Overview of Commercial Burner Test Program With Early Results

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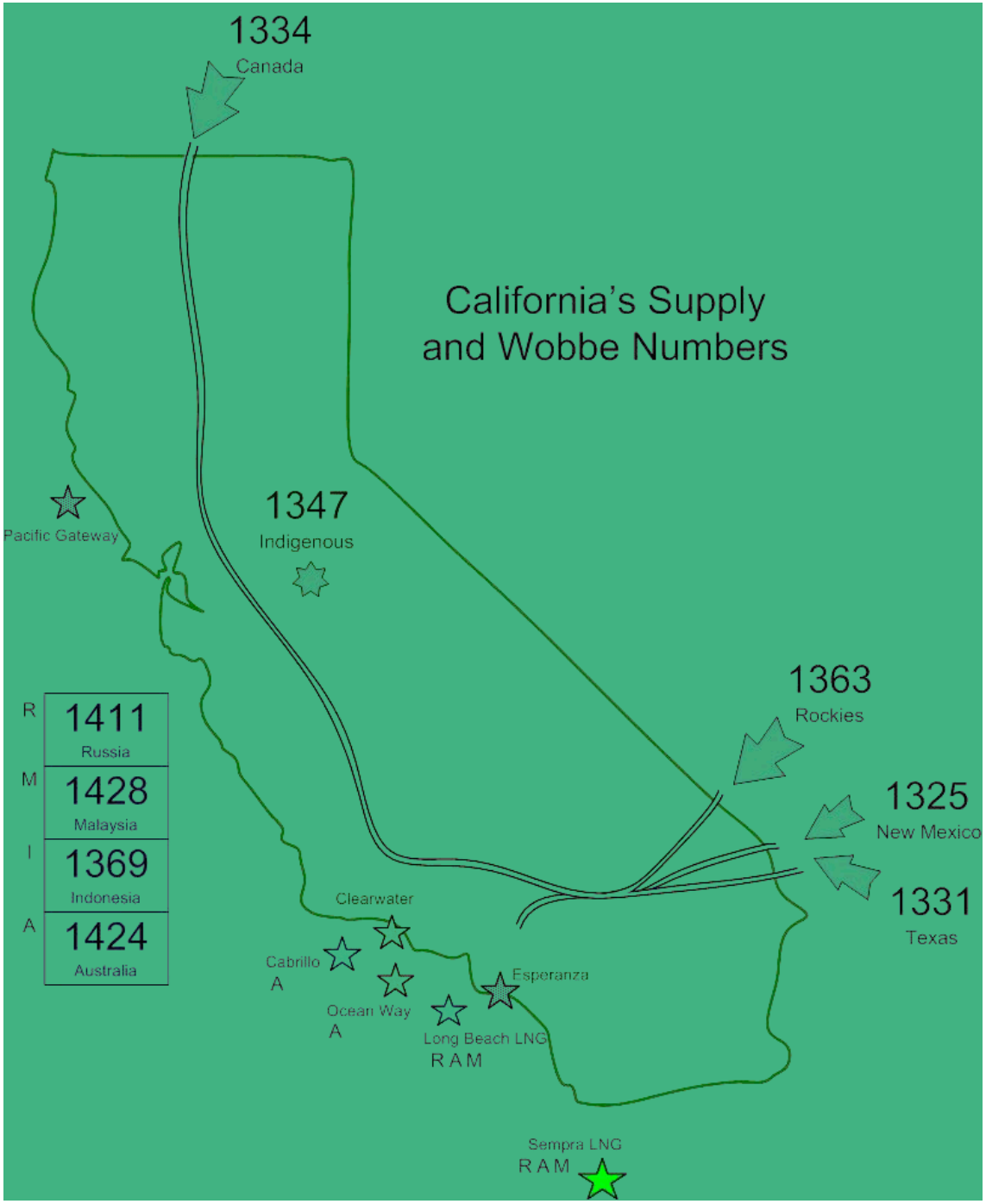
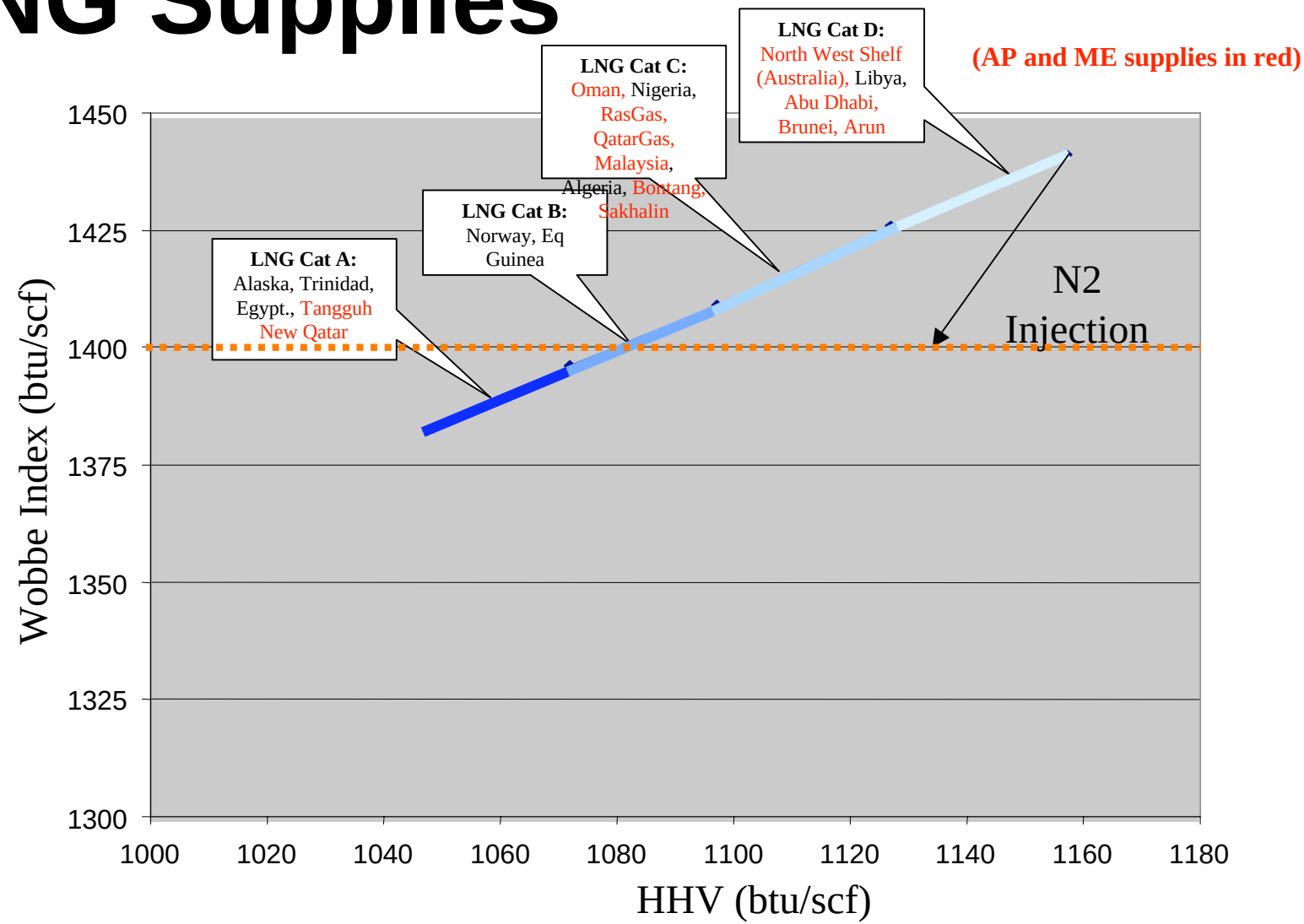
CEC Stakeholders Group
Sacramento, CA
October 29, 2007

California Gas Variability



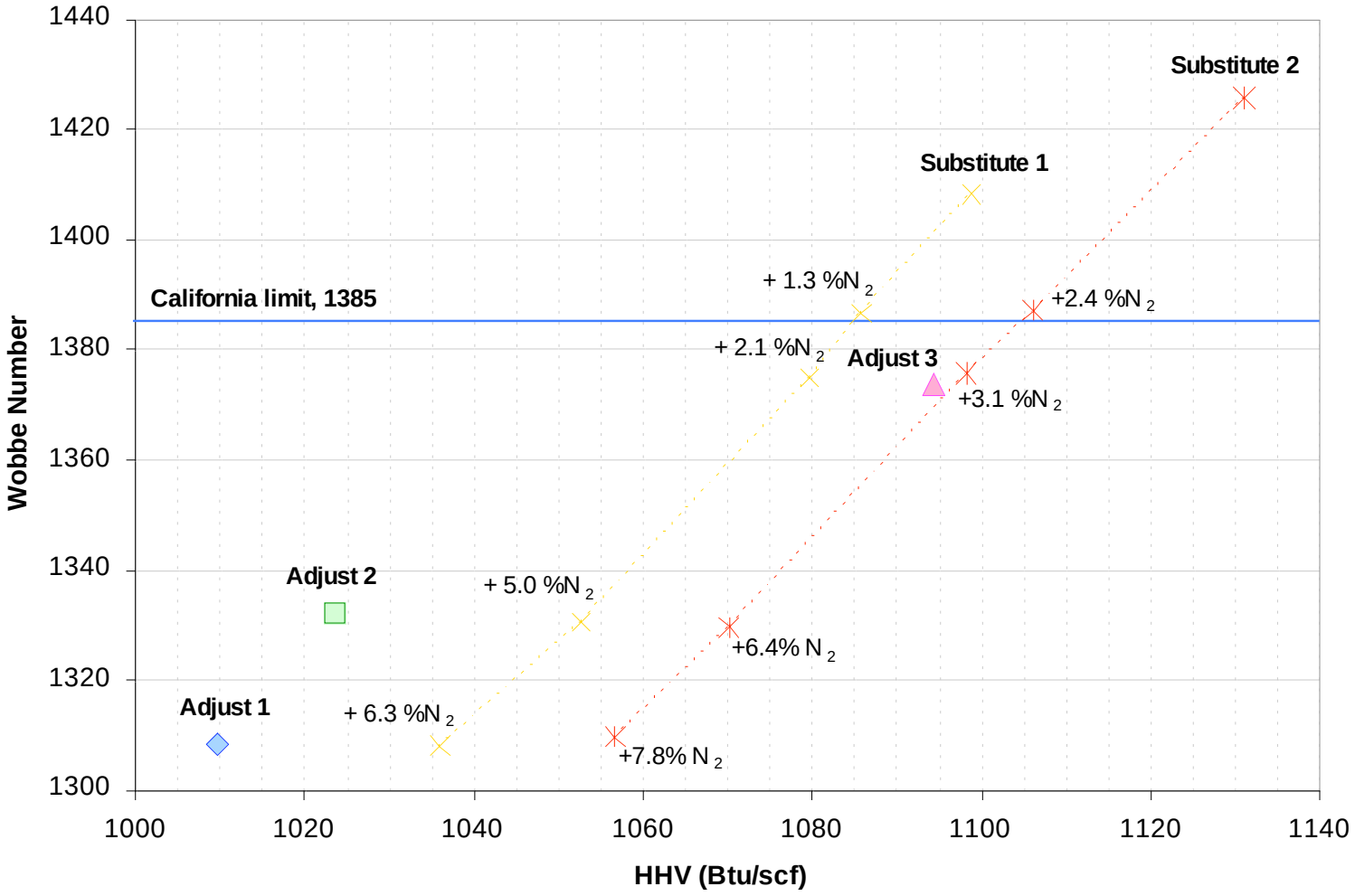
LNG Supplies



- **LNG expectational ranges only, might not be true reflection of guarantees from LNG export plant**
- **N2 tuning for example only**

Shell Gas & Power

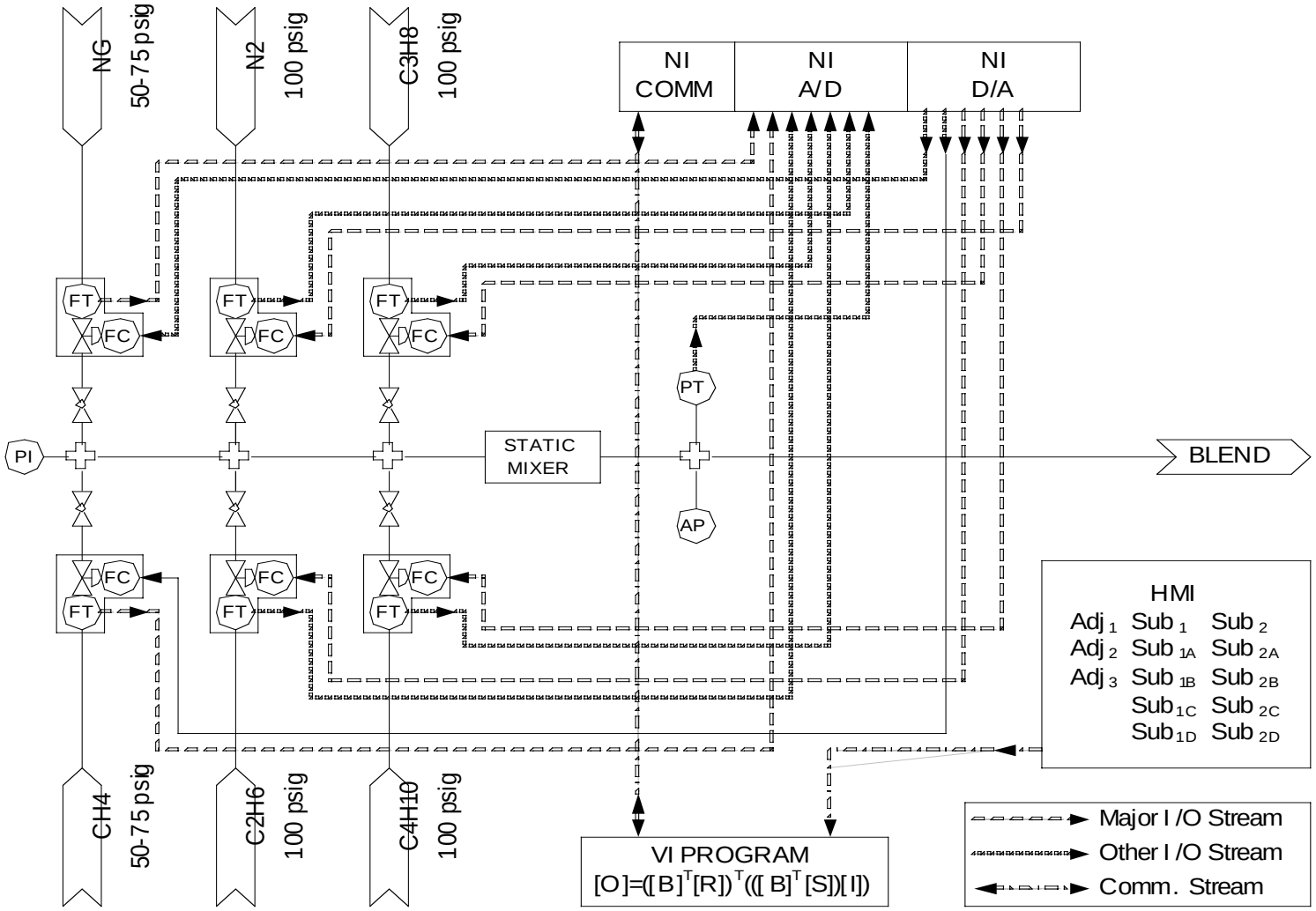
Test Gases Selected in Task 4



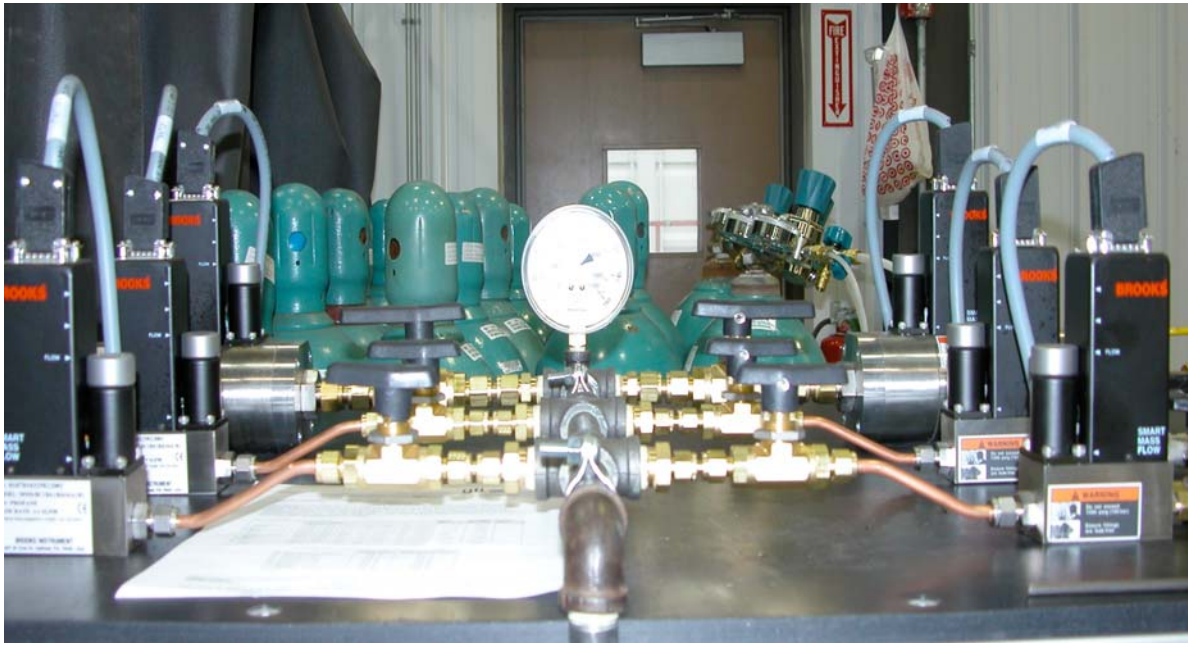
Gas Blends

		Composition							HHV* (Btu/scf)	Wobbe Number*
1	Adjust Gas 1 (A1)	%C1	%C2	%C3	%C4	%C5+	$\%N_2$	$\%CO_2$	1010	1308
		93.2%	2.52%	0.41%	0.16%	0.08%	2.69%	0.92%		
2	Adjust Gas 2 (A2)	%C1	%C2	%C3	%C4	%C5+	$\%N_2$	$\%CO_2$	1024	1332
		94.5%	2.55%	0.42%	0.14%	0.10%	1.36%	0.93%		
3	Adjust Gas 3 (A3)	%C1	%C2	%C3	%C4	%C5+	$\%N_2$	$\%CO_2$	1097	1375
		90.5%	2.45%	3.40%	1.38%	0.10%	1.30%	0.89%		
4	Substitute Gas 1 (S1)	%C1	%C2	%C3	%C4	%C5+	$\%N_2$	$\%CO_2$	1099	1408
		92.4%	4.90%	1.90%	0.79%	0.00%	0.00%	0.00%		
5	Substitute Gas 2 (S2)	%C1	%C2	%C3	%C4	%C5+	$\%N_2$	$\%CO_2$	1130	1425
		89.4%	7.10%	2.50%	1.04%	0.00%	0.00%	0.00%		

Gas Blending



Blending Station



Classification of Industrial Burners

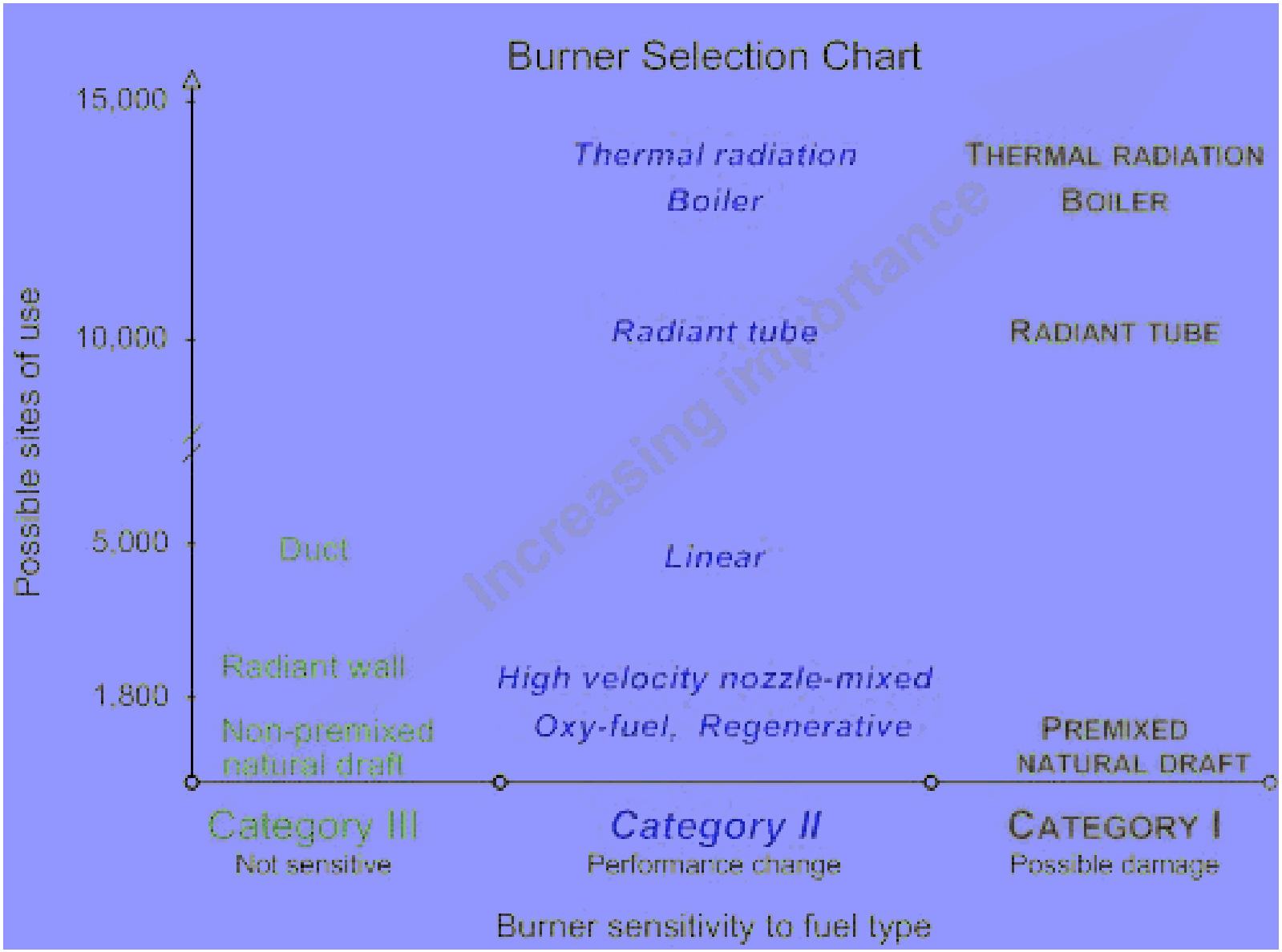
Classification Criteria

1. Mixing Type
2. Fuel Type
3. Oxidizer Type
4. Draft Type
5. Heating Type
6. Burner Geometry

Burner Types & Burner Applications

1. Radiant Burners
2. High Velocity Burners
3. Regenerative Burners
4. Natural Draft Burners
5. Boiler Burners
6. Linear Grid / In-Duct Burners
7. Oxygen Enhanced / Oxy-Fuel Burners
8. Flare Burners

CA Burners and Sensitivity



Test Burners Selected in Task 4

Manufacturer	Model Name	Comment	Control	Capacity, MMBtu/hr
Radiant Burners				
North American	Evenglow	Radiant Tube	Modulating +Pressure Balance	0.02—0.5
Maxon	Radmax	Radiant Panel	On/Off + Venturi mixer	0.025 per head
Boiler Burners				
COEN	Delta NOx	Low NOx w/ FGR	Cam linkage + O_2 Trim	Custom
COEN	Delta NOx ULN	Ultra Low NOx w/FGR	Cam linkage + O_2 Trim	Custom
Powerflame	NVC	Packaged System	Cam linkage + O_2 Trim	2-14.7
John Zink	FRMB	ULN w/ FGR, Rapid Mix	Cam linkage + O_2 Trim	5.25-25
Linear/Grid/Duct Burners				
COEN	Powerplus	Duct Burner (turbine re-burn)		
Flynn Burner	Pipe	Linear Burner (baking)	Modulating +Venturi mixer	0.04 per inch
Oxygen Enhanced Combustion				
Eclipse	PrimeFire 300	High Luminosity	On/Off + Pressure Balance	0.5 – 8.0
Regenerative Burners				
Bloom Engineering	1150	Nozzle-Mixed type	Modulating +Pressure Balance	
Nozzle Mixed Burners				
Eclipse Combustion	ThermJet	High Velocity	Modulating +Pressure Balance	0.15-20

- All relevant types are covered.
- Top sellers are from a variety of manufacturers – by market presence.

Burner Evaluation Criteria

Heat Flux

Air-Fuel Ratio

Flame Temperature

Noise

Emissions

Turndown Ratio

Stability

Incomplete Combustion

Exhaust Temperature

Furnace Temperature

Flame Shape

Ignition Limits

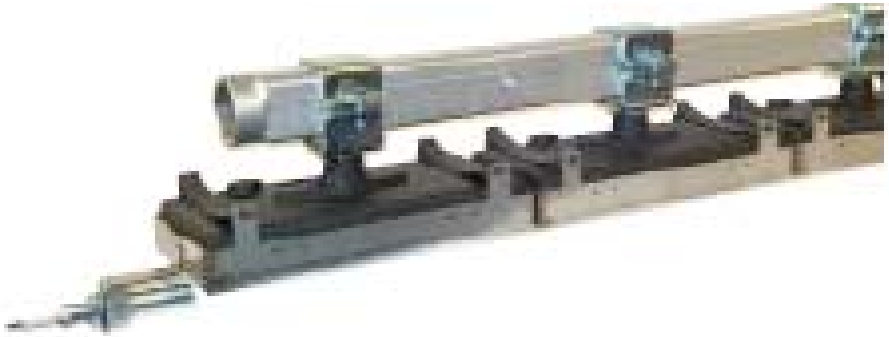
Test Burner

Reported Top Selling Thermal Radiation Burner

Thermal Radiation
- Fabricated Metal
- Food and Beverage
- Textile Mills, Apparel
- Paper, Printing
- Electronics
- Chemical

Manufacturer	Model	Comment	Capacity, MMBtu/hr
Maxon	RadMax	Radiant Panel	~0.025 per head

Front view – Type 50 (side-to-side) assembly with direct spark/flame sensing ports



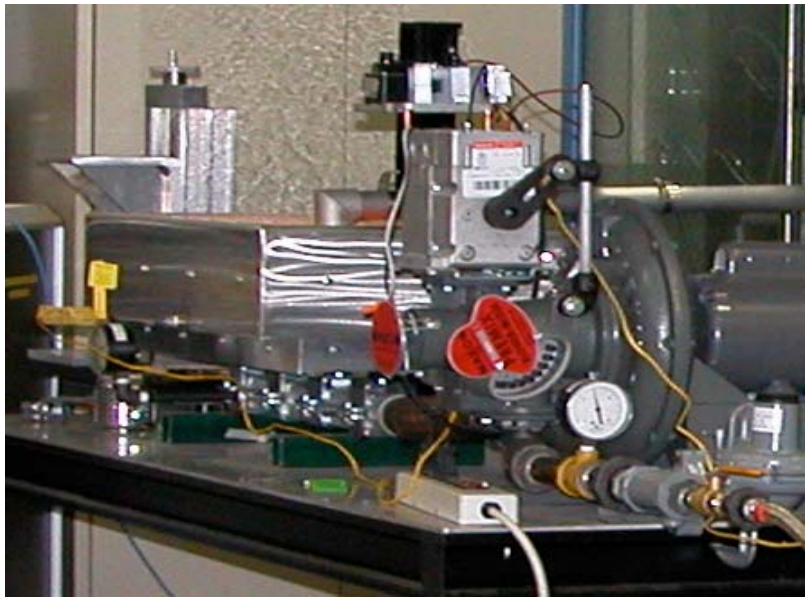
Side view – Type 25 assembly

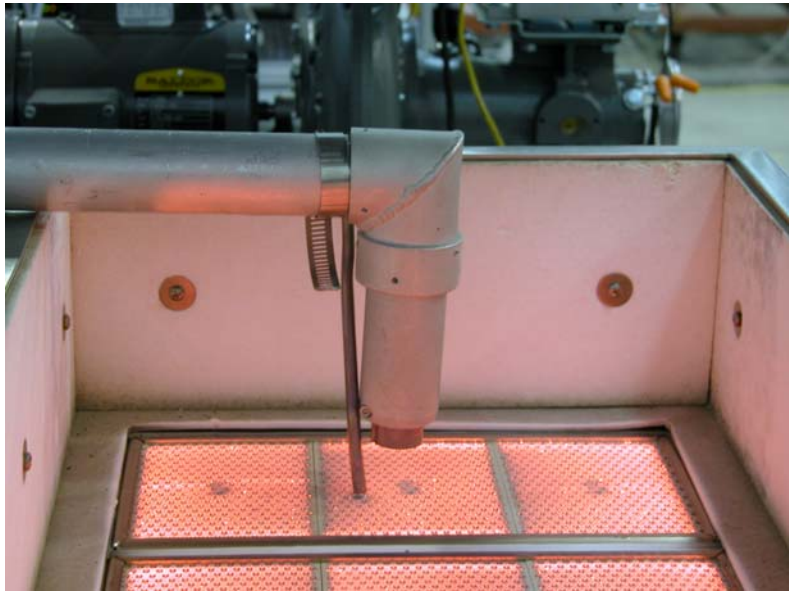
Test Burner

- Maxon's RadMax 4-50
- 4 heads
- Firing capacity:
  - *Nominal 100,000 Btu/hr*
  - *Max 23,500 Btu/hr per head*
- Typical temperature range
  - *1050ºF-1650ºF*
- Enclosure to prevent side effects

Evaluation Methodology

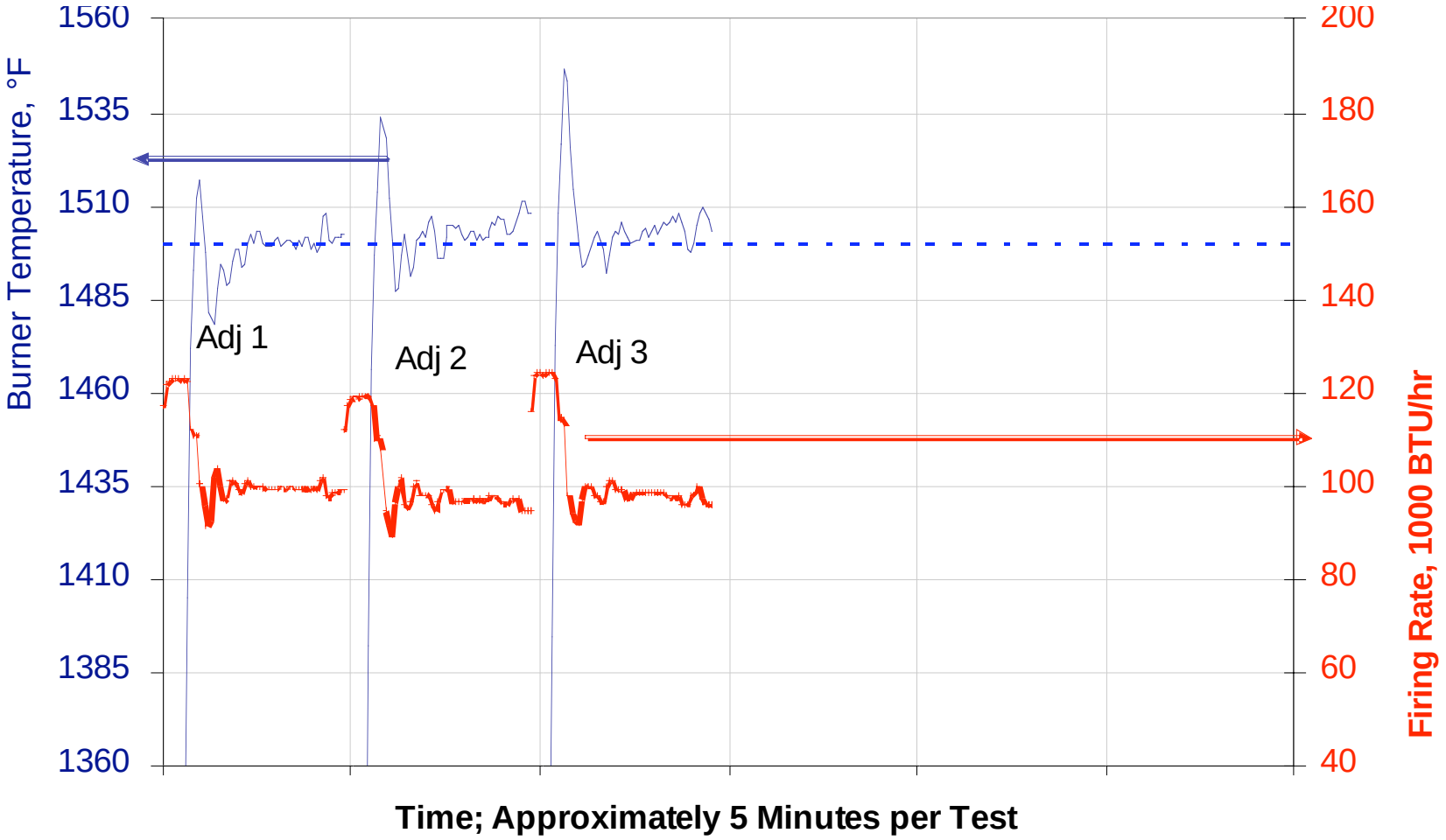
- Burner installed per mfgr's specification
- Burner face temperature < 1650ºF
- Water-cooled heat flux sensor
- Velmex auto-positioning system





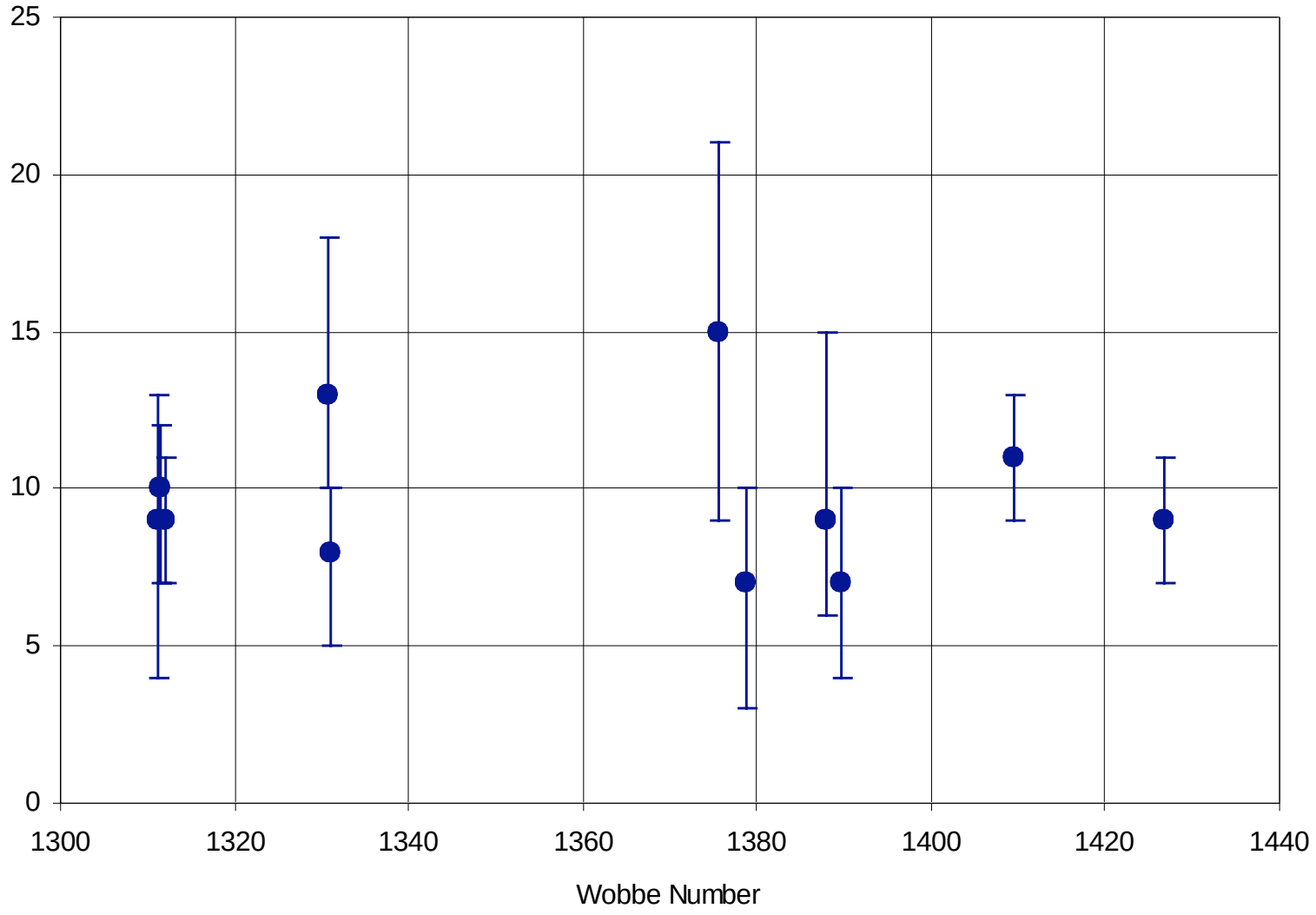
IR Burner Ignition Tests

(example for All Three Adjust Gases)



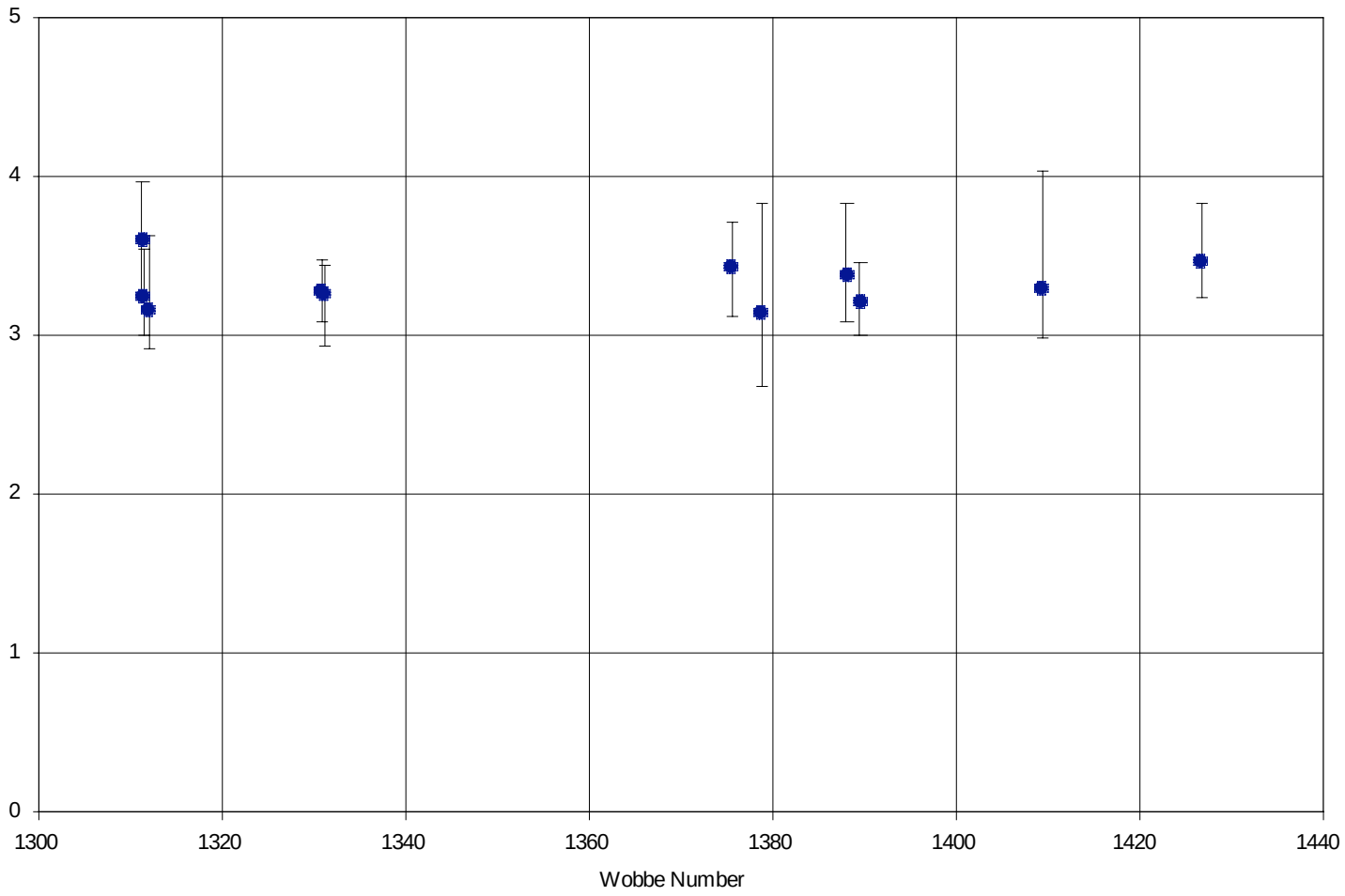
Carbon Monoxide [vppm]

(IR burner test, Adjust 1)



Nitric Oxides [vppm]

(IR burner test, Adjust 1)



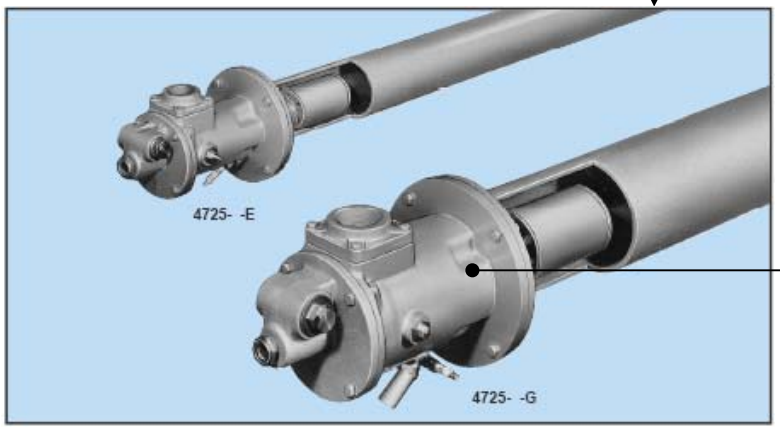
Radiant Tube Burner Selection

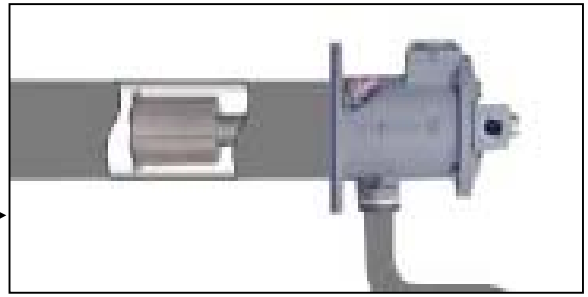
Reported Top Selling Radiant Tube Burners, and Selected Burner

Radiant Tube

- Fabricated Metal
- Food and Beverage
- Electronics
- Chemical
- Primary Metal

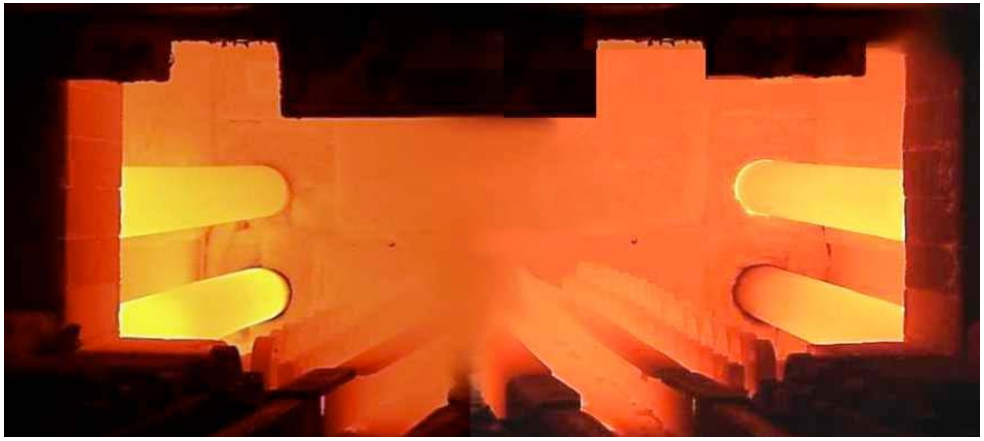
Manufacturer	Model	Comment	Capacity, MMBtu/hr
Eclipse	TFB	Radiant Tube	0.025—2.0
Eclipse	IJ	Immersion Tube	0.18—4.8
North American	Evenglow	Radiant Tube	0.02—0.5
Maxon	Unirad	Radiant Tube	0.15—0.3
Pyronics	SER	Radiant Tube	0.05—0.19





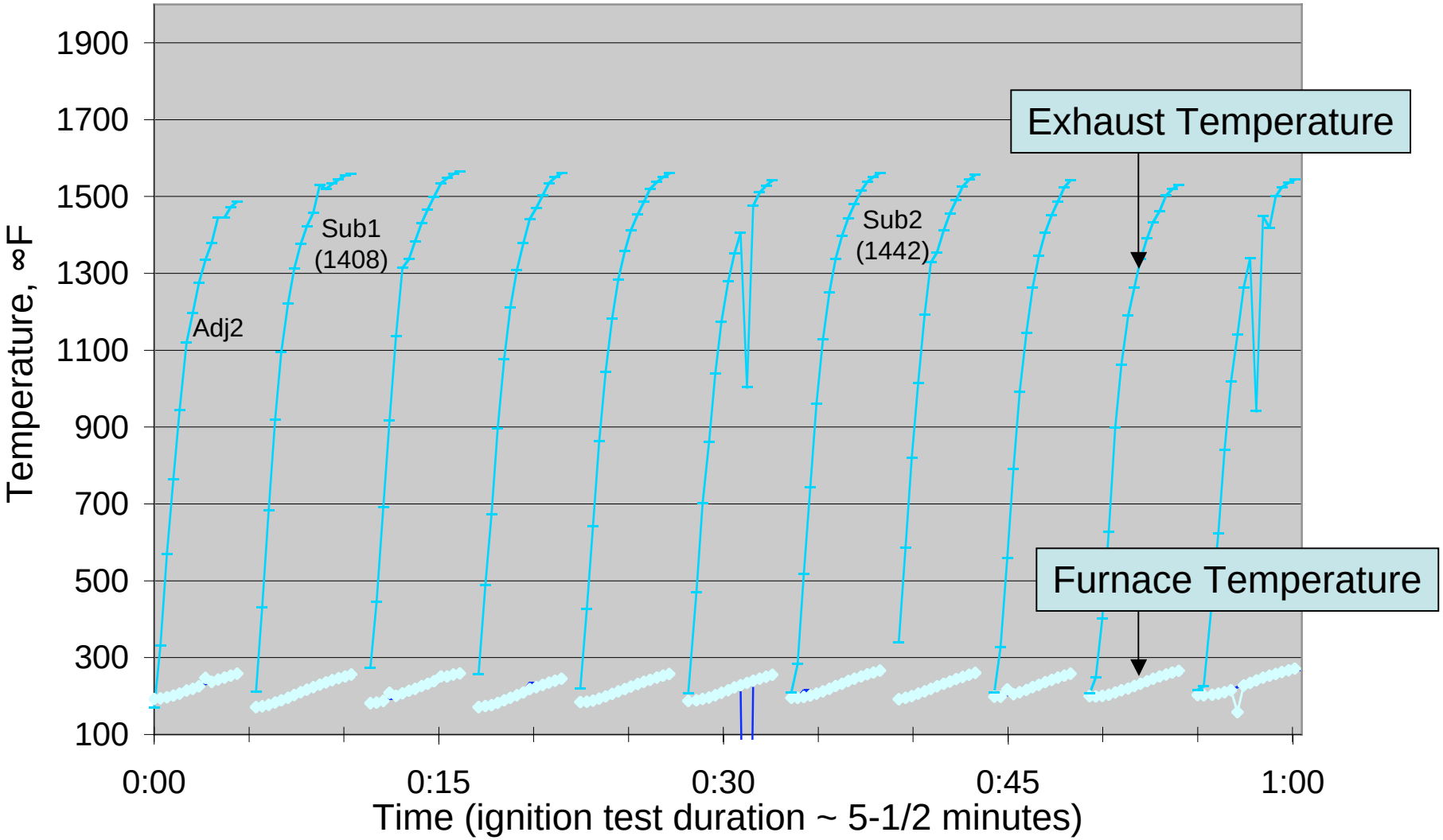
Evaluation Outline

- Parameters to be measured:
  - Flows (air, gas)
  - Temperatures (furnace, radiant tube surface, air preheat, exhaust, etc.)
  - Emissions
  - Noise
  - Flame shape
  - Turndown



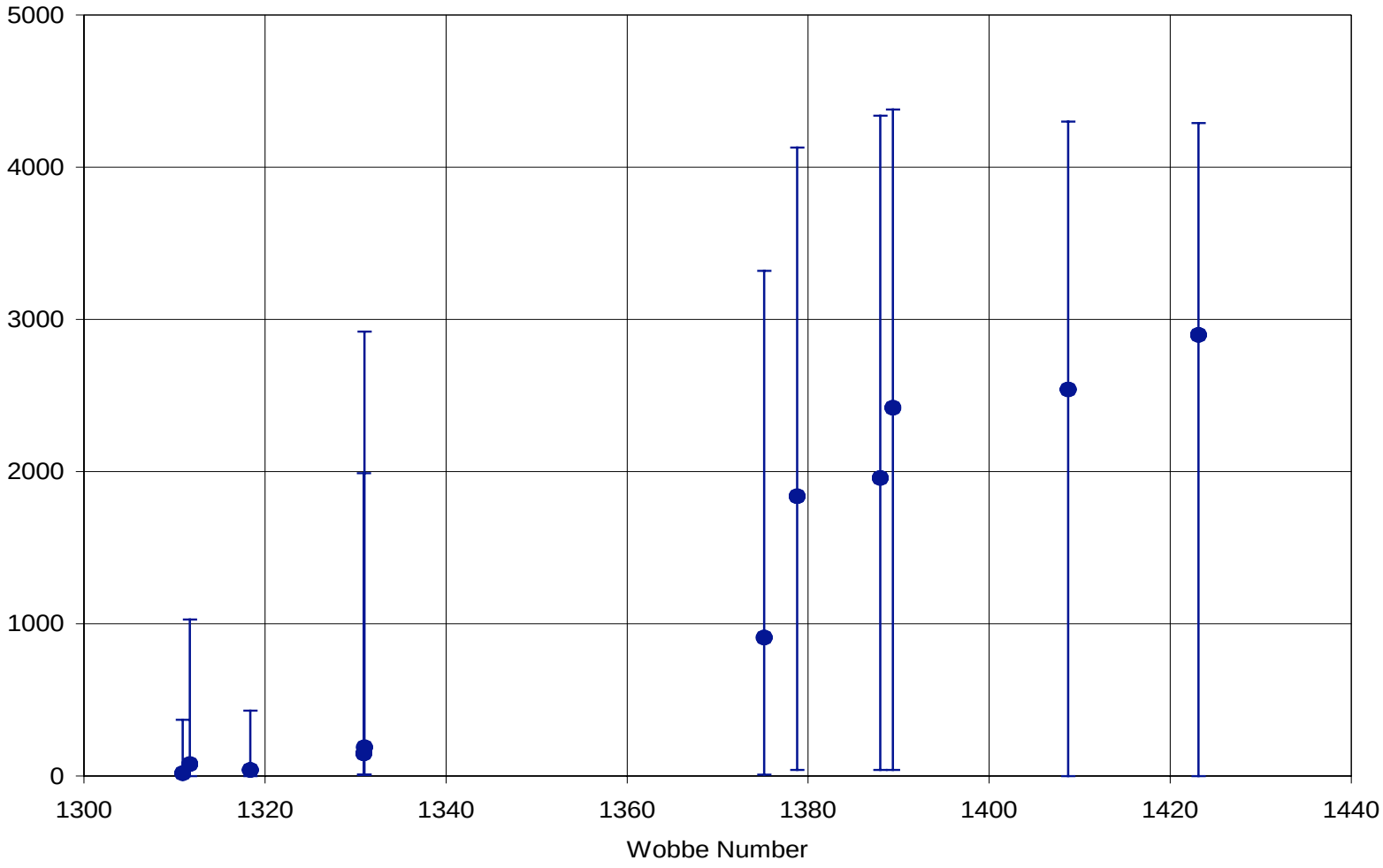
Radiant Tube Burner

Ignition Tests for Adjust Gas 2



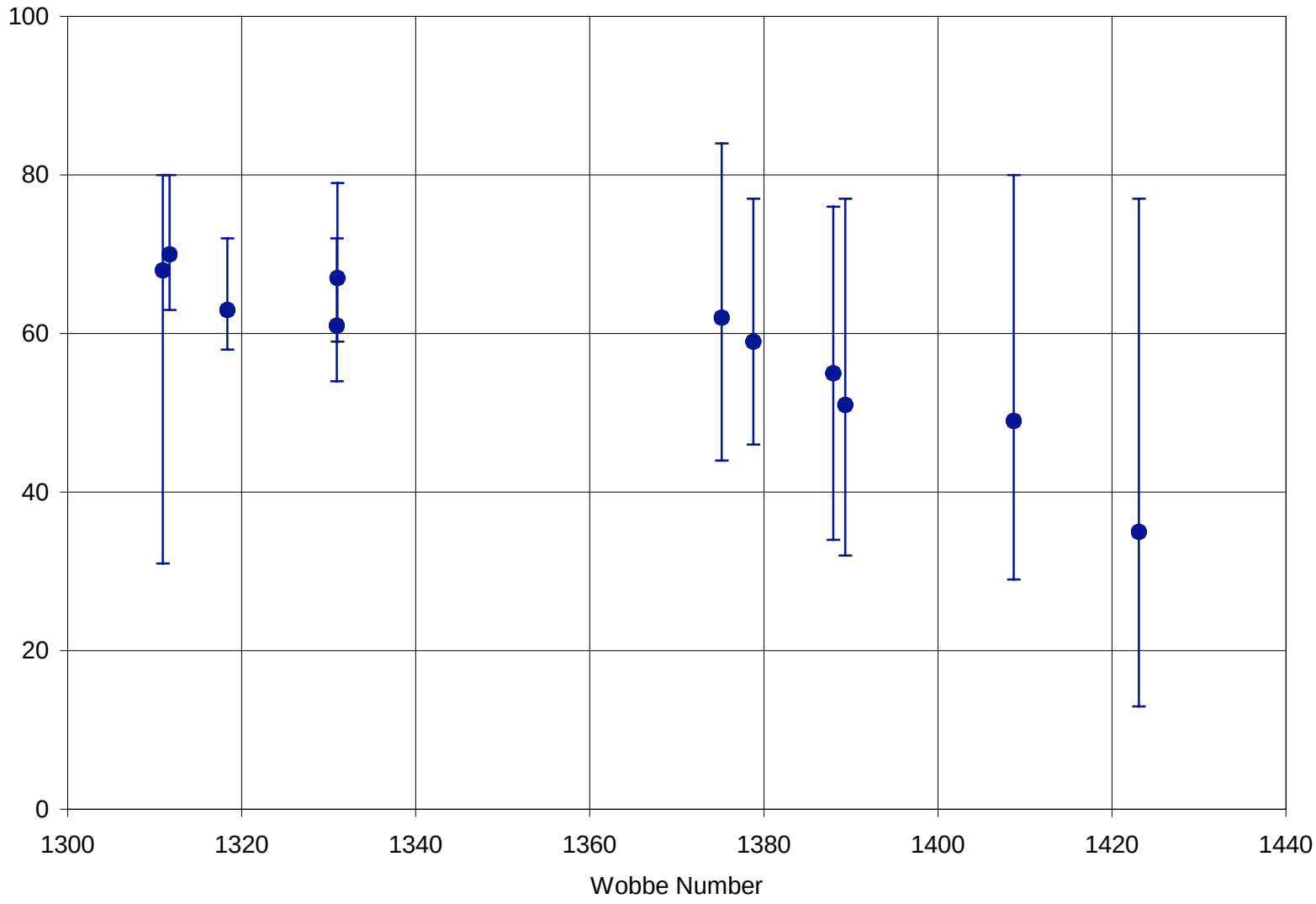
Carbon Monoxide [vppm]

Radiant Tube Burner, Adjust Gas 2



Nitric Oxides [vppm]

Radiant Tube Burner, Adjust Gas 2



Linear Burner Selection

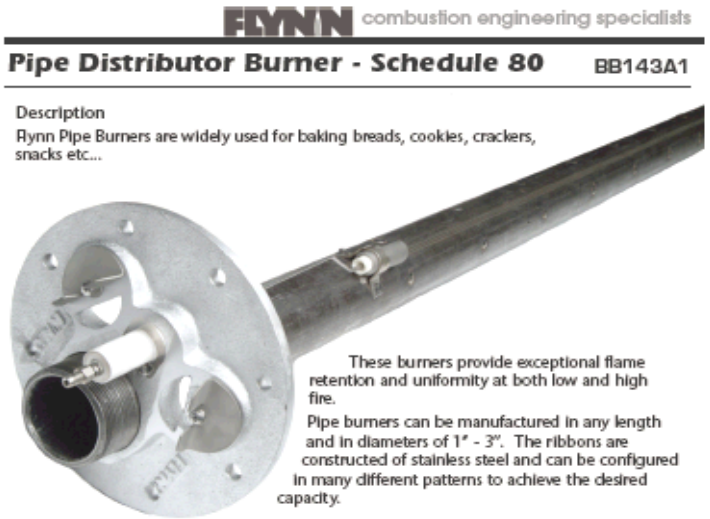
Reported Top Selling Linear Burner

Linear

- Food and Beverage

Manufacturer	Model	Comment	Capacity, MMBtu/hr
Flynn Burner	Pipe	Linear	~0.04 / inch

XTRUded Selective Flame Distributor Burner – BB123A1



FLYNN combustion engineering specialists

Pipe Distributor Burner - Schedule 80 BB143A1

Description

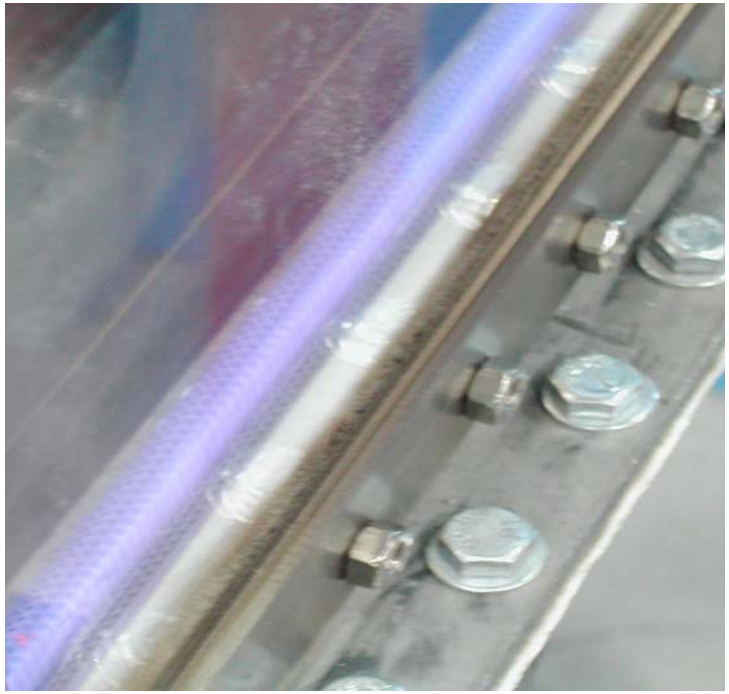
Flynn Pipe Burners are widely used for baking breads, cookies, crackers, snacks etc...

These burners provide exceptional flame retention and uniformity at both low and high fire.

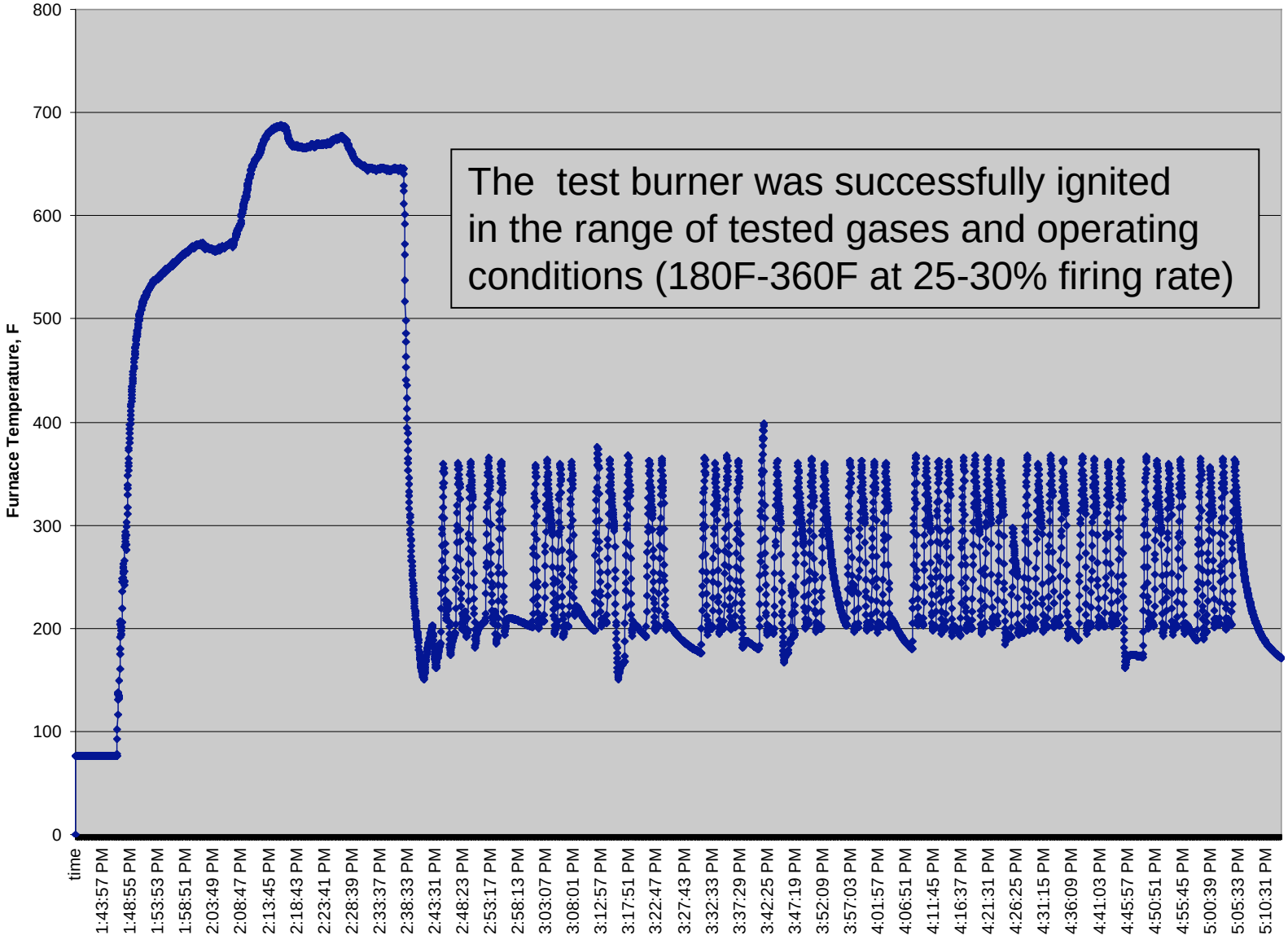
Pipe burners can be manufactured in any length and in diameters of 1" - 3". The ribbons are constructed of stainless steel and can be configured in many different patterns to achieve the desired capacity.

Evaluation Outline

- Parameters to be measured:
  - Flows (air, gas)
  - Temperatures
    - Flame
    - Combustion products
  - Emissions
  - Flame shape
  - Turndown

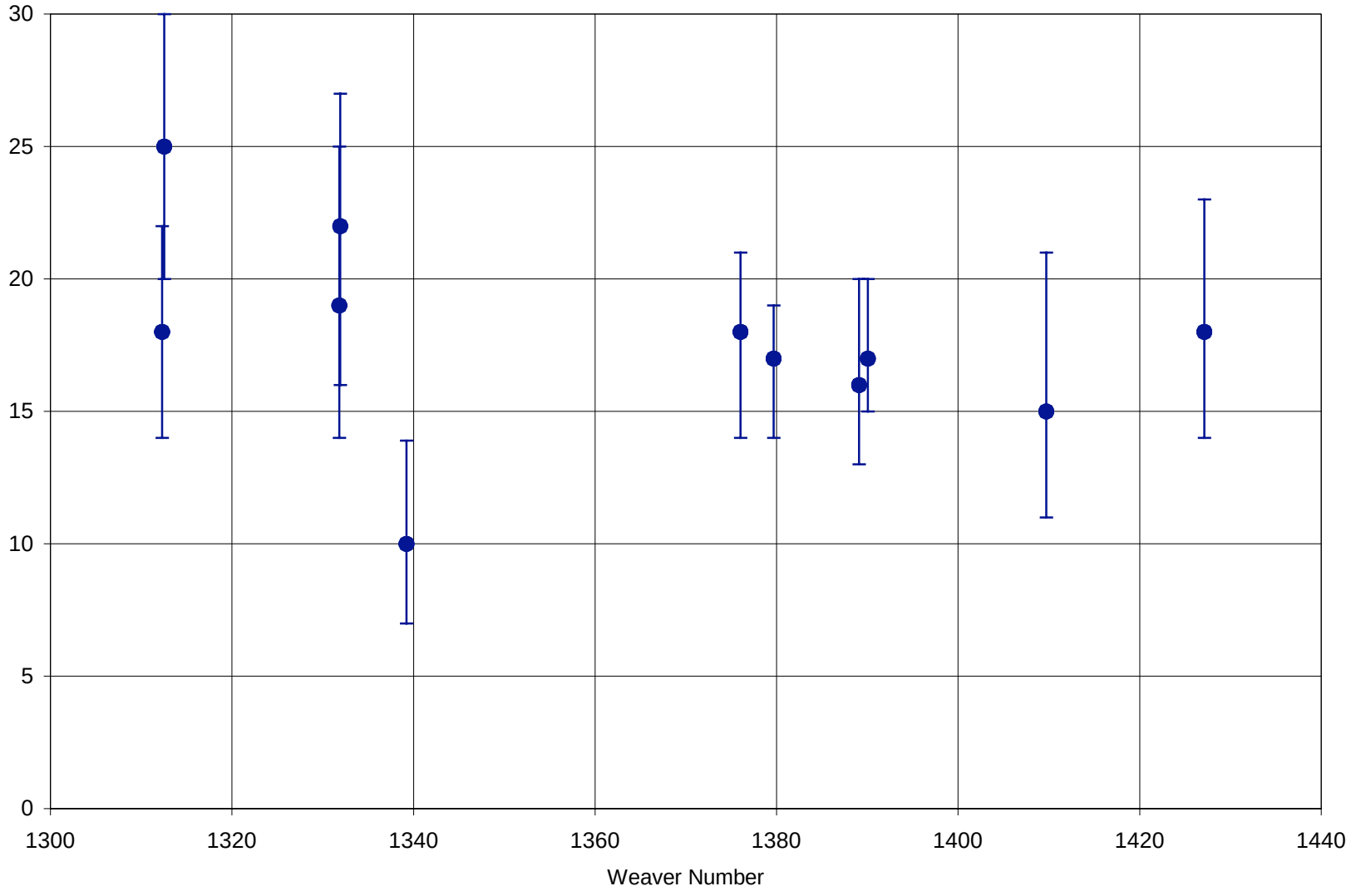


Linear Burner Ignition Tests



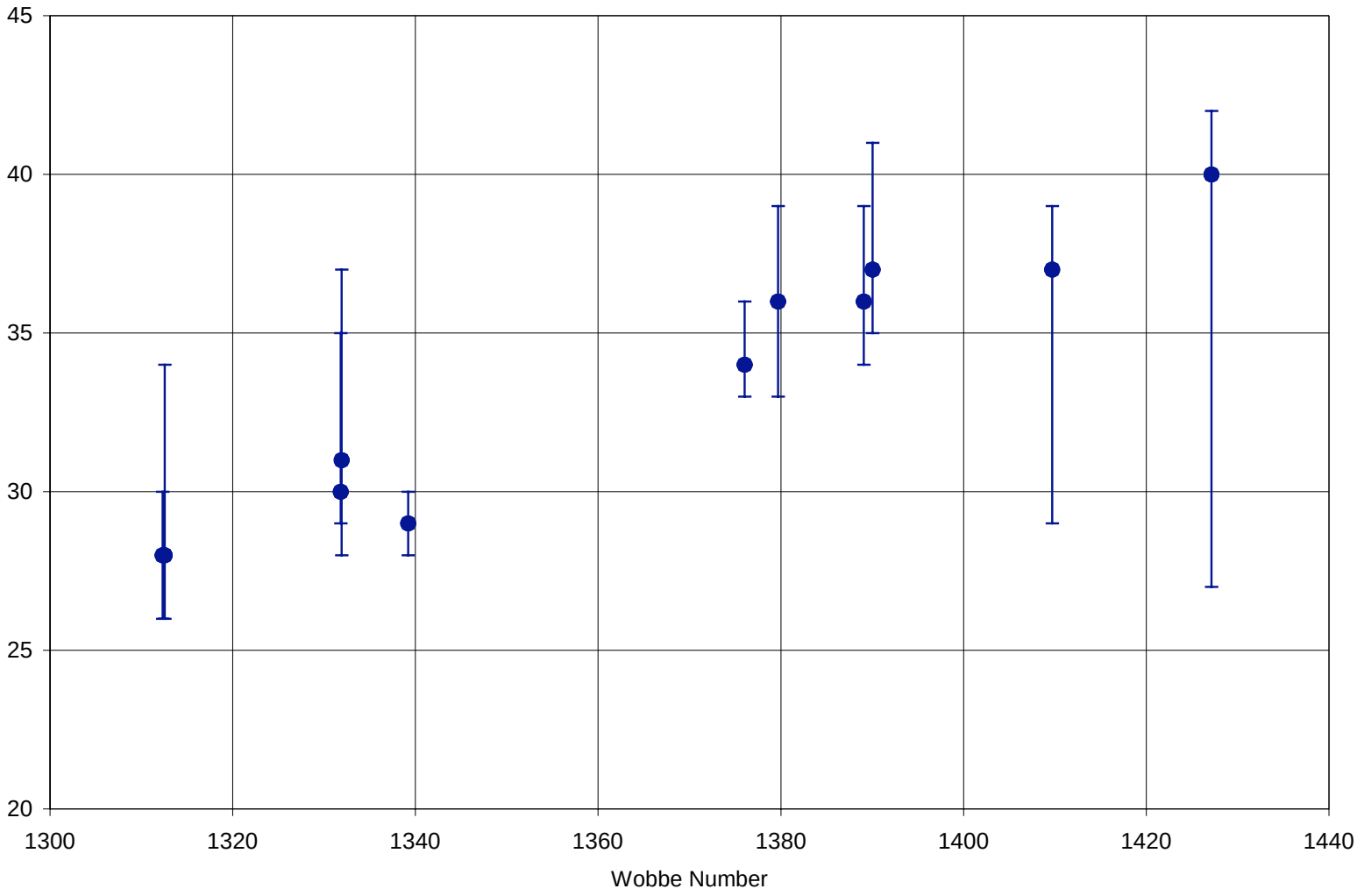
Carbon Monoxide [vppm]

Linear Ribbon Burner, Adjust Gas 2



Nitric Oxides [vppm]

Linear Ribbon Burner, Adjust Gas 2



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