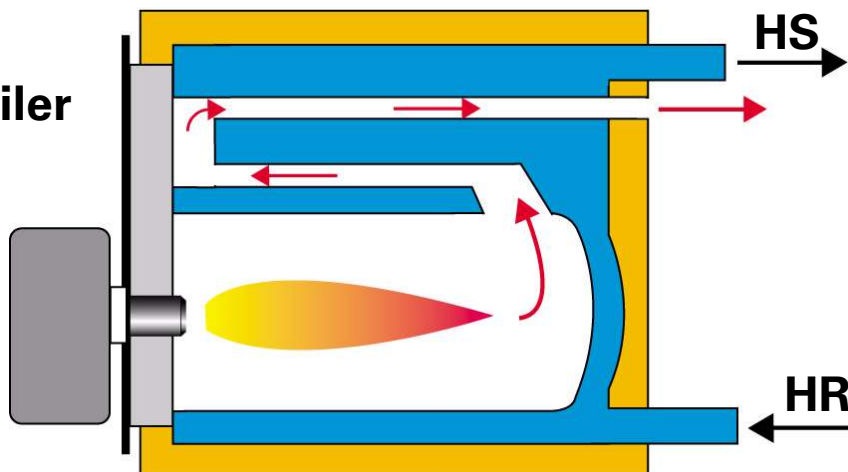
Condensing boiler



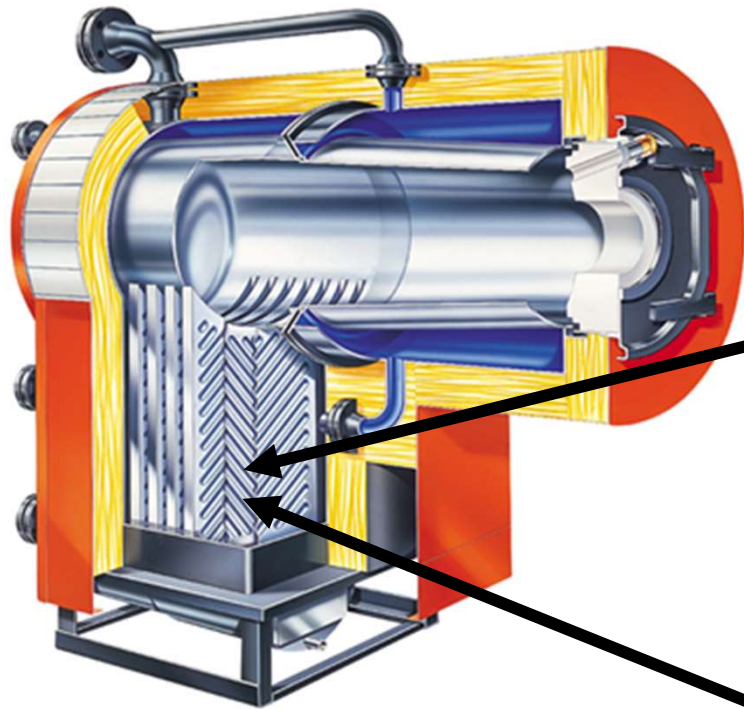
Condensing boiler requirements:

- Counterflow principle for flue gas and boiler water – optimal heat transfer
- Parallel flow direction for flue gas and condensate – uniform flow with self-cleaning effect of heat transfer surfaces

Normal heating boiler



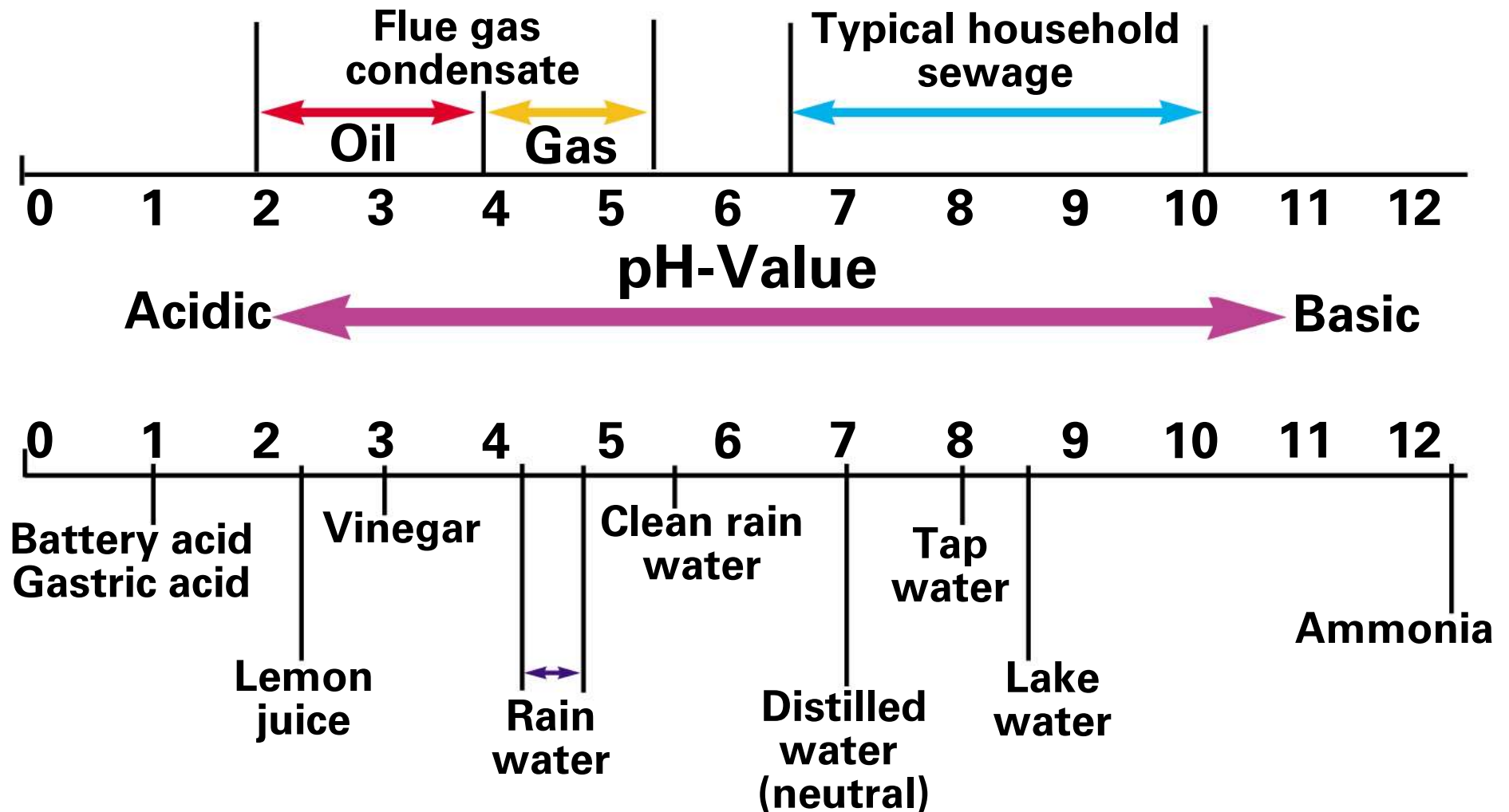
HEAT EXCHANGER CONSTRUCTION



Why is material construction of the boiler heat exchanger so important?



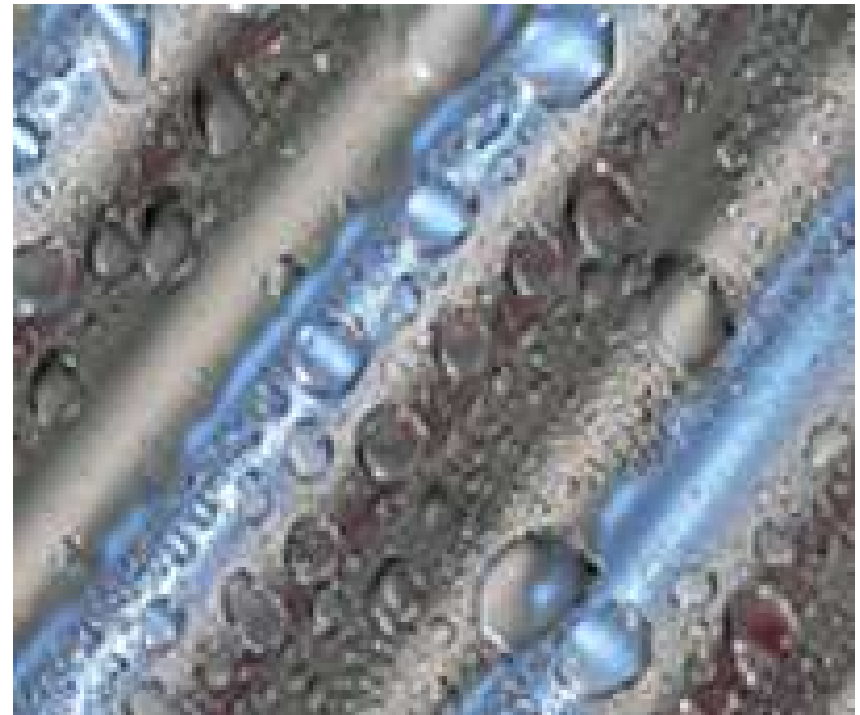
pH VALUES OF VARIOUS FLUIDS



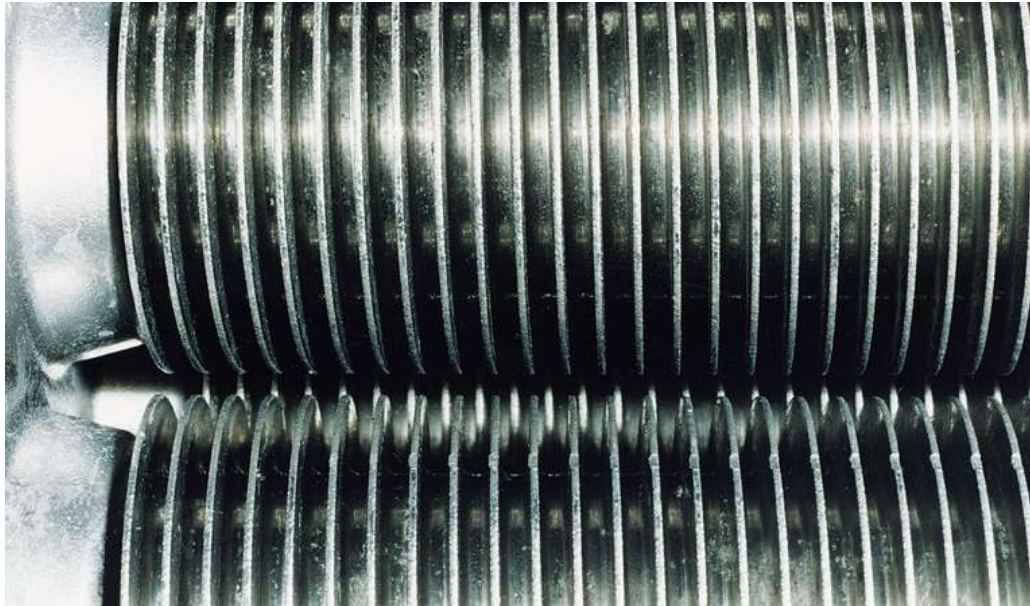
MATERIAL REQUIREMENTS FOR CONDENSING BOILERS



- **Highly corrosion resistant**
- **High strength with thin wall thickness**
- **Formable**
- **Long term reliability**



FINNED TUBE HEAT EXCHANGERS



**New aluminum fin
heat exchanger
surface**



**Same heat exchanger
surface after short term
use**



CONDENSATE DISPOSAL



**How much condensate will
be produced?**

What do we do with it?



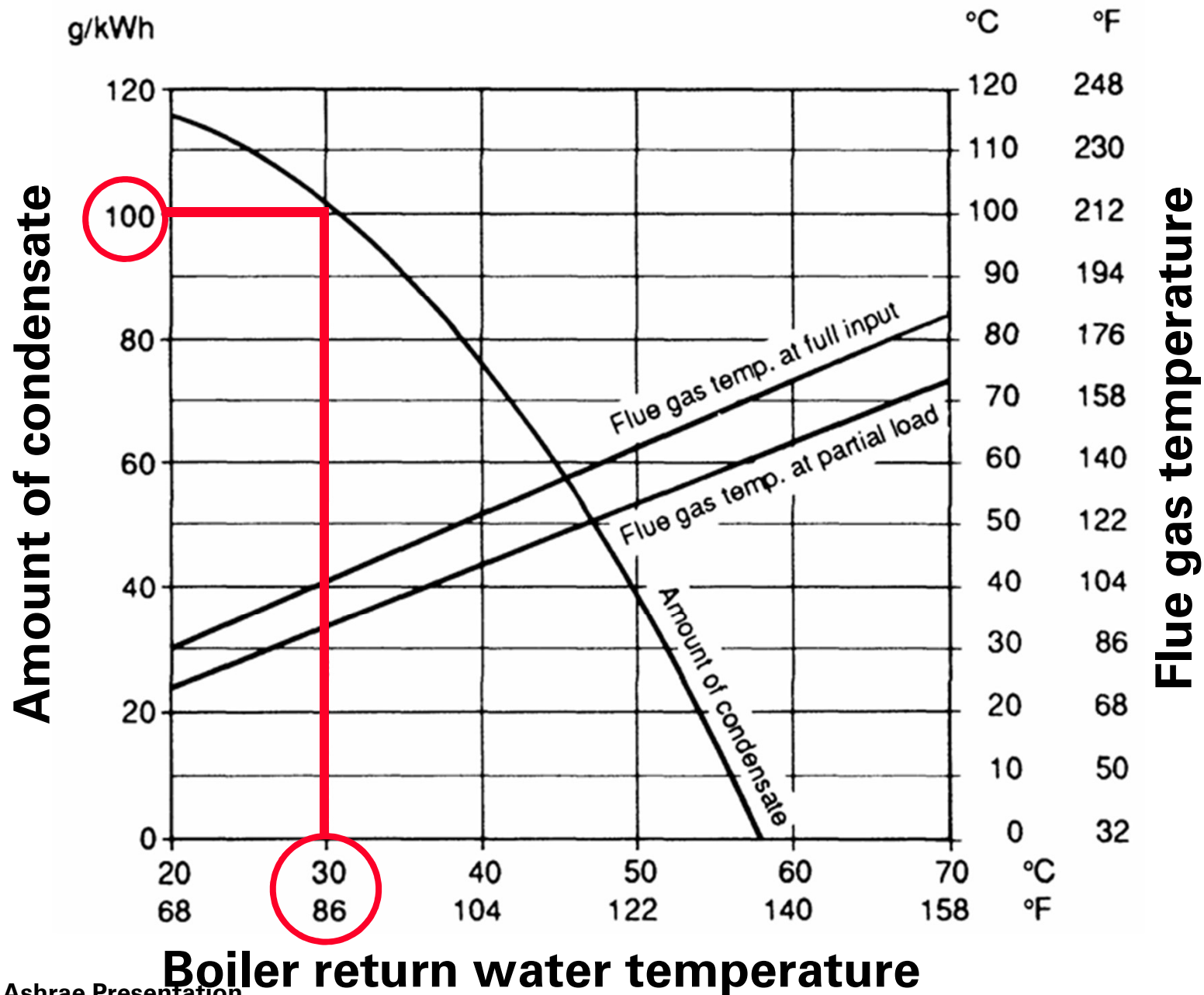


Components Tested	Drinking Water Limits	Wine	Vertomat 05 - 89 DIN-DVGW Test
	mg/ltr.	mg/ltr.	mg/ltr.
Lead	0.04	0.1 - 0.3	< 0.01
Cadmium	0.005	0.001	< 0.005
Chrome	0.05	0.06 - 0.03	< 0.01
Copper	3.0*	0.5	< 0.01
Nickel	0.05	0.05 - 0.03	< 0.01
Mercury	0.001	0.00005	< 0.0001
Vanadium	-	0.26 - 0.06	not determined
Zinc	5.0*	3.5 - 0.5	< 0.05
Tin	-	0.7 - 0.01	< 0.05
Sulphate	240	5 - 10	4.6
pH Value	6.5 - 9.5	3 - 4 (at 1.9 - 07 g/ltr. tartaric acid)	3.5 - 5 Without neutralization

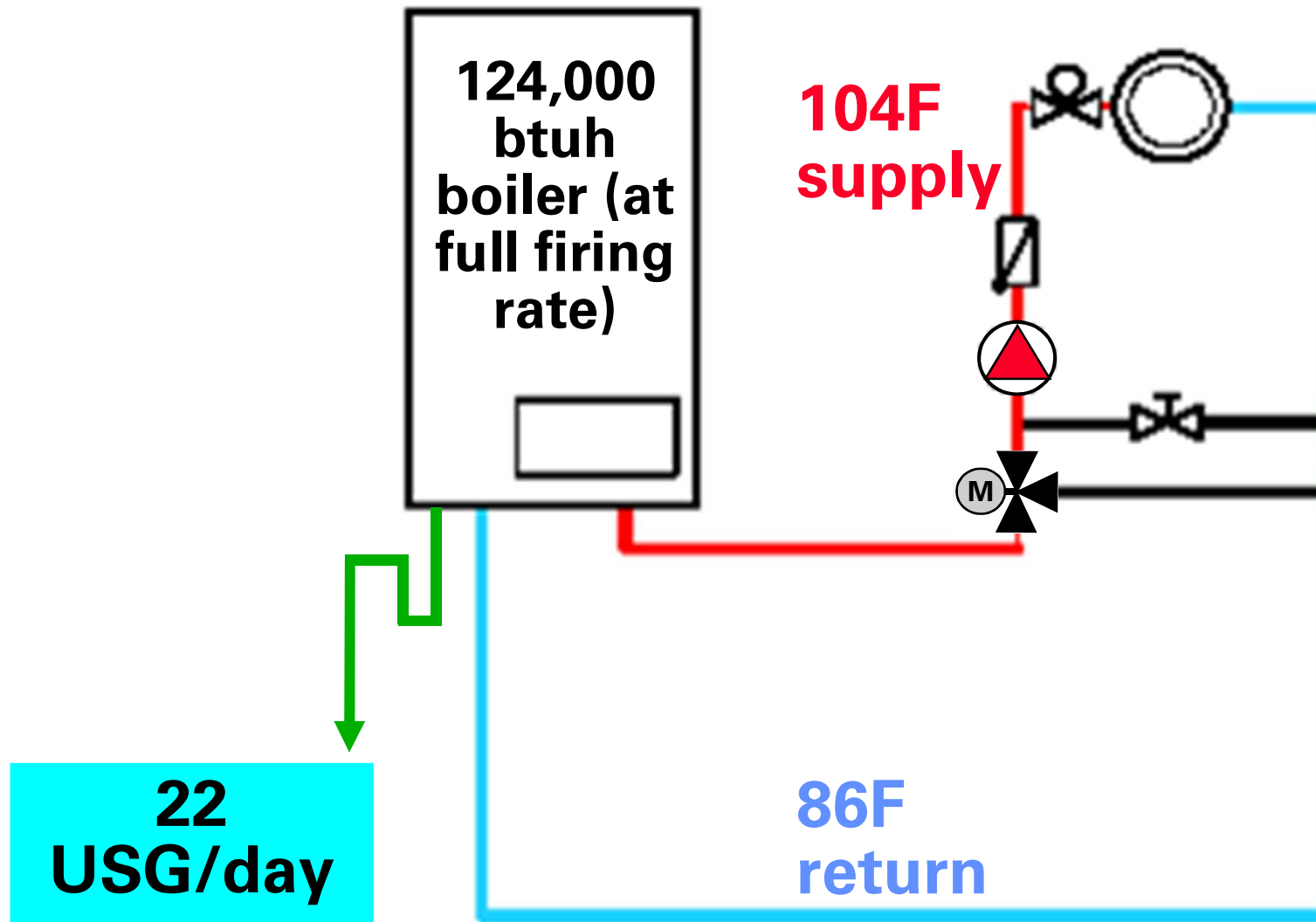
Comparison of condensate components



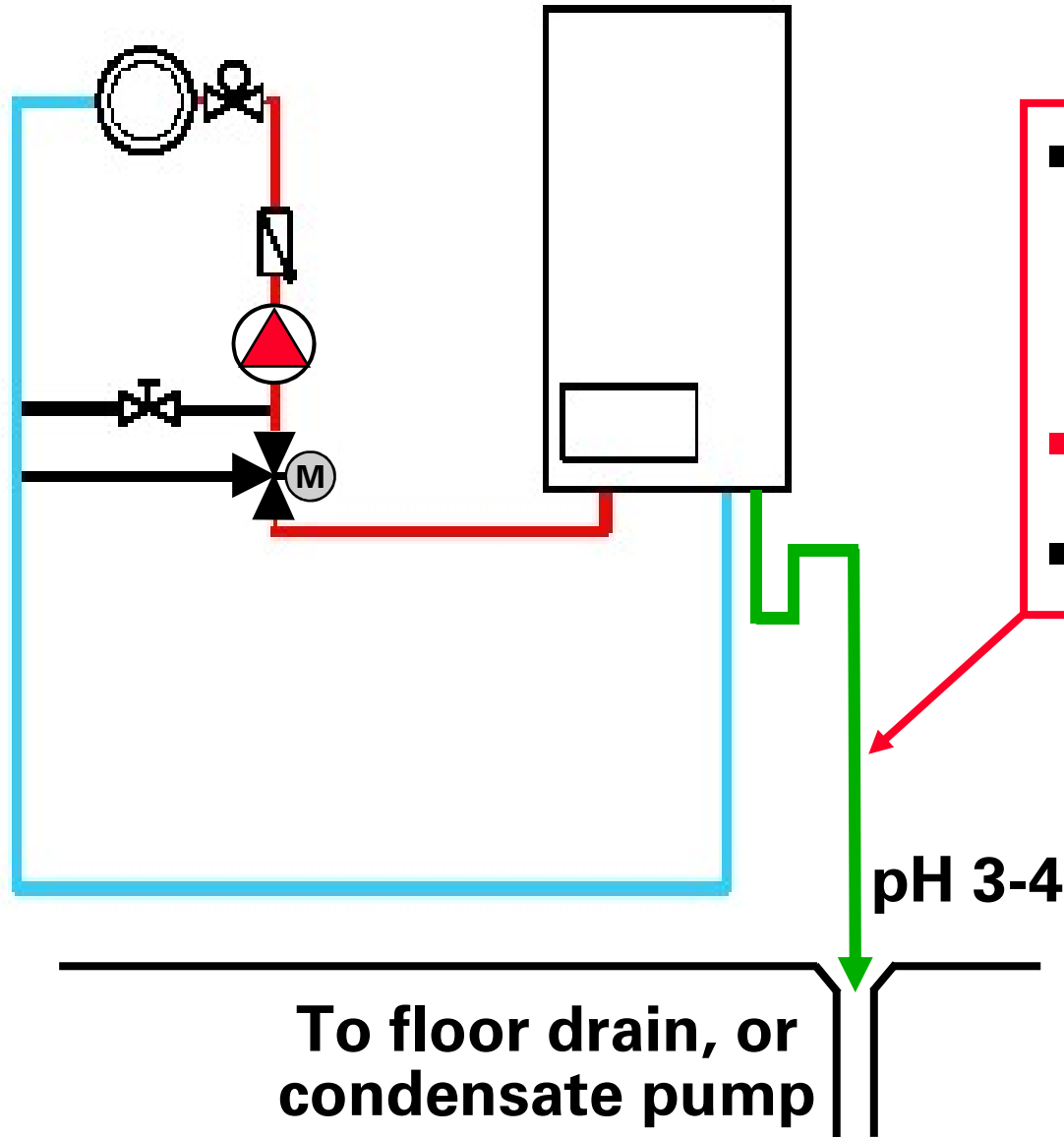
CONDENSATE FLOW RATE



CONDENSATE FLOW RATE



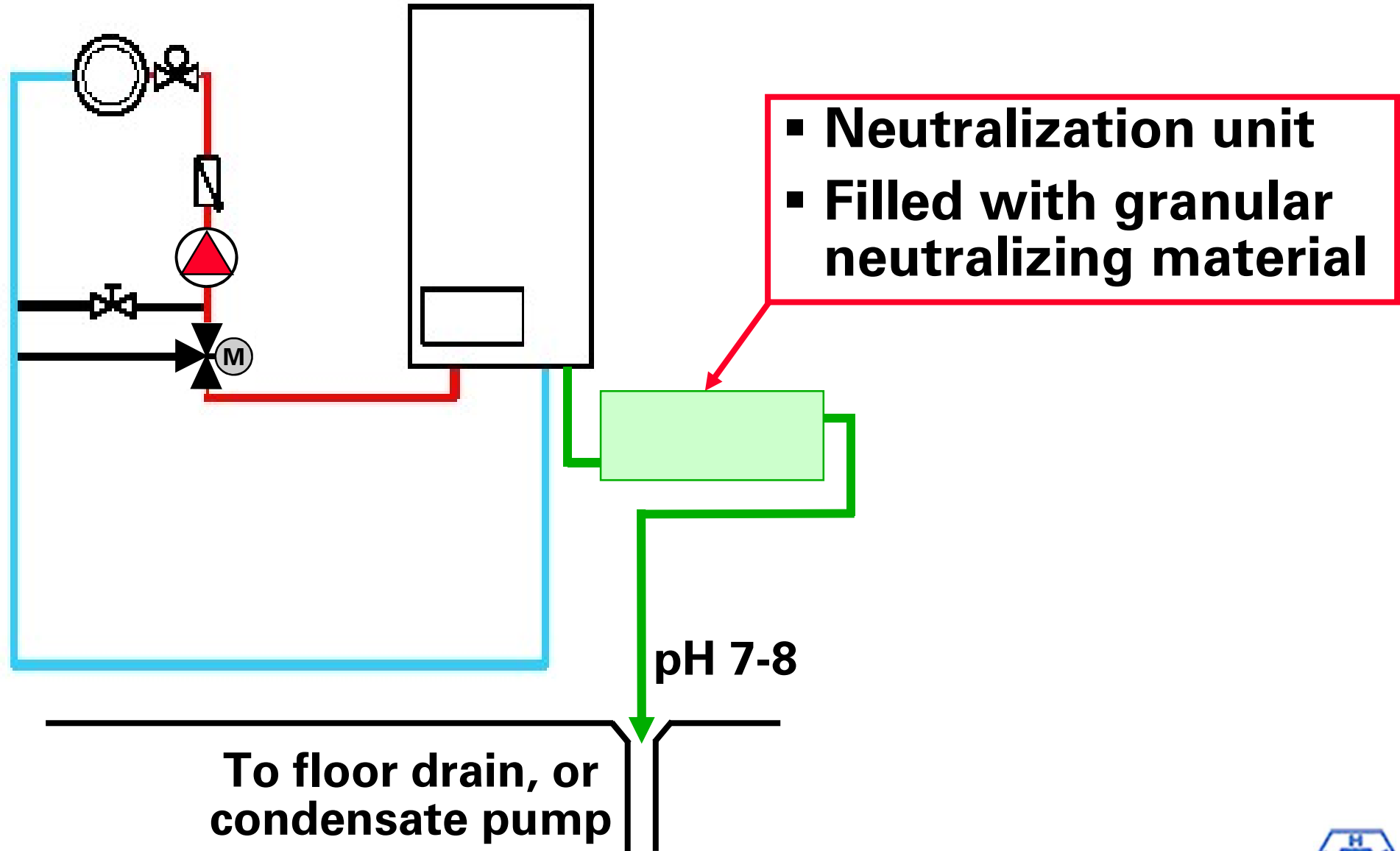
CONDENSATE DISPOSAL



- Plastic pipe (CPVC, ABS, PEX) sloped towards drain
- **NO Copper!**
- P trap required



CONDENSATE NEUTRALIZATION



CONSTRUCTIVE AND PHYSICAL REQUIREMENTS FOR CONDENSING BOILERS



- **Combustion with minimal excess air (high CO₂)**
- **Fully modulating burner**
- **Low heat exchanger surface temperatures**
- **Parallel flow of flue gas and condensate**
- **Counter-flow of flue gas and heating water**
- **Highly corrosion resistant material**



SYSTEM DESIGN REQUIREMENTS FOR CONDENSING BOILERS



- **Low temperature heat release surfaces**
- **Modulate water temperatures with outdoor reset controls**
- **Higher system water temperature drops**
- **Piping layouts to reduce boiler return water temperatures**



CONDENSING BOILER TECHNOLOGY



THANK-YOU

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