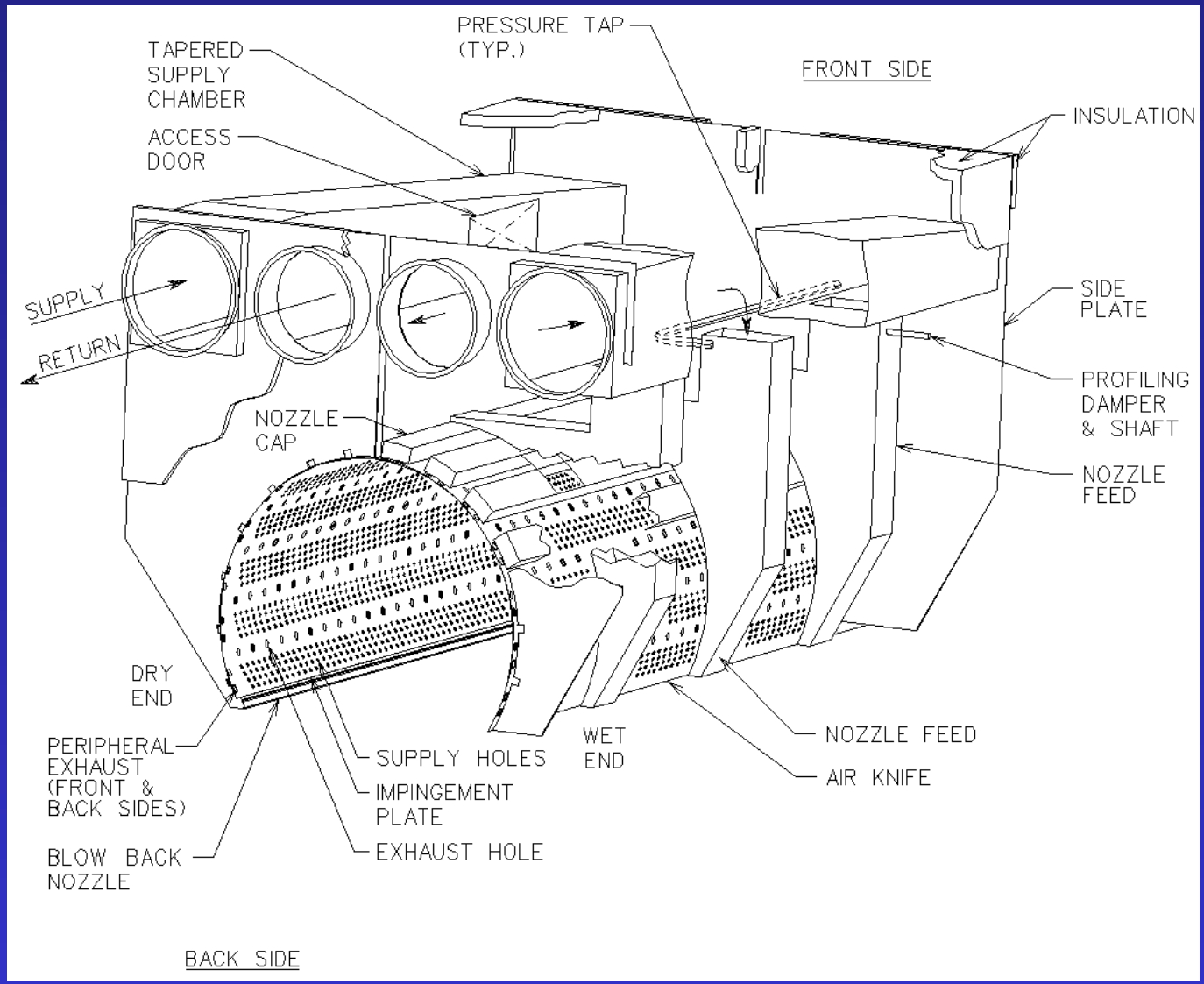
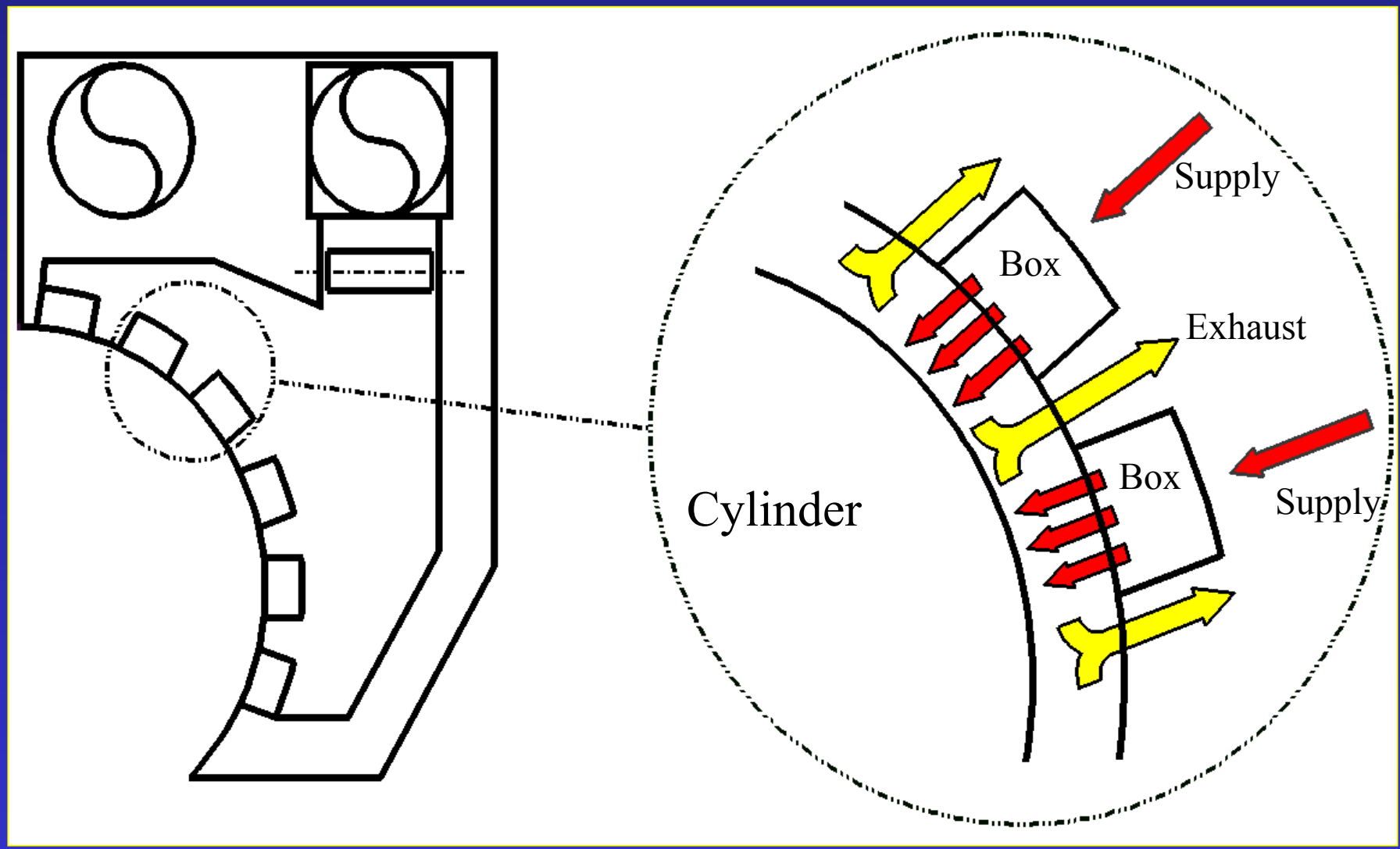
Yankee Hood

Improved Drying Efficiency

Hood Main Items



Air Distribution System

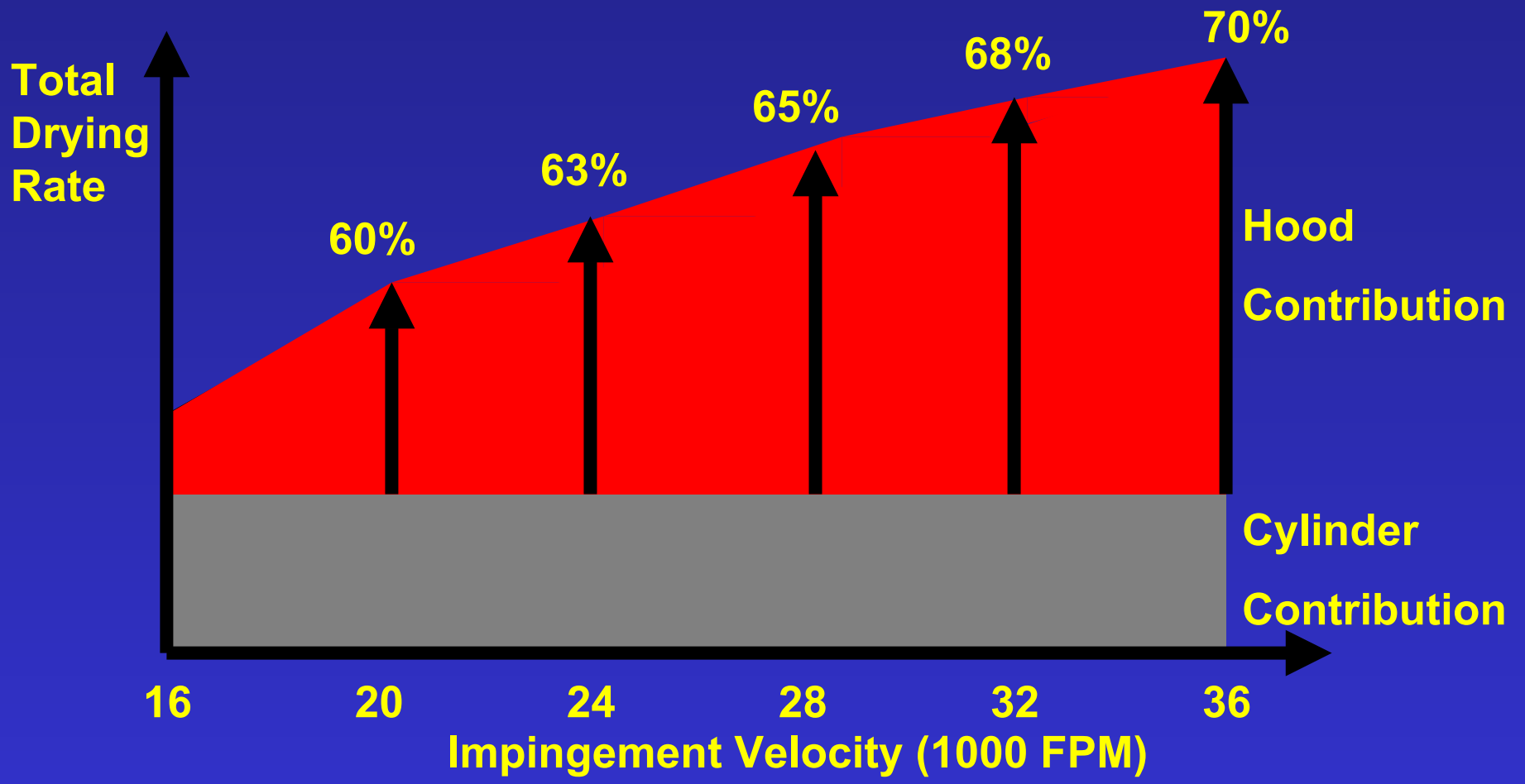


Impingement Air Drying Fundamentals

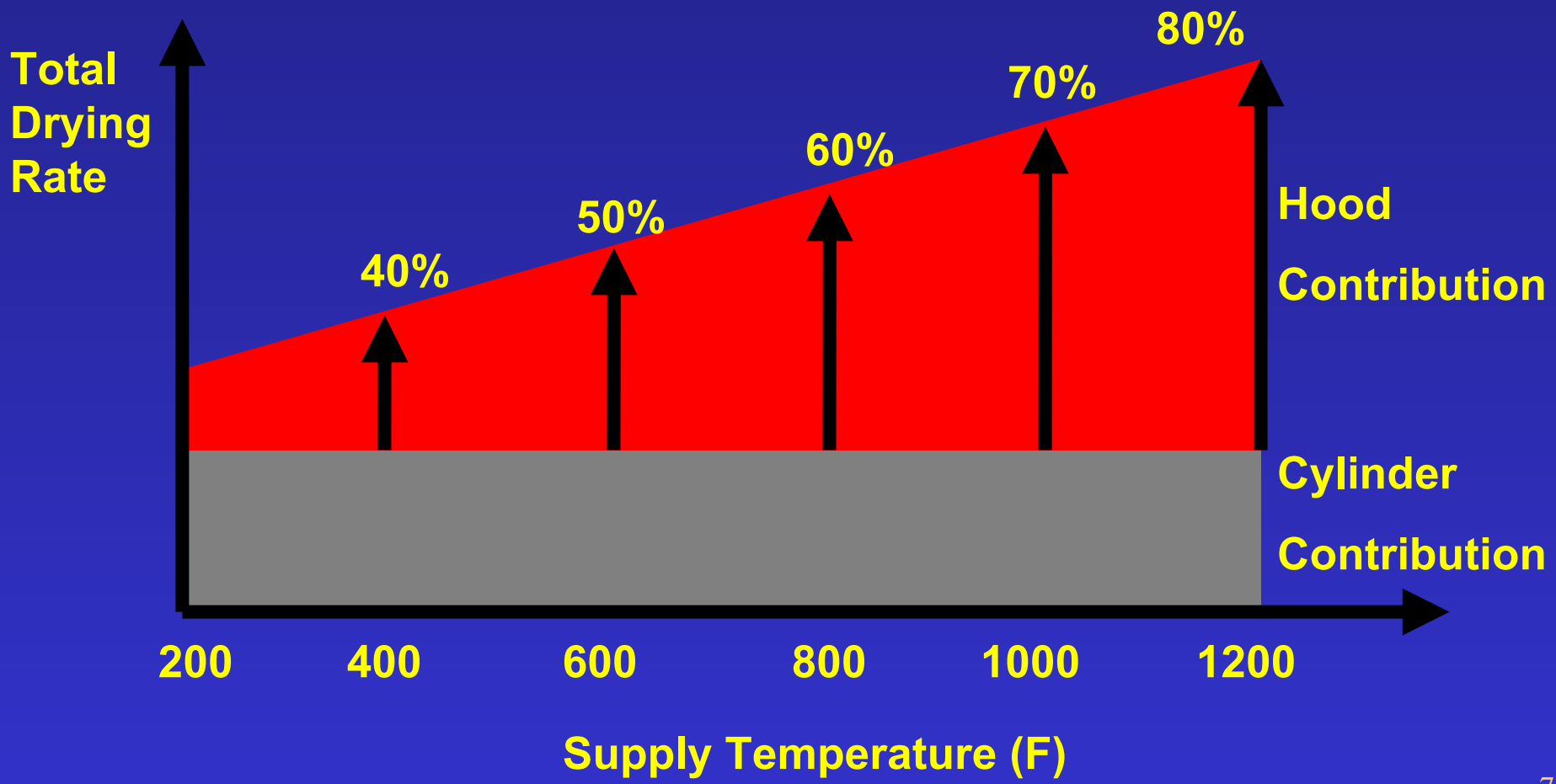
Drying Rate Parameters

- Air Velocity
- Air Temperature
- Air Humidity
- Hood-Cylinder Gap (Impingement Distance)
- Nozzle Open Area

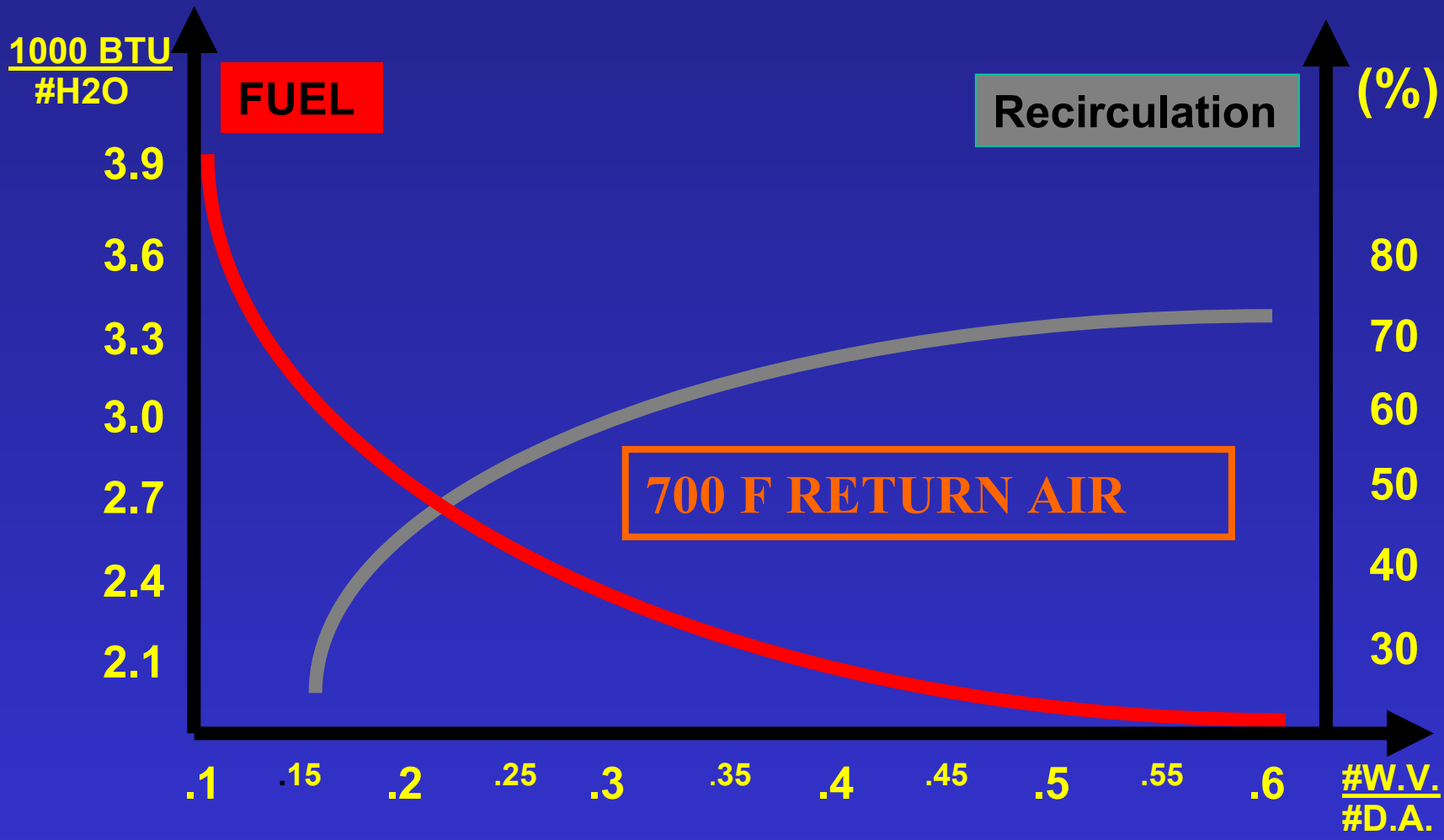
Impingement Velocity vs Drying Rate



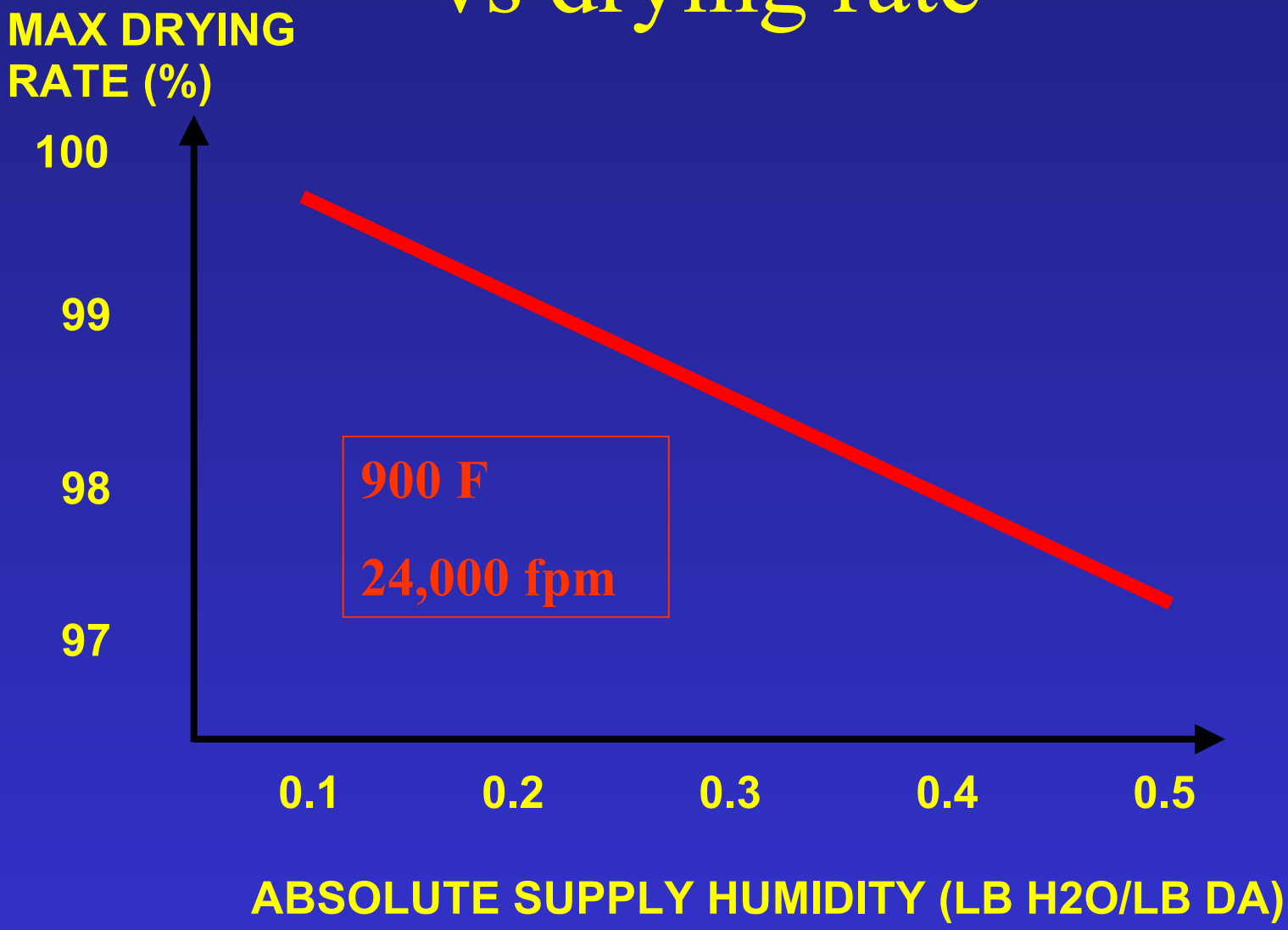
Supply Temperature vs Drying Rate



Fuel Usage vs Exhaust Humidity
Exhaust Humidity vs Air Recirculation



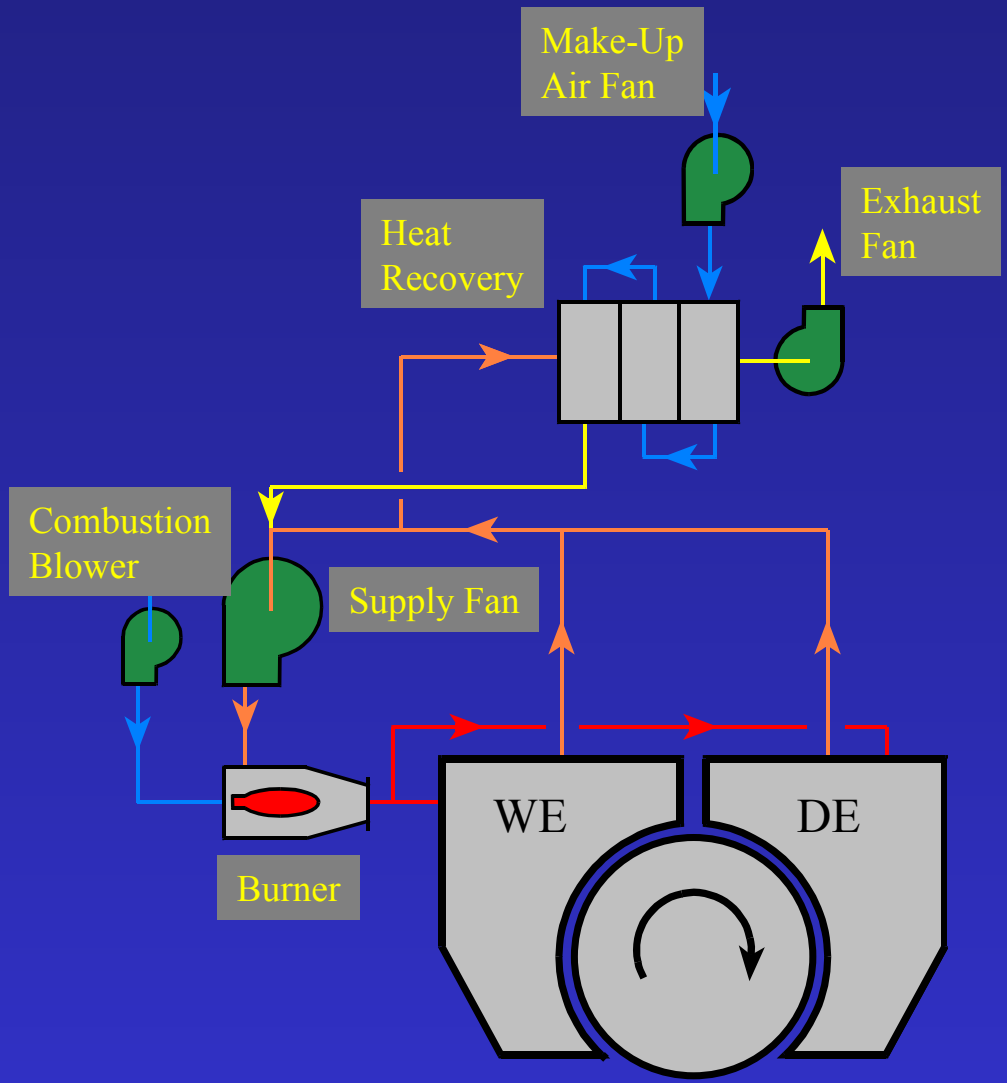
Impingement air humidity vs drying rate



Air Systems Arrangement

- Mono
- Parallel
- Cascading

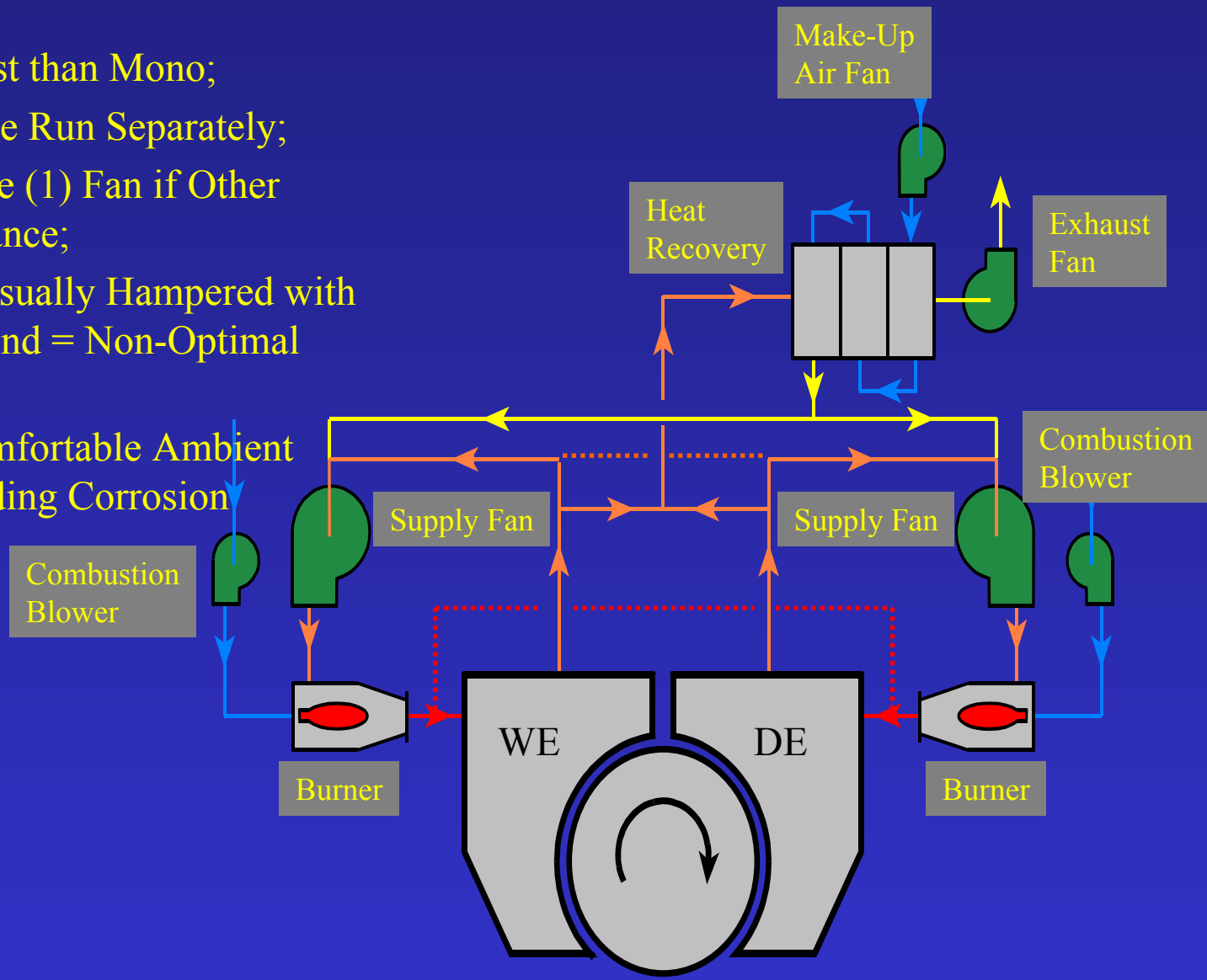
Mono Air Circulation System



- ✓ Lowest Capital Cost;
- ✓ Non-Optimal Hood Balancing = Higher Energy Consumption;
- ✓ Non-Optimal Hood Balancing = Hot and Humid Air Leaking = Uncomfortable Ambient Conditions + Building Corrosion
- ✓ Least Fexibility in Operating Temperature and Nozzle Velocities

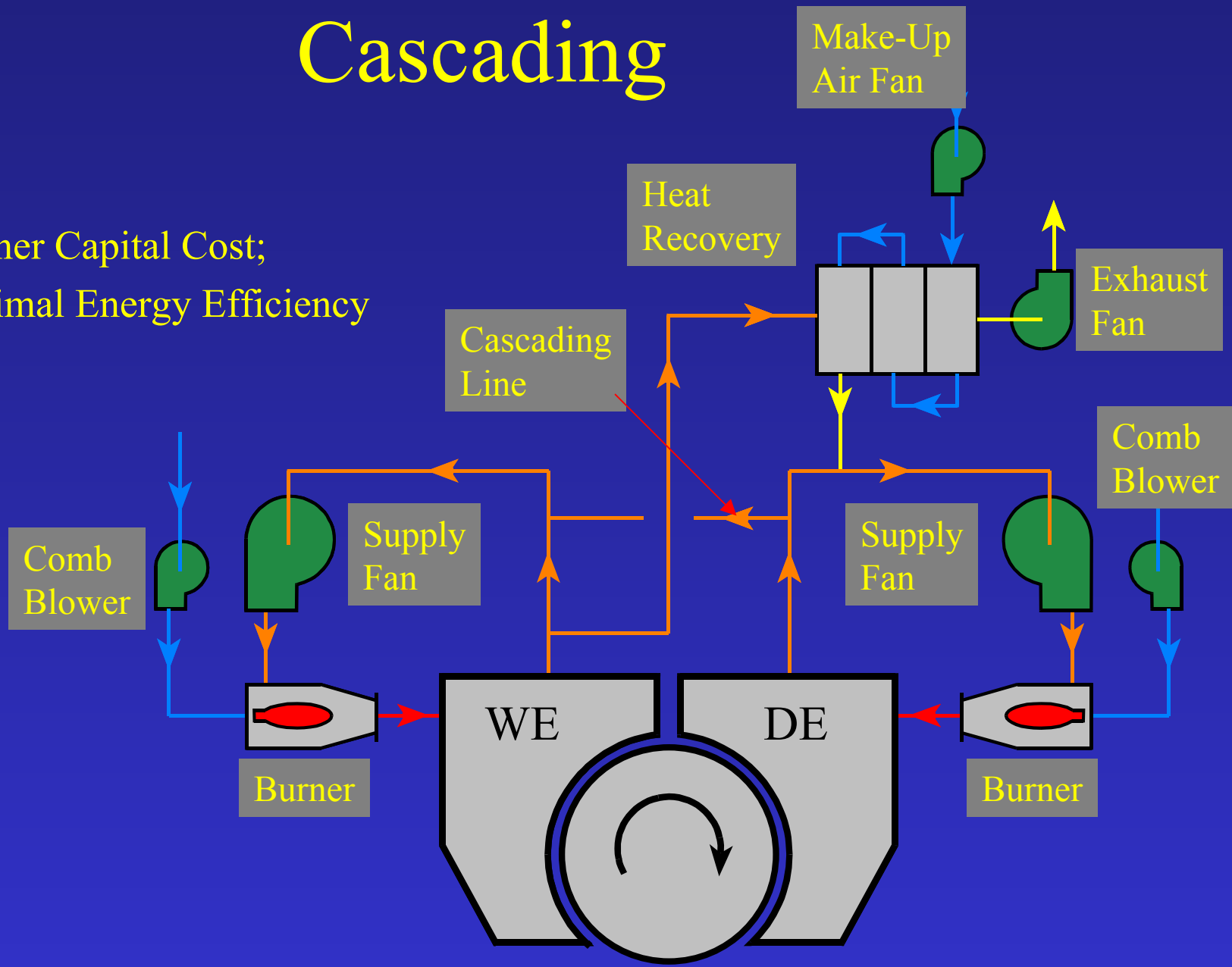
Parallel Air System

- ✓ Higher Capital Cost than Mono;
- ✓ Allows Hoods to be Run Separately;
- ✓ Operational on One (1) Fan if Other Requires Maintenance;
- ✓ Hood Balancing Usually Hampered with Blow Out at Dry End = Non-Optimal Energy Efficiency;
- ✓ Blow Out = Uncomfortable Ambient Conditions + Building Corrosion

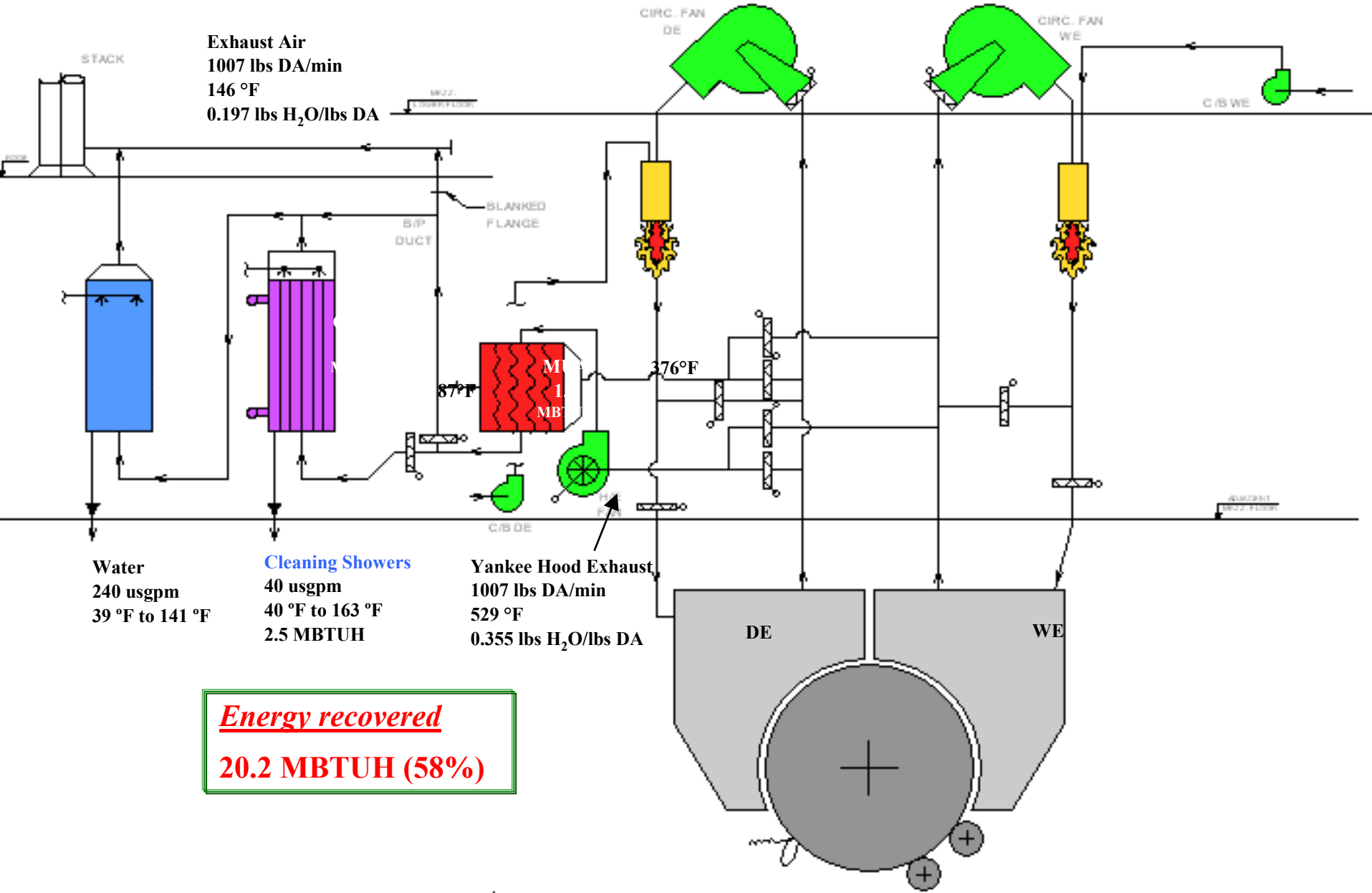


Cascading

- ✓ Higher Capital Cost;
- ✓ Optimal Energy Efficiency



Typical Yankee Heat Recovery
SCA Tissue ,Menasha ,PM-3



Exhaust Air
1007 lbs DA/min
146 °F
0.197 lbs H_2O/lbs DA

Water
240 usgpm
39 °F to 141 °F

Cleaning Showers
40 usgpm
40 °F to 163 °F
2.5 MBTUH

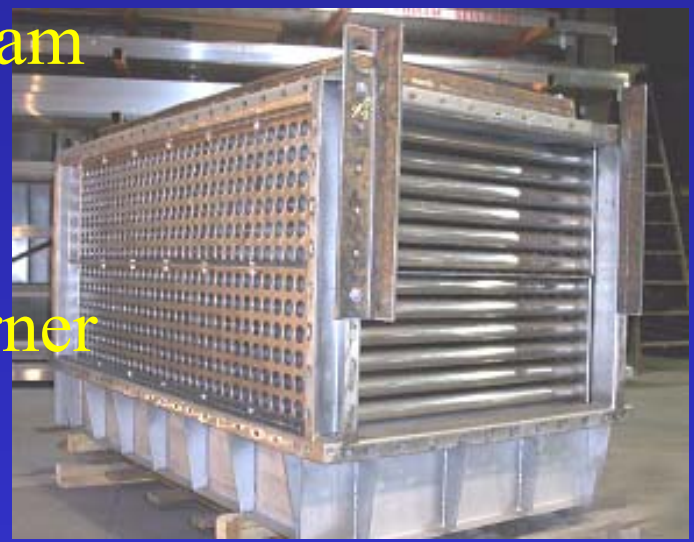
Yankee Hood Exhaust
1007 lbs DA/min
529 °F
0.355 lbs H_2O/lbs DA

Energy recovered

20.2 MBTUH (58%)

Combustion Air Pre-Heating

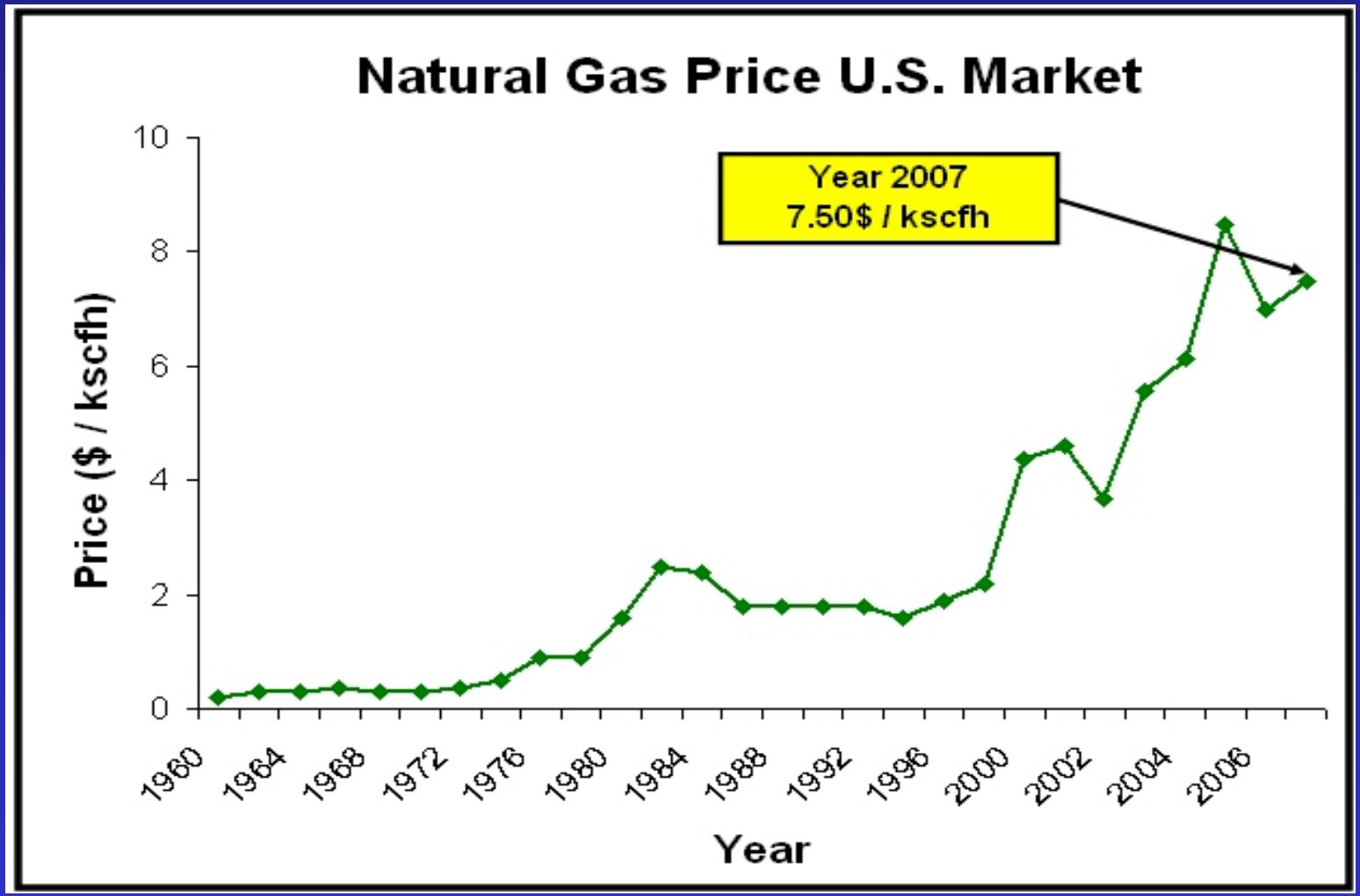
- Fuel Saving: 5%;
- Typical Design
  - ➔Indirect Air-to-Air Tube(s) Heat Exchanger (Higher Air Pressure);
  - ➔Exchanger Located Downstream of the Combustion Blower;
  - ➔Maximum temperature of air (400ºF) usually limited by burner



1. Yankee Drying Performance Survey

Establish machine's drying performance baseline...

Yankee energy breakdown



Steps to improve drying efficiency

1. Yankee drying performance survey

2. Key performance indicators (KPI)

3. Operational optimization (immediate)

4. P.A.S. upgrade/modification (short term)

5. Advanced Control System (mid term)

Drying Air Systems Operation

Main Challenge:

To Achieve a Given Drying Rate (Production) While Minimizing Fan Motor and Burner Energy Consumption and Maintaining Acceptable Ambient Conditions for Operators

→ Assumption: cylinder drying rate remains constant

Energy Efficiency - Main Factors

- Exhaust Air Humidity (% recirculation);
- Optimum Balance of Supply Air Temperature vs Impingement Velocity
- Heat Recovery Systems (Make-Up air & Combustion Air Pre-Heating);
- Hood Balance;
- Burner Stoichiometric Balance

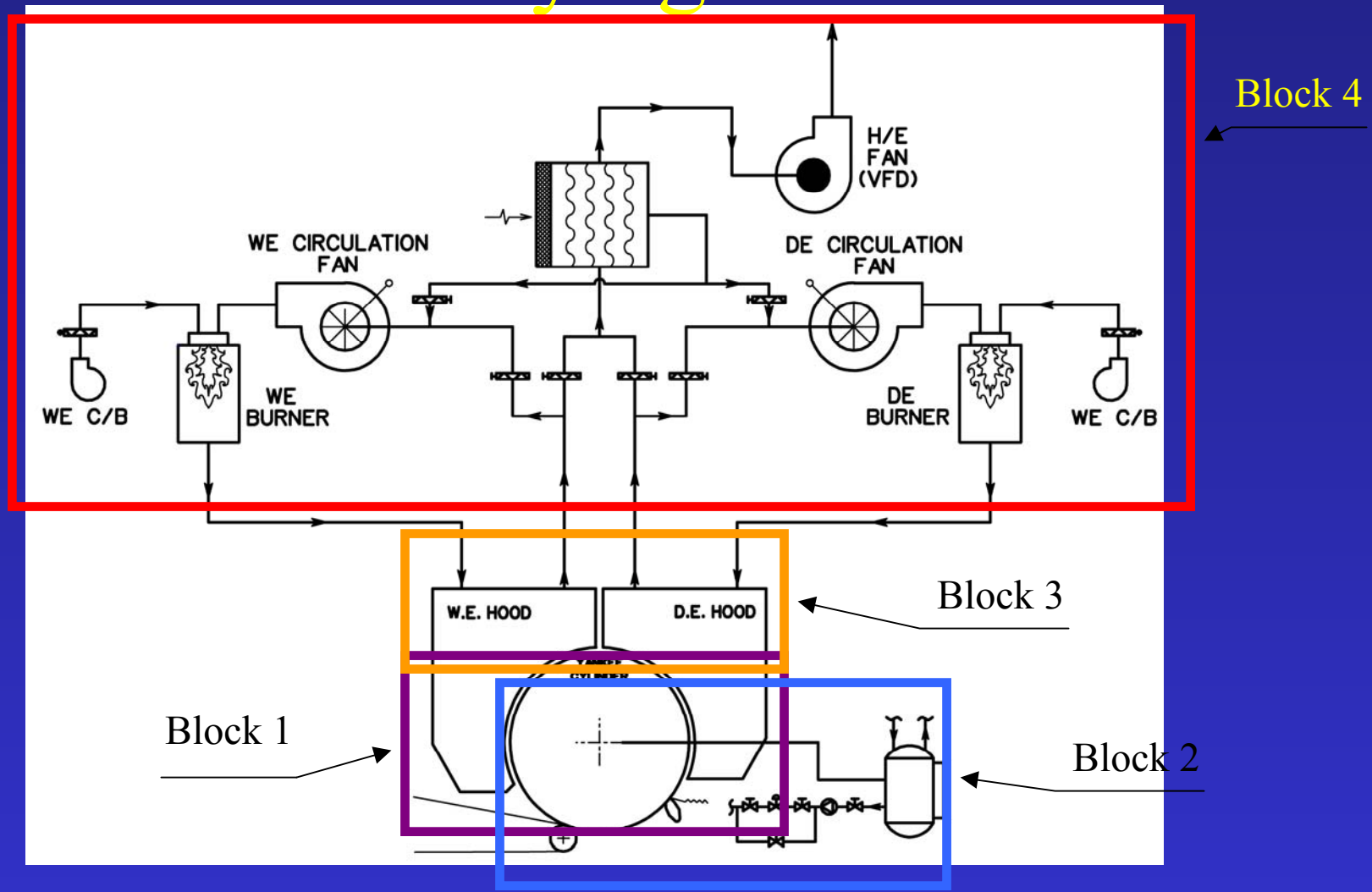
Hood-Cylinder Gap

Effective Convective Drying Consistent Below a Ratio of

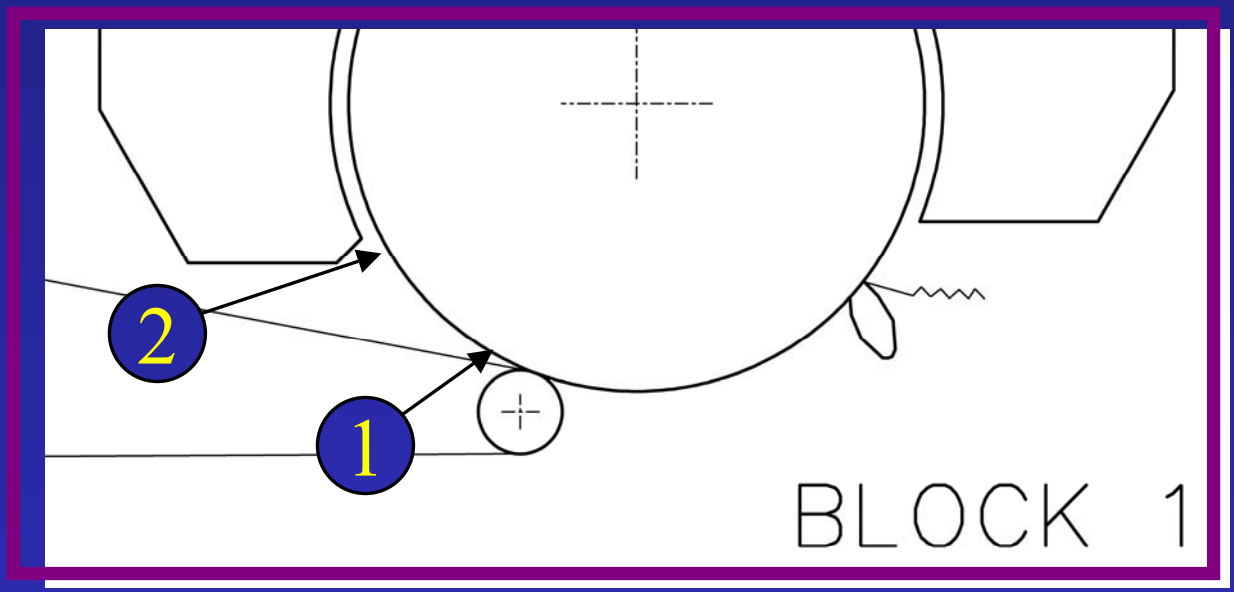
$$\frac{\text{Impingement Distance}}{\text{Nozzle Diameter}} \leq 5$$

Typical Impingement Distance:	3/4 inch
Typical Nozzle Diameter:	9/32 inch

Yankee Drying Schematic

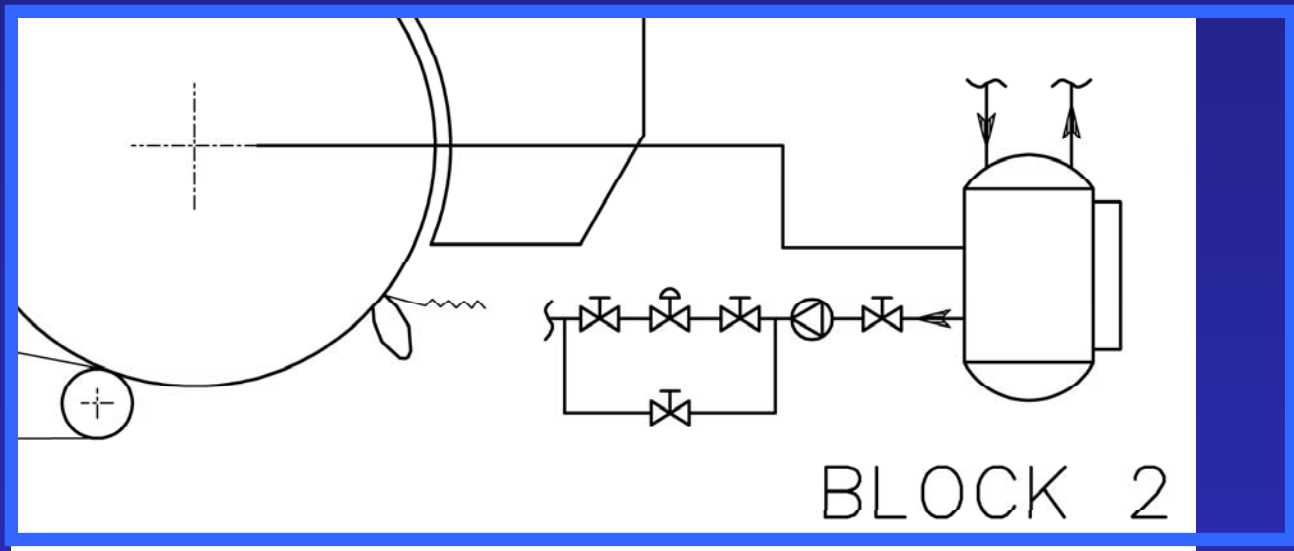


Survey methodology
Drying Rate Total - RW_{total}



- Measurements: Grab tests at (1) and (2)
- KPI: Yankee total drying rate RW_{total}

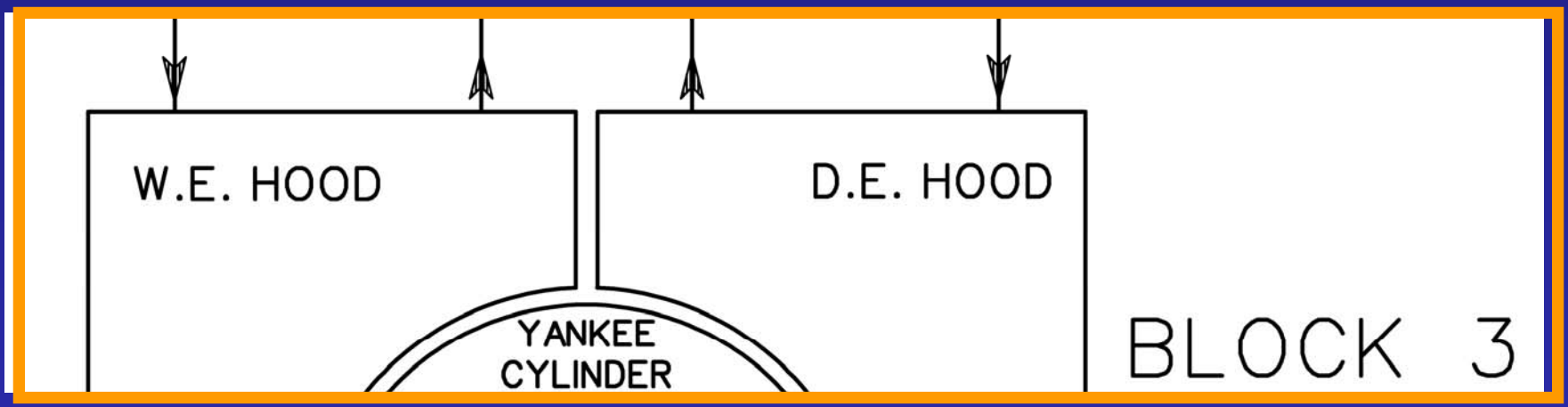
Survey methodology
Drying Rate Steam - RW_{Steam}



- Measurements: Condensate rise test
  Heat losses

- KPIs: Cylinder drying rate, RW_{steam}

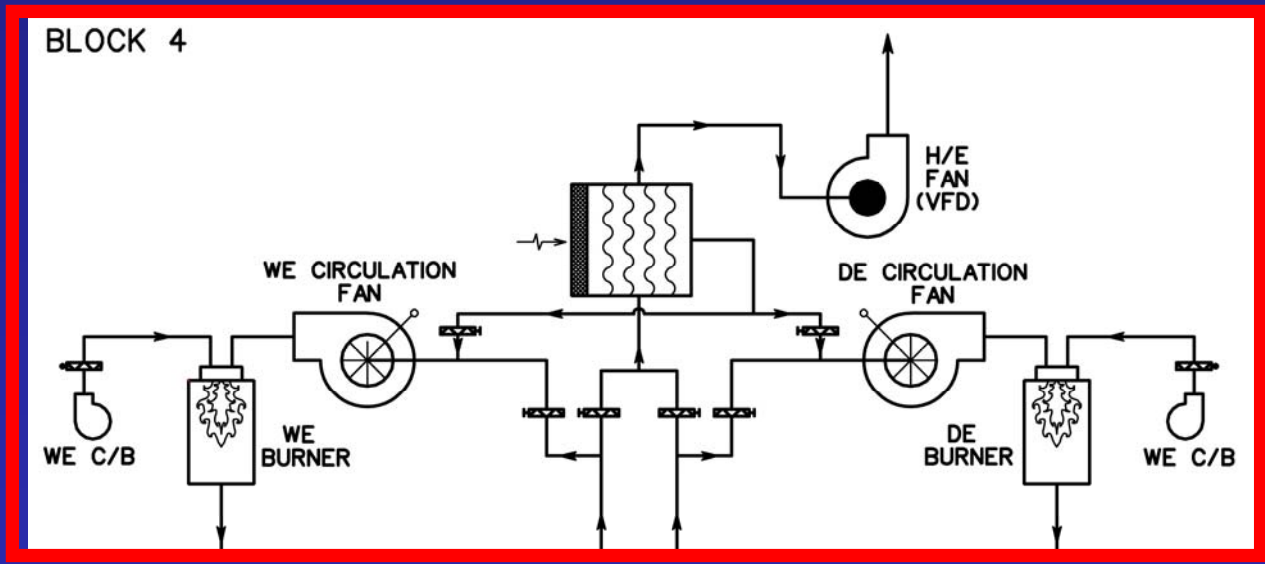
Survey methodology
Hood air flows



- Measurements: Air characteristics in/out of hoods
- KPIs: Hood air balance; W.E. & D.E.

  Hood humidities; W.E. & D.E.

Survey methodology
Thermal Efficiency (T.E.) & other KPIs



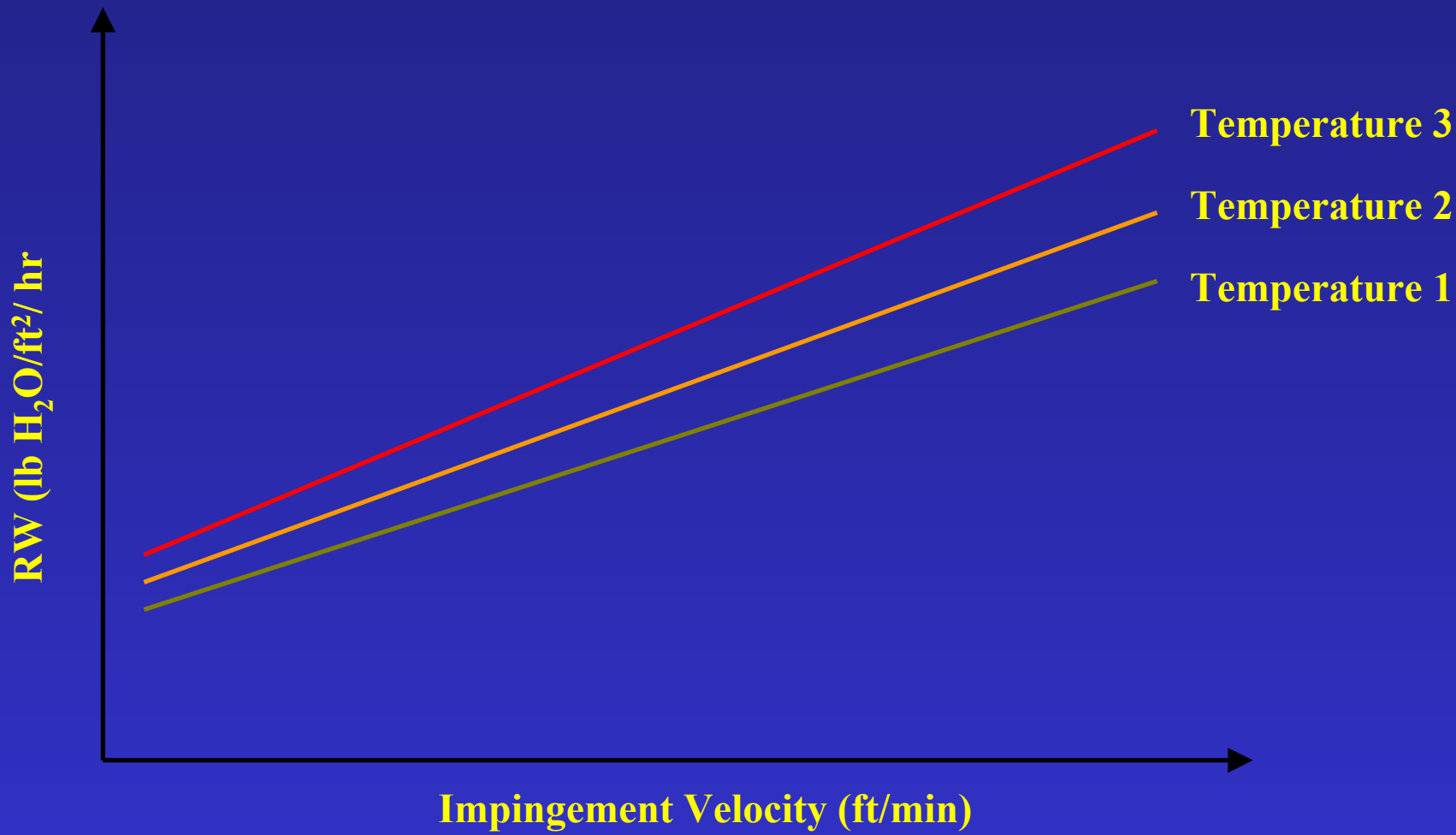
- Measurements: humidity , air flows & burner load

- KPIs: Thermal Efficiency Hood **(T.E. hood)**
  Burner air-gas ratio
  Fan performances

2. Key Performance Indicators (KPI)

Compared to industry good values, is your machine a Gas-guzzler?

KPI - RW Hood (lb H_2O/hr/$ft^{2)}$



KPI - Thermal Efficiency
(T.E. Hood)

T.E. Hood

thermal energy required by the hood to evaporate a pound of water (Btu/lb H_2O)

- T.E. modern hoods → 1650 to 2200 Btu/lb H_2O
- Cylinder consumes → 1300 to 1400 Btu/lb H_2O

Other Hood KPIs

KPI	**TARGETS**
• Hood Humidities (lb H_2O/lb D.A.)	0.50 W.E. 0.35 D.E.
• Hood Air Balance	100% W.E. 95% D.E.
• Burner air/gas ratio	10 stoichiometric 12-14 in practice

3. Operational Optimization

- *Operating your hood as efficiently as your current equipment allows*

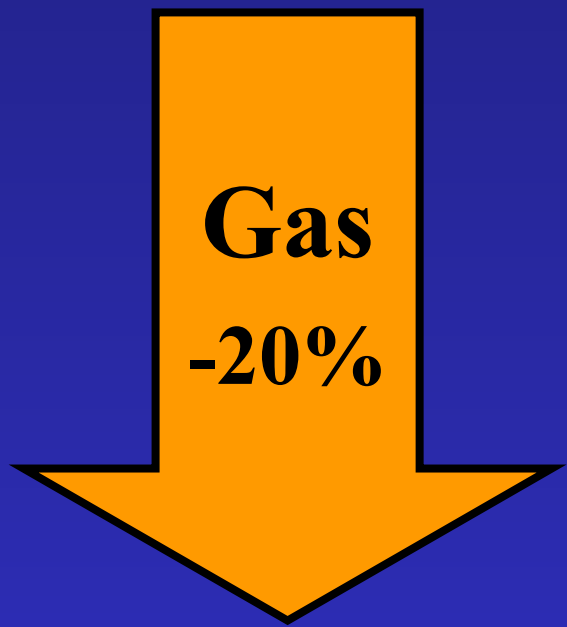
Improving T.E. Hood

Immediate Operational Adjustments

- Reduce exhaust flow
- Adjust make-up air flow
- Adjust air balance close to:

  100% W.E.
  95% D.E.

- Balance supply fan capacity
- Adjust hood temperatures
- Re-open the profiling dampers when possible



Operating Conditions
For Best Hood Energy Efficiency

- Humidity level : 0.5 lb H_20/lb D.A. or above
- Impingement velocity : 20,000 to 28,000 fpm
- Air/gas modulation : Fully automated
- Supply temperature : 700 to 950°F
- Dry crepe machines : Cascading mode
- Hood design : Cross machine boxes
  return slots
  ¾ in. hood-cylinder gap

4. Short Term Upgrade/Modification

- *Can typically lead to 25% in gas savings...*

Parameters to be measured
Yankee Cylinder

- Cylinder steam pressure
- Cylinder differential pressure
- Condensate flow

Short Term Upgrade & Modifications

- Pre-heat combustion air: 10% gas savings
- Pre-heat make-up air: 10% gas savings
- Adjust hood-cylinder gap
- Set burner air/gas ratio around 12:1
- Automate air/gas modulation

Modern Yankee Hood Efficiency

Hood Style		T.E. Hood (Btu/lb H_2O)	
Modern hoods	best	1600	
c/w CMD supply boxes	**average**		**2200**
	worst	2800	
Other types of hood	best	2500	
slot design, longitudinal supply boxes, supply plenum c/w return tubes	**average**		**3550**
	worst	6000	

$1 M/yr

Estimated yearly savings

18 ft Yankee - 11 short tons/hr @ 5500 ft/min - 65% drying by hoods

5. Advanced Control System (YACS)

- *Virtual operator for 24/7 high efficiency operation...*

YACS - Components

Phase I

- ➔ Real time KPIs calculator and logger
- ➔ Cockpit console c/w KPI status display and alarms
- ➔ Software based troubleshooting agent
- ➔ Advisor to get operation back on KPIs

Phase II

- ➔ Automated control loops
- ➔ Autonomus sentinel to maintain 24/7 high efficiency operation

KPIs to be monitored

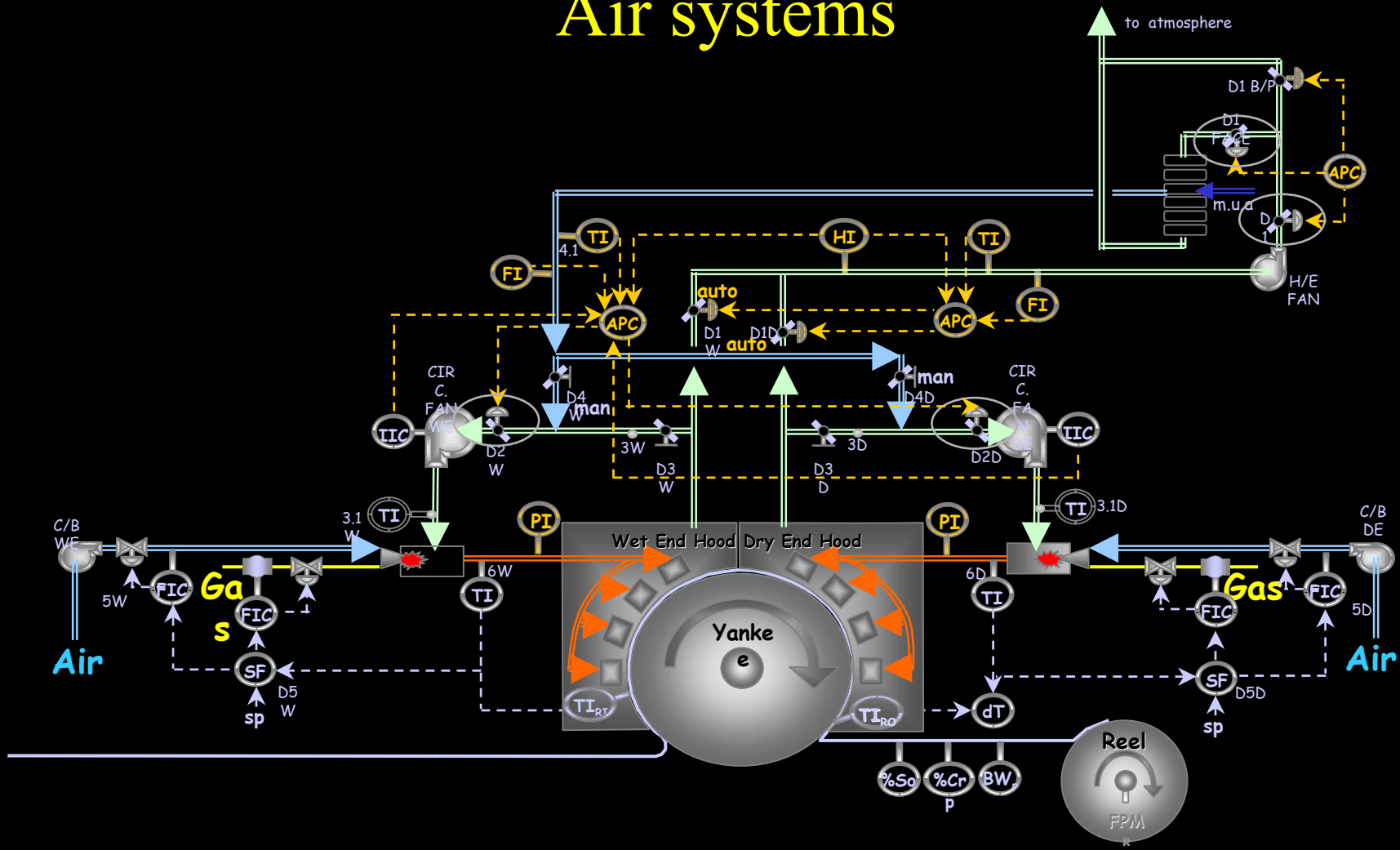
- Thermal Efficiency (*T.E. hood* Btu/lb H_2O)
- RW steam (Rw_{steam} lb H_2O/hr/ft^2)
- RW hood (Rw_{hood} lb H_2O/hr/ft^2)
- Gas Consumption (*GC* Btu/ton paper)
- Steam Consumption (*SC* Btu/ton paper)
- Electrical Consumption (*EC* Btu/ton paper)
- Total Energy Consumption (*TEC* Btu/ton paper)
- Post Pressure Roll Moisture (PPRC sheet moisture %)

Parameters to be measured

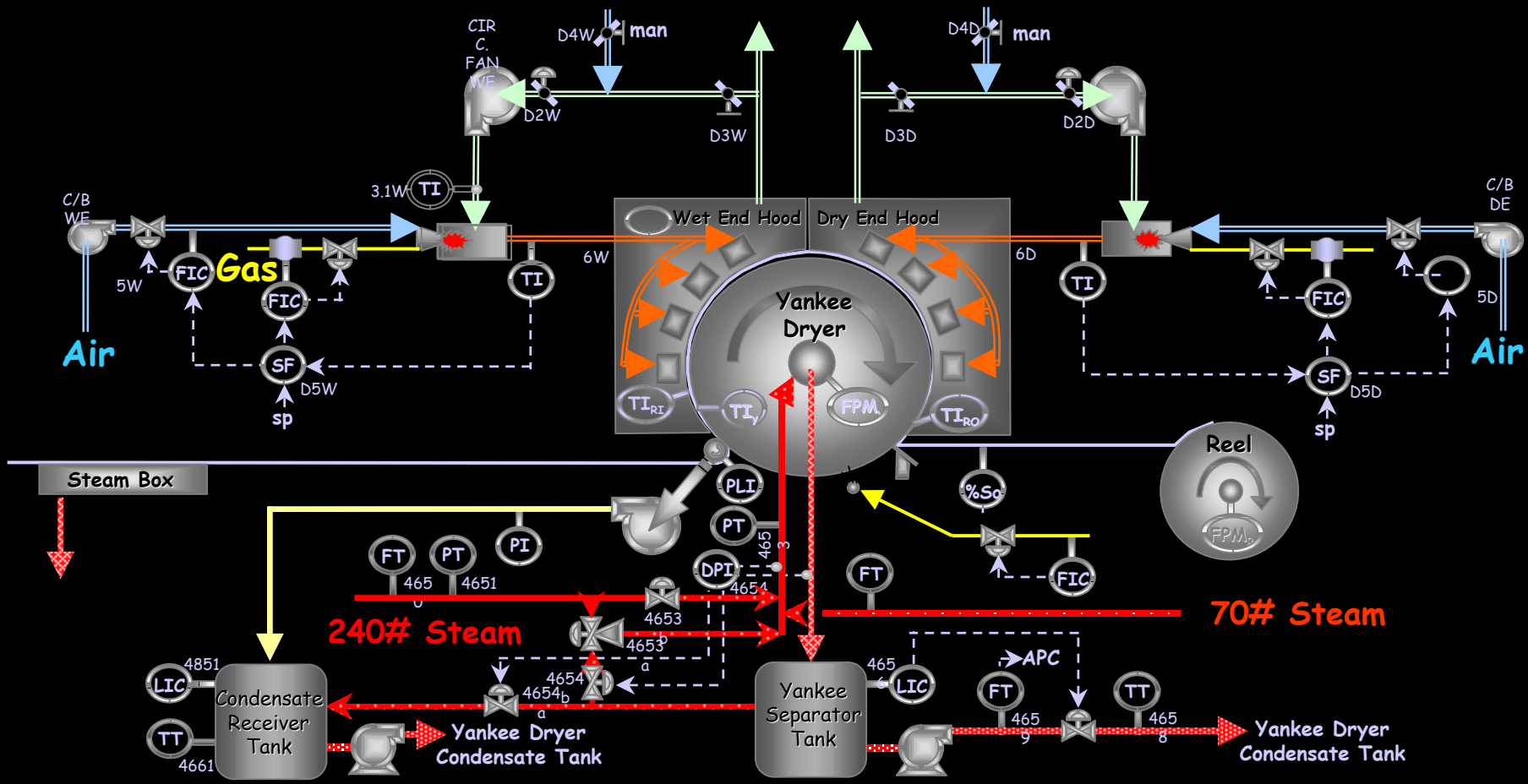
Yankee Hood and Gas Burners

- Exhaust humidity, temperature and flow
- Supply temperatures and pressures
- Return temperatures, pressures and flow
- Make-up air temperature and flow
- All damper positions
- Combustion air flow and temperature
- Gas flow & pressure

YACS
Air systems



YACS
Steam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Wet End Hood
Dry End Hood
C/B
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5W
FIC
Gas
FIC
6W
TI
6D
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FIC
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Air
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4851
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Yankee Dryer
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Yankee Dryer
Condensate Tank


QUESTIONS?