

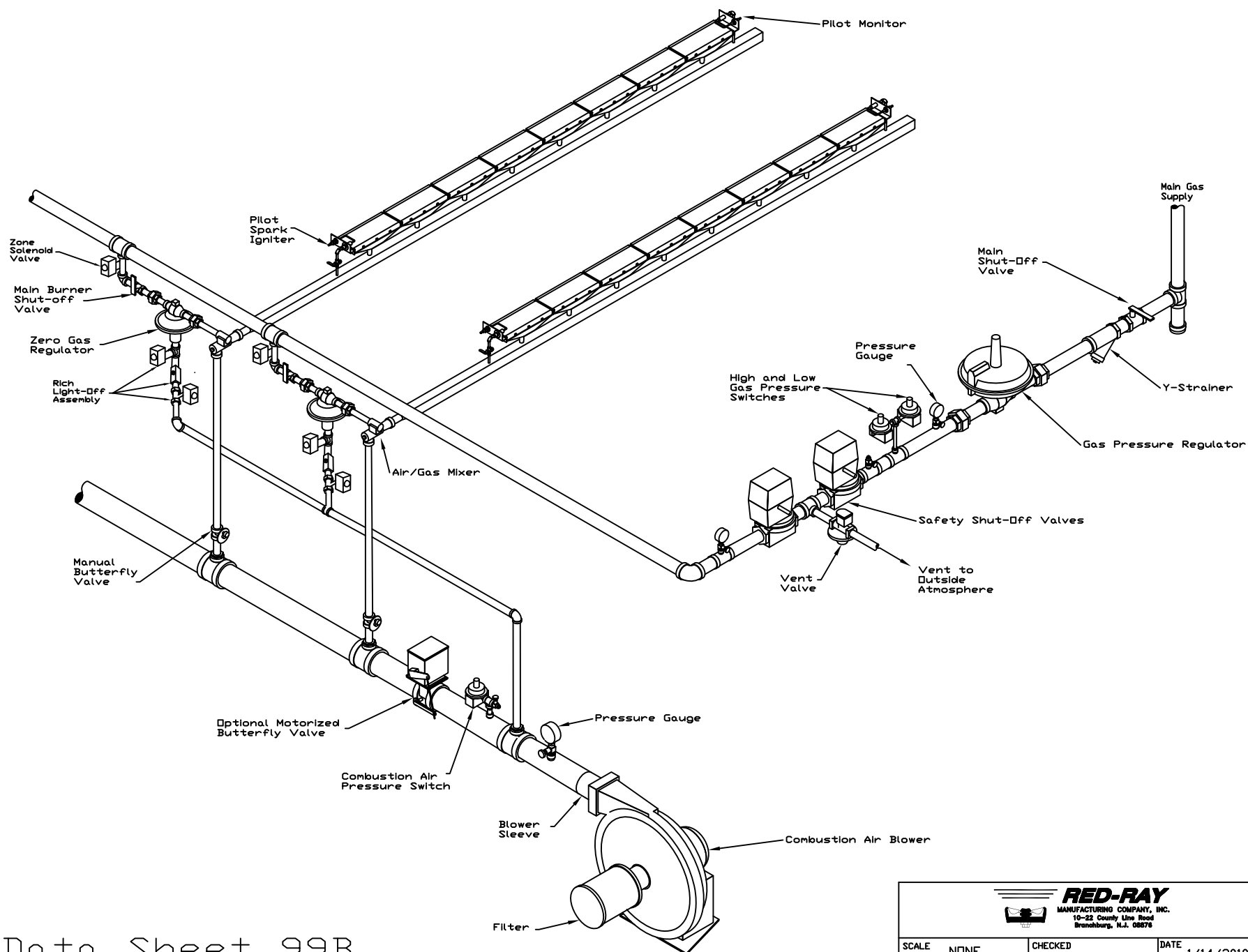
DESIGNING A COMBUSTION AIR/GAS PRE-MIX SYSTEM FOR RED-RAY INFRARED PROCESS BURNERS

1. Determine load requirements based on application (BTU/hr)
2. Choose burner type based on process / application / requirements
3. Determine number of burners required and configuration (number of burners per row based on oven and product constraints)
4. Determine Ignition / Monitor Methods
 - a. RP-I / RP-M for burners less than 4 ft
 - b. IPQ-1 / MPQ-1 for burners greater than 4 ft
 - c. UV Scanners
 - d. IW (ignition wire) and MW (monitor wire) length (~25-50 ft per burner)
5. Mixer selection (based on 1 mixer per 1 row of burners)
 - a. Determine mixture pressure (based on burner type) and gas volume per row (1,000 BTU/hr = 1 CFH)
 - b. Use Pyronics Flomixer Data Sheet 2301 to select mixer (Manufactured Gas – 1000 BTU – 0.6 Sp Gr)
 - c. Round up to higher capacity air insert size (1/32")
 - d. Pyronics Flomixers – highly recommend which includes
 - i. Manual butterfly valve
 - ii. Air Sleeve and Insert combined to create suction
 - iii. Gas Adjuster valve for air/gas ratio adjustment
 - iv. Zero gas regulator (BZR)
 - v. Gas shut-off cock
 - vi. Flanged outlet
6. Blower Selection (16 oz static pressure – LC Series 4121)
 - a. Determine SCFH_{air} required
 - i. $\text{Total system load (BTU/hr)} \div 1000 = \text{SCFH}_{\text{gas}}$
 - ii. $\text{CFH}_{\text{gas}} \times 11$ (11 to 1 air gas ratio) = SCFH_{air}
 - b. Use SCFH_{air} to determine 16oz blower model from the Pyronics Blower 4121 Data Sheet.
 - i. Specify blower model #, discharge position, motor HP, TEFC (total enclosed fan cover), voltage
 - ii. Select flexible sleeve with clamps (same size as blower outlet)
 - c. Specify Air Filter
 - i. Non-washable Cylindrical Element

- iii. Round Replaceable Element
- 7. Select Combustion Air Pressure Switch – (10" - 30" w.c. range)
- 8. Select All-In-One Gas Train Assembly
 - a. Based on total CFH_{gas} (to include all burners and pilots)
 - b. Assembly to include
 - i. Main shut-off ball valve
 - ii. Main pressure regulator
 - iii. Low and high gas pressure switches
 - iv. Visual and electronic position indication switches
 - v. Double blocking valve
 - vi. Threaded body flange
- 9. Select Main Gas Shut-Off Ball Valve (size based on plant gas line running to equipment)
- 10. Select Y-Strainer (same size as main gas ball valve)
- 11. Add (3) ¼" NPT dial (visual) pressure gauges 0-30" WC with ¼" NPT ball valve (rated for gas)
 - a. (1) use for combustion air header
 - b. (2) use before/after All-In-One Train Assembly
- 12. Control Panels – contact Red-Ray for design and pricing
- 13. Automated burner control
 - a. Temperature controller
 - b. Motorized butterfly valve – Pyronics Flanged Butterfly Motorized Package Valves 1302 Data Sheet
 - i. For system control – size based on main air header blower outlet
 - ii. For individual burner control – size based on mixer inlet
 - c. Temperature measuring methods
 - i. Thermocouple probe (used to measure ambient air)
 - ii. Optical pyrometer (used to measure product temperature)

Typical Installation

Two Zone Control with Single Zone Modulation



Data Sheet 99B

RED-RAY <small>MANUFACTURING COMPANY, INC. 10-22 County Line Road Branchburg, N.J. 08578</small>			DATE
SCALE	NONE	CHECKED	1/14/2010
DRAWN BY	JPP	APPROVED	DRAWING NO.
			JP-046

COMPARATIVE CHARTS AND CALCULATIONS

Typical Economics			
1.0M btu/hr (293Kwh)			
	Gas	Electric	Differential
Capital costs			
Heaters	27	22	-5
System	18	22	4
Total	45	44	-1
Operating costs			
Gas cost per ccf	\$0.65		
Electric costs per Kwh		\$0.07	
Operating cost per yr (2 shifts/day @ 5 days)	\$ 26,000	\$ 82,040	3.2
Size of IR array			
Radiant density			
Watts/sq in		25	
Btu/hr/sq in	340		
# of heaters needed			
5" x 12"	49		
12" x 36"		27	
Size of array needed (sq ft)	20.4	81.4	4.0
Other savings			
Average heater lifetime (yrs)	5	2	0.4
Less labor cost	yes		
Increased uptime	yes		

BTU Requirement Calculations						
Part Requirement						
Length (inches)	Width (inches)	Area (sq in)	Area (sq ft)	Weight for gauge (Lbs)	Part Weight (Lbs)	
100	48	4800	33.33	2 Lbs	66.67	
Oven Loading						
Part wgt lbs	Spacing (Ft)	Belt speed ft/min	Belt speed conversion ft/hr	Input Lbs/ hr		
66.67	1	2	120	8000		
Heat Requirement						
Oven loading	Beginning temp in F°	Ending temp in F°	Temp differential	Heat capacity (BTU/lb F°)	BTU/hr required	
54000	100	200	100	0.12	648000	
Red-Ray Burners Required						
BTU/hr required	Efficiency (loss) factor	Actual BTU/hr required	MR-12 burner capacity BTU/hr	Number of burners required	AR-125 burner capacity BTU/hr	Number of burners required
648000	1.5	972000	20,400	48	30000	32
648000	2	1296000	20,400	64	30000	43

Gas Fired Infrared Burners (Premix: 10% excess air in air/gas mixture or 19.3% O2 with methane)				
Type of IR emitter	Metal Fiber (sintered mesh) (Apollo-Ray)	Metal Foam (metal refractory) (MR-12)	Ceramic Refractory (Cordierite) (KN, F)	Atmospheric (foam or ceramic) (MR-7, AB-7)
Type of combustion	Surface	Surface	Impingement	Surface
Ratio of IR to convection	65/35	65/35	30/70	50/50
Body construction	SS	Cl, Ni plated, cast SS	Cl	Cl
Inlet pressure ("w.c.)	3.5-4.0	3.5-4.0	6.5	12
Heat flux density (BTU/hr/sq ft)	72,000	48,960	173,793	27,400
(BTU/hr/sq m)	775,027	527,018	1,870,755	294,941
(BTU/hr/sq in)	500	340	1,207	190
(BTU/hr/sq cm)	78	53	187	29
(Kwh/sq ft)	21.1	14	51	8
(Kwh/sq m)	227	154	548	86
(Kwh/sq in)	0.15	0.10	0.35	0.06
(Kwh/sq cm)	0.02	0.02	0.05	0.01
Turn down ratio	2.5:1	2.5:1	4.0:1	0
Thermal response	3-4 sec	5-6 sec	20-25 min	5-6 sec
Heat velocity (cu ft/hr/sq ft)	792	539	1912	301
Durability	High	Medium	Very High	Medium
Corrosion resistance	Medium	High	Med - High	Medium
Food applications	Yes	Yes	Yes	Yes
Max process operating temp				
(Degrees F)	650	550	800	500
(Degrees C)	343	288	427	260

Burner cost for IR heat				
(\$/IR BTU/hr)	0.026	0.030	0.027	0.142
(\$/IR KWh)	8.16	9.60	8.60	45.27
Gas cost for IR at high fire				
(\$/hr per sq ft@\$0.8 per CCF)	0.374	0.255	0.417	0.110
(\$/hr per sq m@\$0.0273 per Wh)	0.37	0.25	0.42	0.11

Percent Oxygen for Various Fuels

		Rich	Lean
Methane	CH ₄	18.90%	19.20%
Propane	C ₃ H ₈	20.10%	20.40%
Butane	C ₄ H ₁₀	20.20%	20.50%

GENERAL TECHNICAL INFORMATION

1. Run **combustion air blowers** while cleaning ovens.

Why? This helps prevent moisture from entering burners, which may cause problems if not dry for subsequent firing.

2. Inspect and clean **Blower Filter Elements** on a regular basis. Keeping an extra blower filter element on hand as a replacement while cleaning the other is an effective way to virtually eliminate downtime.

Why? A clogged blower filter element will create a pressure drop, which can be detrimental to burner performance, product in process and burner life.

3. When rebuilding any of our burners, inspect and replace **manifolds** that have become warped or bowed. Consider replacing them with our new custom made **stainless steel manifolds** for improved oxidation resistance and longer high temperature dimensional stability.

Why? Bowed or warped manifolds will interfere with proper **burner section alignment**. Replace the manifold and union connectors when warping interferes with parallel and matching height burner alignment. Poor alignment may result in uneven heat. Burner sections could also impinge upon each other which reduces their life.

4. Replace burner sections **after rebuilding** in their **same location on the manifold**. Label or number burner section base plates with matching location numbers on the manifold prior to rebuilding to help relocate their original position.

Why? Replacing sections in the same location will make for easier realignment. Poor alignment may cause direct flame impingement on adjacent burner sections, reducing burner longevity and transferring uneven heat to your product in process.

5. The outer cone of a **pilot flame** must be in constant contact with a **flame rod** for correct placement.

Why? Poor placement will reduce or interrupt the flame rod signal to the control panel which should shut off the burner.

6. If you want long life for your burners, **don't box them** in.

Why? "Boxing in" or hooding burners creates a barrier preventing the heat from dissipating. By not allowing the heat to dissipate, the burners will operate in an overheated condition which could drastically shorten their life.

Another tech tip compared the air/gas mixture entering a burner to the coolant in an engine. Along the same line, "boxing in" burners is like blocking air flow to a car engine's radiator. In both cases, overheating can result, which shortens service life.

EFFICIENCY TECHNICAL INFORMATION

“Regular infrared burner maintenance increases in importance, as fuel costs increase”

1. **"Tune up"** your infrared burners to save fuel costs.
Infrared burners become much more efficient after rebuilding in the same way that a car's engine does after a tune up. Dark areas of the refractories and tailing flames are wasting fuel.
Adjusting to the correct air/gas ratio will also maximize your burner's efficiency.
2. **Retrofit** with the more infrared energy efficient **Apollo-Ray, MR-12 and QC-12** burners where applications permit. Many of our customers have done this already. You can pay for a retrofit very quickly with fuel savings at the ever increasing energy prices. Call us to help review the financial benefits of retrofitting in your application.
3. Invest in a **gas flow meter** as an excellent first step to understand a specific oven or burner system's fuel usage. The cost savings of a "tune up" of your burners will then become clear. This is very similar to monitoring your car's gas mileage.
4. Don't over-fire your burners. Run your burners **slightly lean** for improving both fuel efficiency and burner life.

Why?

a) The **best fuel efficiency** is obtained by making sure that there is enough oxygen (O₂) available to combust all the fuel. An ideal target is 10% excess air which is equivalent to a 19.2% O₂ reading of the air/ natural gas mixture going into the burner.

b) Running rich provides much less air in the mixture. Less cool air coming into the burner is like running your car or truck with insufficient engine coolant. The metal parts of the burner (and engine in the analogy) will **overheat**. Unlike the overheated car or truck, the Red-Ray burners will continue to run in the overheated condition. The overheated metal parts will expand with time, which shortens the burner's life and makes these parts unsuitable for reuse.

	AIR	GAS	%O ₂
LEAN	12	1	19.3
LEAN	11	1	19.2
ON RATION	10	1	19.1
RICH	9	1	18.9
RICH	8	1	18.6