Getting the MOST out of your combustion system

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Getting the ***MOST***

- ***MOST*** Production
- ***MOST*** Quality
- ***MOST*** for your fuel $/***MOST*** energy efficiency

- When you consider these issues, your combustion system in combination with your kiln/furnace is the key in acheiving these objectives.

FIRST, take a good hard look at your present system/situation.

MAINTAIN YOUR EQUIPMENT

- Burner tuning
- Combustion air filtering
- Kiln maintenance
- Controller tuning
- Training/Record keeping

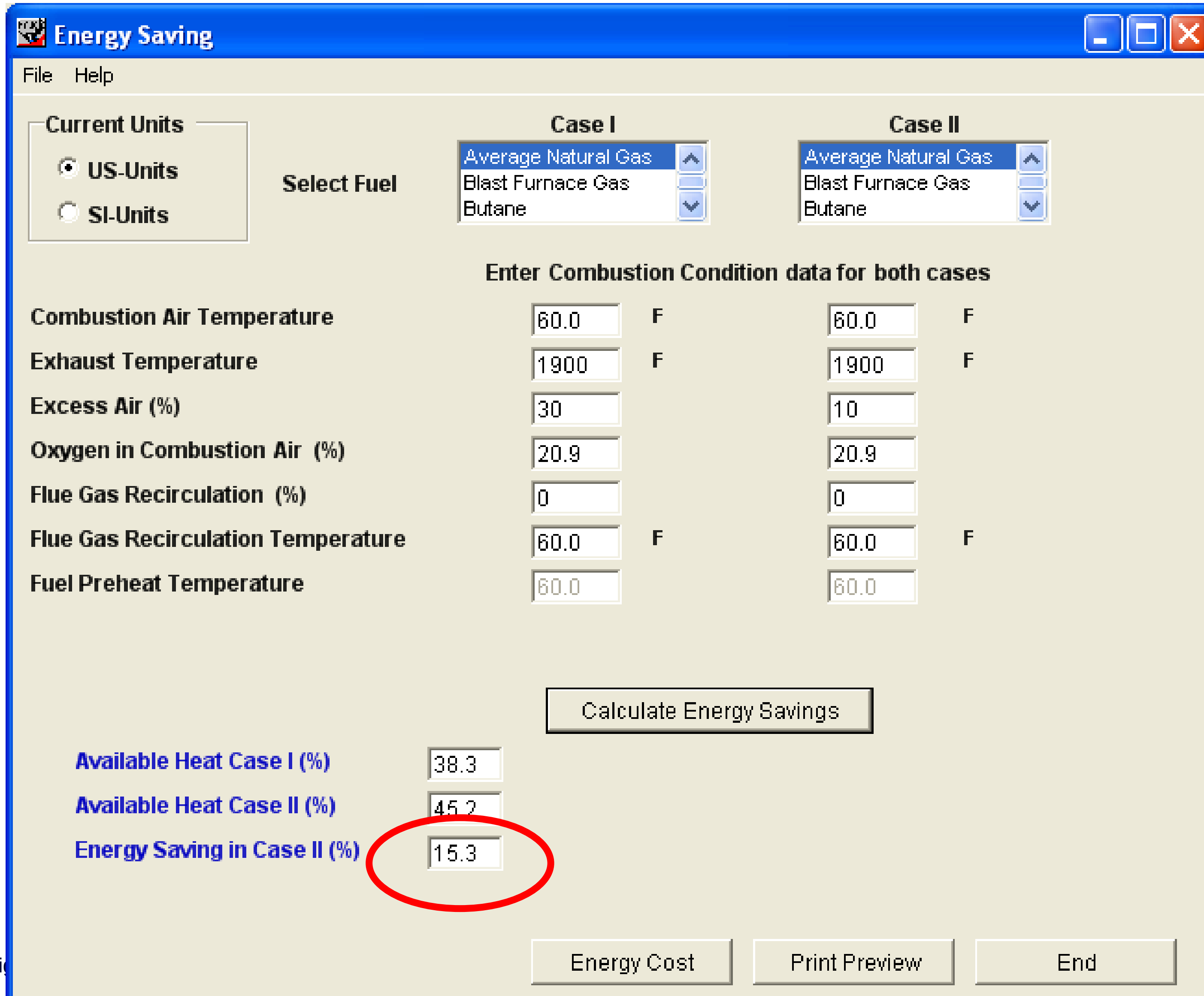
BURNER TUNING

Air/Fuel Ratio

- Over time burner settings (air/fuel ratio) will drift, because of component wear, temperature, etc…, this can ultimately affect:
  - Efficiency/Fuel Usage
  - Product Quality

BURNER TUNING

Example: A burner's air/fuel ratio drifts to 30% excess air from it's initial setting of 10%. Readjustment back to 10% will result in a 15% energy savings.



Combustion Air Filtering

- Unfiltered Systems
  - Overtime dust/particulate will build up in pipes/burners
    - ➢Increased system pressure drop (ie. smaller pipe)
    - ➢Less air to burner = Less air to system = Less input = Less production = Wasted energy
- Filtered Systems
  - Regular maintenance schedule based on operating conditions.

Kiln Maintenance

The objective: Contain heat in the kiln to heat product/minimize heat losses.

- Openings
  - Radiation losses = wasted energy
  - Air infiltration = wasted energy

- Refractory
  - Poor refractory maintenance=wall losses=wasted energy
- Pressure Control
  - Poor/No pressure control = wasted energy/poor uniformity

Controller Tuning

Tuning of controllers

- Tighter control = less fuel usage/tighter uniformity
  - Best controller can't overcome a poorly tuned/designed combustion system

Training/Record Keeping

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Training

- Basic combustion training/knowledge

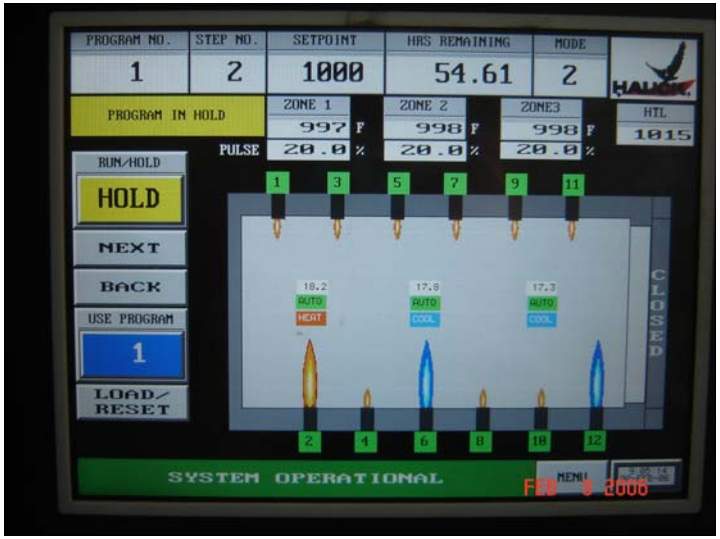
Record Keeping

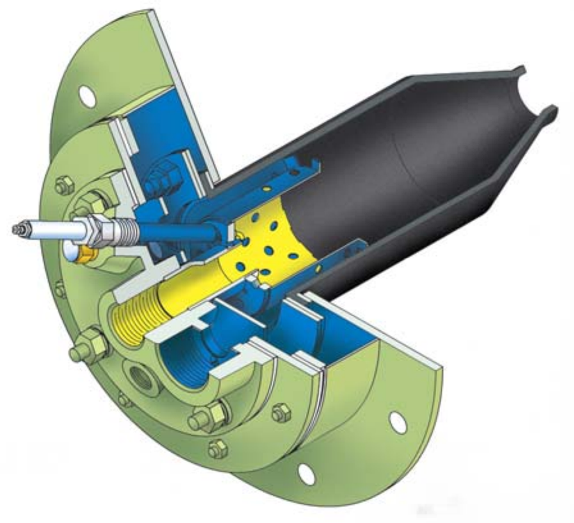
- Baseline reference for optimum operation.
- Easy to check/adjust to baseline.
- Analysis can be done.

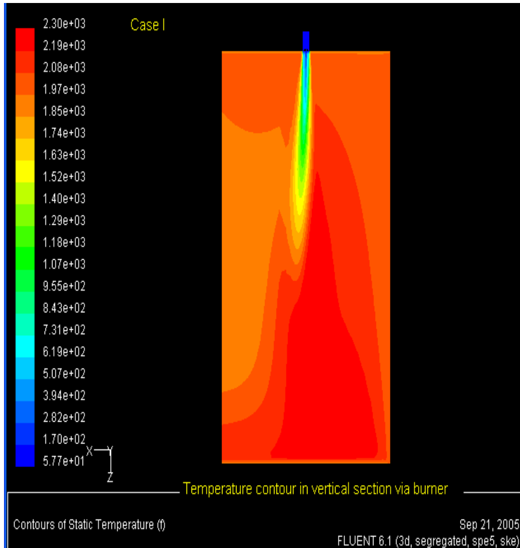
	G	H	I	J	K	L
8	BURNERS BIC 80L	Gas Orifice ΔP ("w.c.)	Gas Flow (scfh)	Burner Inlet Air Pressure ("w.c.)	Air Flow (scfh)	% Excess Air
9	**PREHEAT 3**					
10	R11	3.0	262	16.1	2717	3.7
11	R12	3.0	262	16.1	2717	3.7
12	R13	3.0	262	16.1	2717	3.7
13	R14	3.0	262	16.1	2717	3.7
14	**PREHEAT 4**					
15	R15	6.0	371	32.1	3836	3.5
16	R16	6.0	371	32.1	3836	3.5
17	R17	6.0	371	32.1	3836	3.5
18	R18	6.0	371	32.1	3836	3.5
19	**PREHEAT 5**					
20	R19	6.0	371	32.1	3836	3.5
21	R20	6.0	371	32.1	3836	3.5
22	R21	6.0	371	32.1	3836	3.5
23	R22	6.0	371	32.1	3836	3.5
24	**PREHEAT 6**					
25	R23	6.0	371	32.1	3836	3.5
26	R24	6.0	371	32.1	3836	3.5
27	R25	6.0	371	32.1	3836	3.5
28	R26	6.0	371	32.1	3836	3.5
29	**PREHEAT 7**					
30	R27	6.0	371	32.1	3836	3.5
31	R28	6.0	371	32.1	3836	3.5
32	R29	6.0	371	32.1	3836	3.5
33	R30	6.0	371	32.1	3836	3.5

Sheet1 / Sheet2 / Sheet3

EQUIPMENT AND CONTROL







Equipment and Hardware

Equipment/hardware on the kiln/furnace

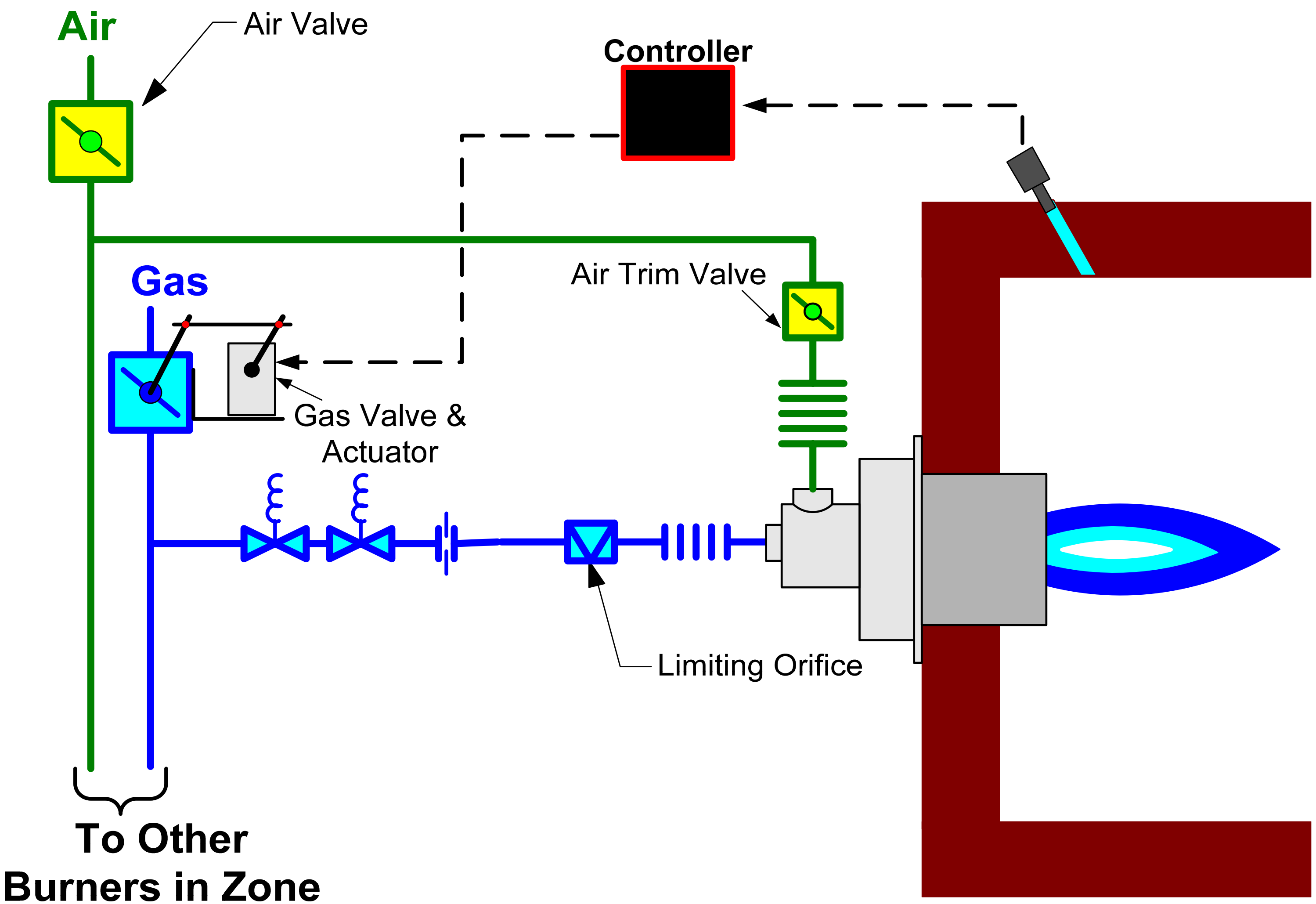
- Is the equipment right for the job?
- Equipment age: Many combustion systems are 15 years or older.
- Burner and Component advancements/improvements:
  - Improved mixing
  - Improved emissions
  - Improved turndown
  - Improved heat transfer
  - Tighter air/fuel ratio control

System Control

Control Systems/Methods

- Best burner + poor/inadequate control scheme = poor performance.
- Advancements in control technologies can assist in system control: Precision and reaction.
- Control of the combustion system has to address the application/product requirements. The design of the system will dictate:
  - Temperature Uniformity = Product Quality
  - Efficiency = Lower Fuel Costs
  - Maximum Heat Transfer = Optimum Production

Fuel-Only/Excess Air Control



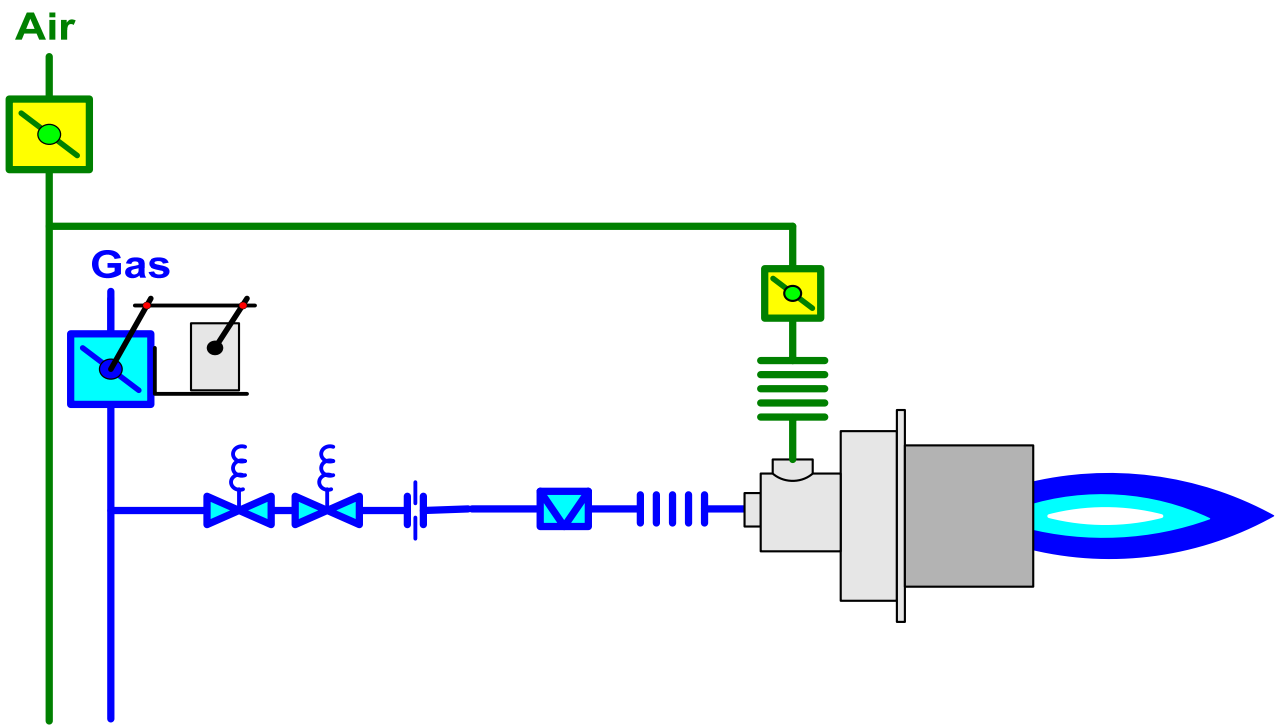
Fuel-Only/Excess Air Control

Advantages

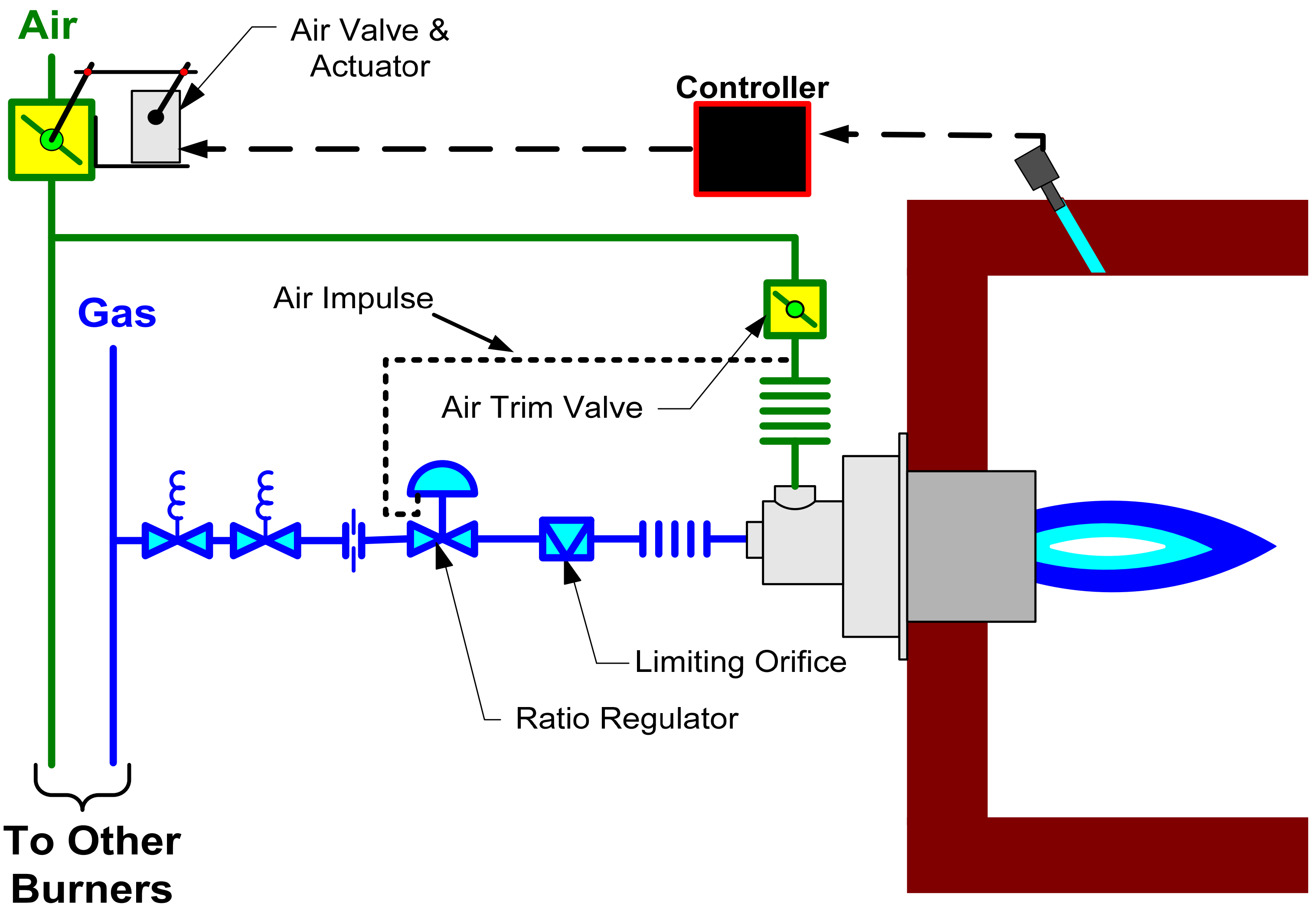
- Simple
- Less expensive
- Maintains high exit velocity/temperature uniformity

Disadvantages

- Versatility
- Thermally inefficient
- Burner must be excess air capable



Ratio/Cross-Connected/Pressure Balanced



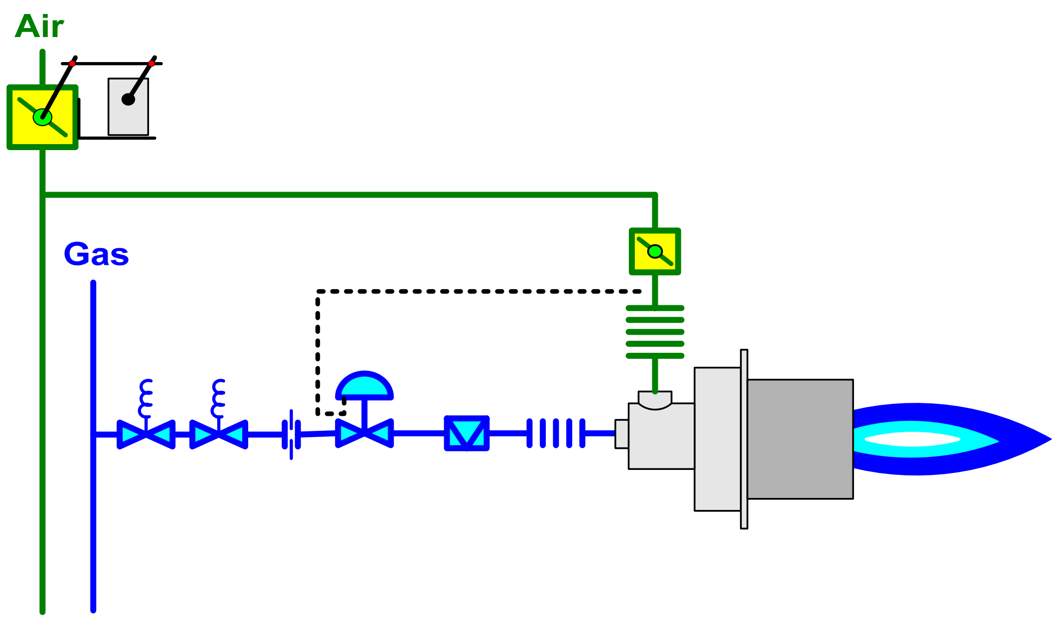
Ratio/Cross-Connected

Advantages

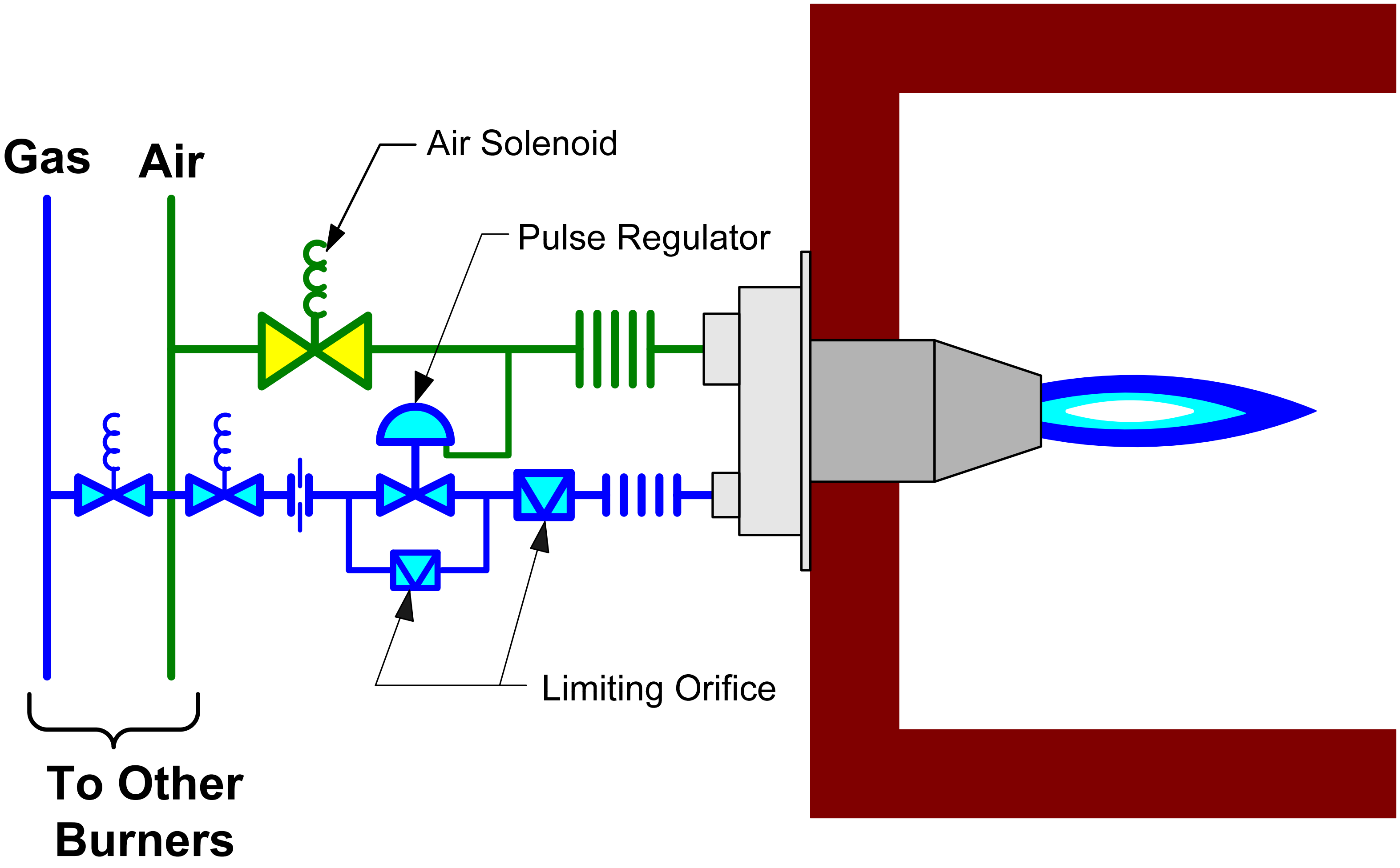
- Simple/relatively easy set-up
- Generally inexpensive
- Fuel efficient

Disadvantages

- Temperature uniformity will suffer with reduction in burner exit velocity with turndown

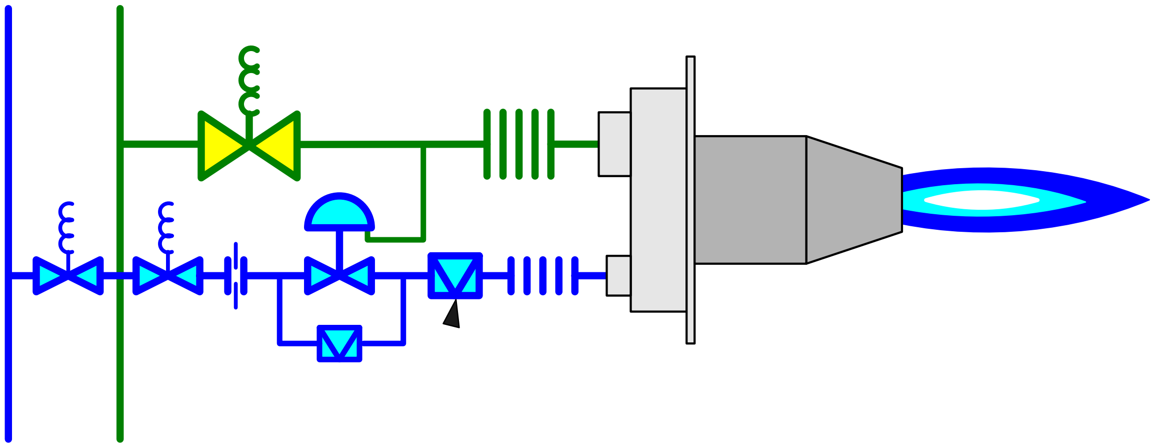


Pulse Fire Control



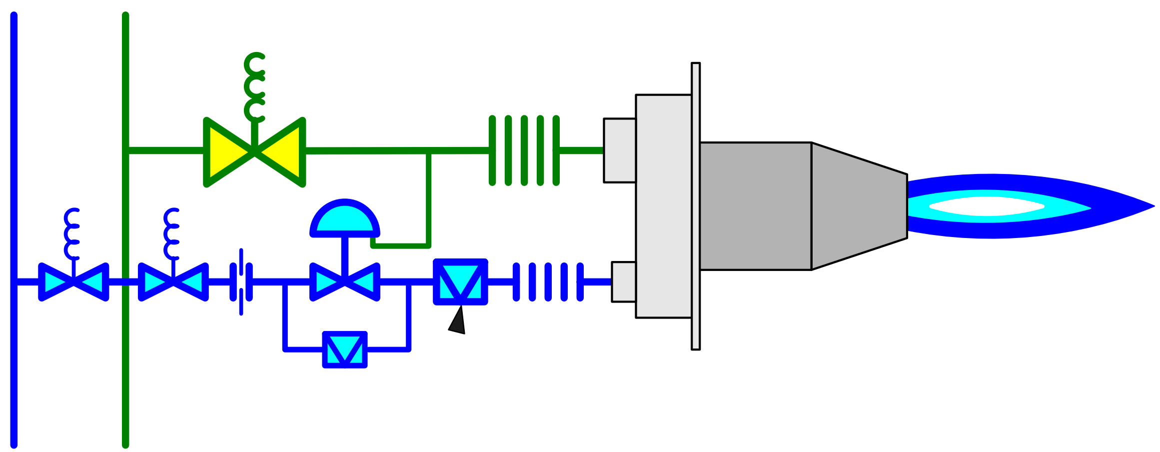
Pulse Fire Control

- Specialized type of cross-connected control
- Frequency modulation instead of amplitude modulation
- Special air solenoids and ratio regulators for each burner.
- Burners fire high-low or high-off
- Can be used with any burner capable of cycling



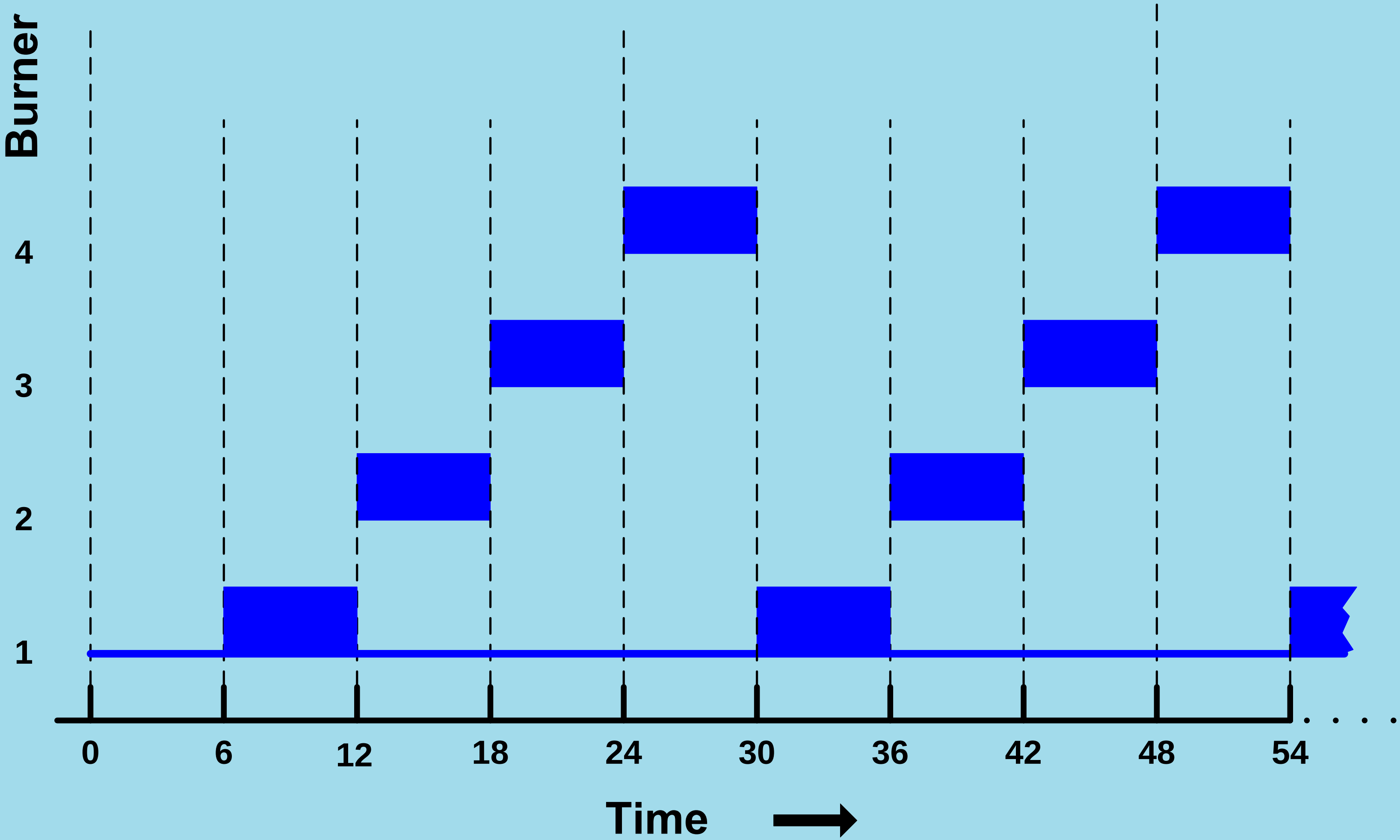
Pulse Fire Control

- Burners operate at either high fire or low fire.
  - High and low flows are fixed and repeatable (for reliable and almost unlimited turndown).
- Heat input is controlled by varying the amount of time the burners are pulsed off.
  - Individual burner “high fire ” times are sequenced so all burners “take their turn” at high fire.



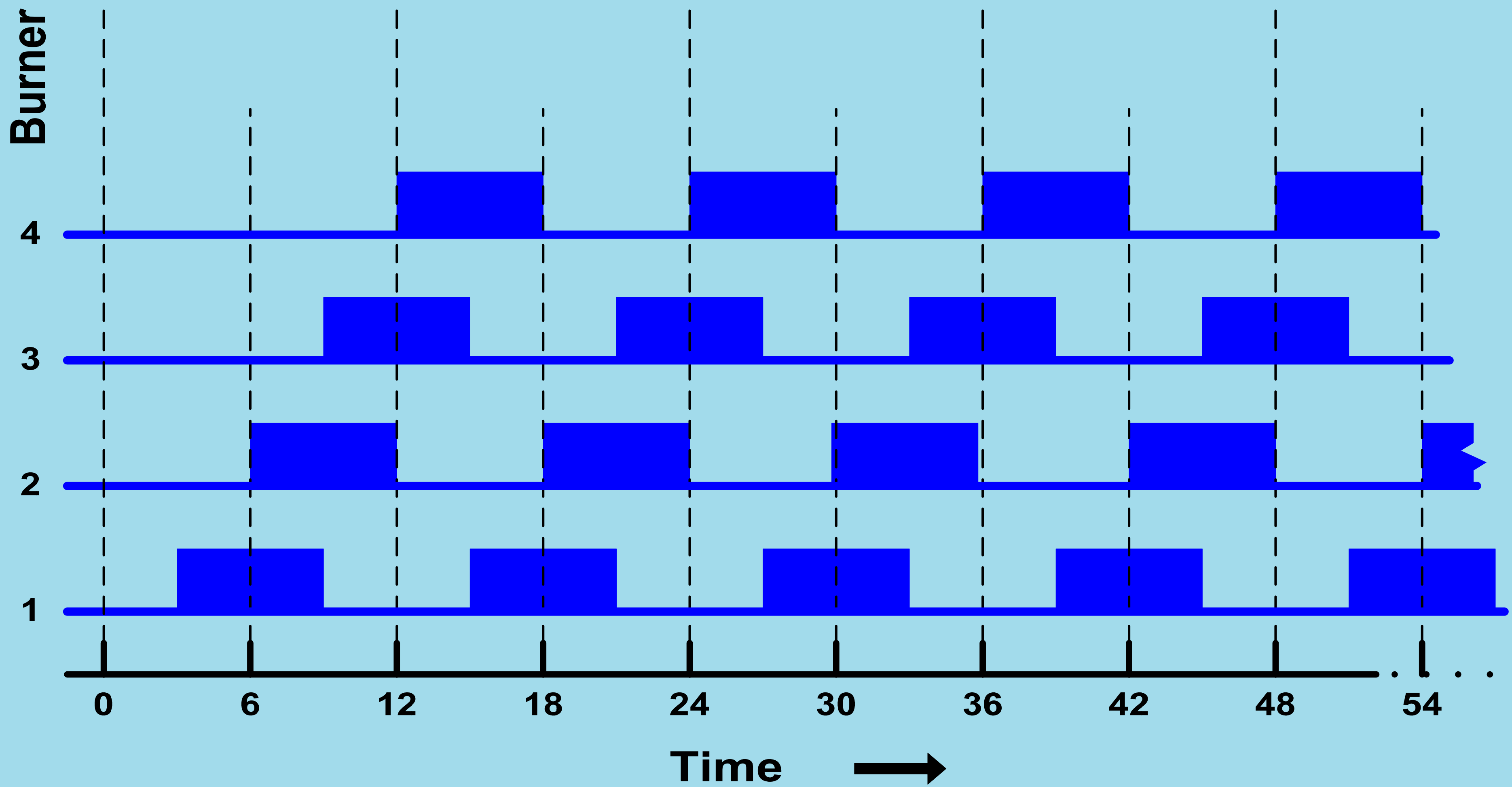
Pulse Fire Control

25 % Demand



Pulse Fire Control

50 % Demand



Pulse Fire Control

<u>*Advantages*</u>

- Reduces fuel usage
  - Reduces excess air required for uniformity & turndown.
  - Increases heat transfer
- Reduces emissions
  - Less fuel input required = A lower emissions potential.
  - Better “natural” flue gas re-circulation.
- Increases/promotes temperature uniformity without excess air
- Uniform piping and equipment to every burner
- All burners are set identically (high/low fire)
- Electronic zoning makes changes easy
- Pulse logic can be tailored for application needs = Flexibility

Pulse Fire Control

Disadvantages

- Hardware costs
  - Each burner has air and gas controls valves so upfront capital costs are higher than traditional control systems
  - Control system can be more expensive

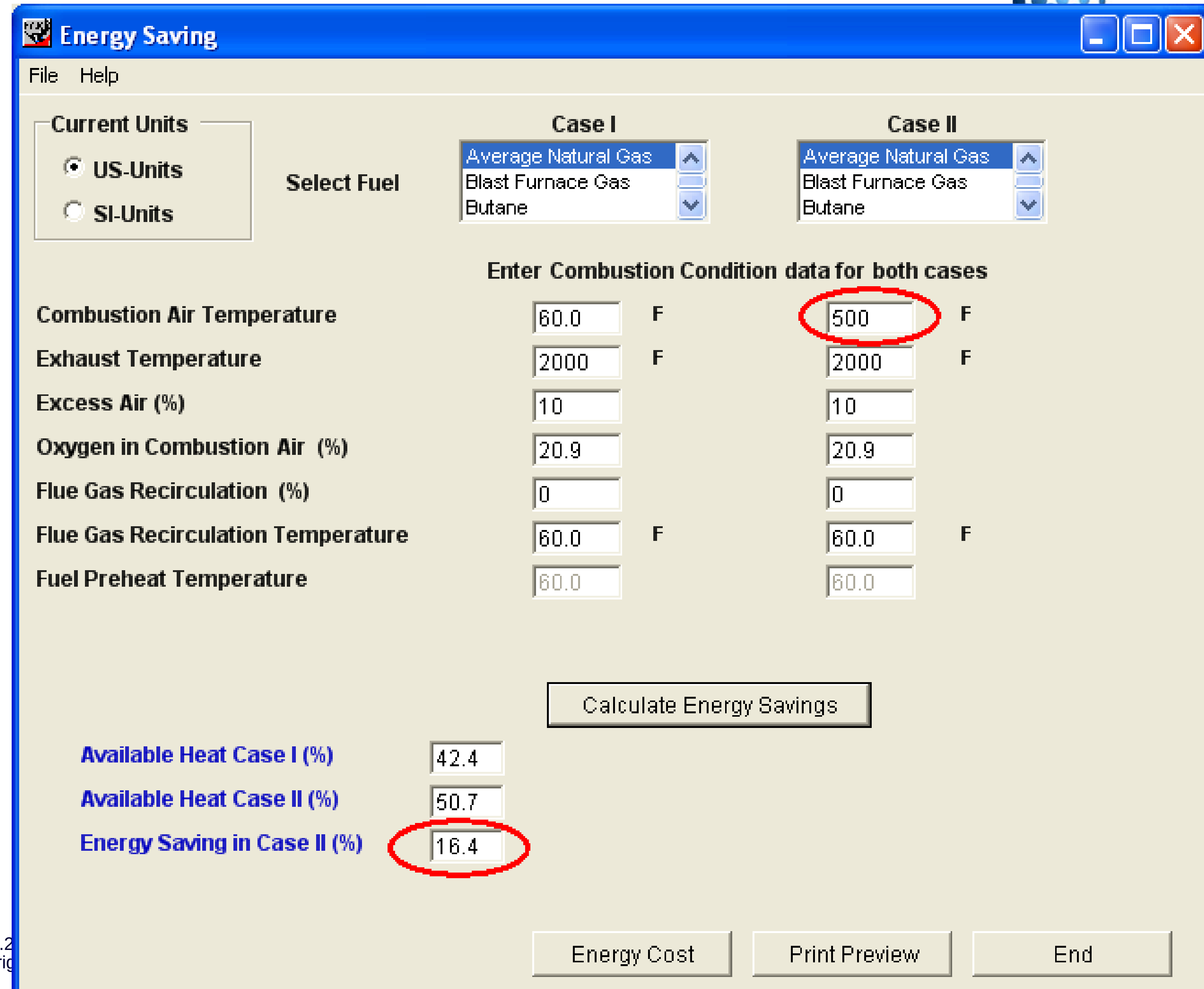
Efficiency

How can fuel usage be reduced further beyond the methods discussed?

Air Preheat

- How does heat recovery save fuel?
  - Preheating the air reduces the heat required to attain exit gas temperature.
  - Flame temperature is increased.
  - More heat is now available to heat the load instead of the air.

PREHEATED AIR



PREHEATED AIR

How do you preheat the air?

<u>Recuperation</u>

- Centralized Recuperator/Heat Exchanger
- Self-recuperative burners

<u>Regeneration</u>

- Paired Regenerative burners

Air preheat will be seen more often as fuel prices continue to rise and CO_2 (carbon) emissions become increasingly regulated.

There is no one burner, one control method, or one system that will act as a magic wand for increased productivity, improved product quality and reduced fuel costs. There are advantages and limitations with all system types.

In the end, the question remains: What change, upgrade, or improvement will be the best choice to achieve *your* goals in *your* application?

Thank you

Questions??