ASGE NATIONAL TECHNICAL CONFERENCE

AMERICAN SOCIETY OF GAS ENGINEERS

MGM GRAND HOTEL—LAS VEGAS—JUNE 7-9, 2010

BOB JACKSON
CIELO TECHNOLOGIES, LLC

REFERENCES

- 1.“ Household Cooking—Gas Appliances”, American National Standard—ANSI Z21.1—2000
- 2.” Household Cooking—Gas Appliances”, American National Standard—ANSI Z 21.1
- Addenda to ANSI Z21.1—1996 & 1997
- 3. “Fundamentals of Gas Combustion”, American Gas Association Laboratories, Copyright 1973
- 4. “Orifice Capacity Charts for Harper Metered Orifices”, Harper-Wyman Company
- 5. “Gaseous Fuels, Louis Shnidman, Published by Mack Printing Company, Copyright 1954
- 6. “Gas Engineers Handbook”, Published by Industrial Press, Copyright 1965
- 7. “Combustion and Gas Appliances” Carl Suchovsky, Published by Gas Consultants, Cleveland Ohio, Copyright May 2004
- 8. “National Fuel Gas Code”, ANSI Z223.1/NFPA 54
- 9. “ Engineering Fundamentals”, 4th Edition, by Michael R. Lindburg, PE, Published by: Professional Publications, Inc. Copyright 1998.
- 10. “Thermodynamics”, by Gordon J. Van Wylen, Published by John Wiley & Sons, Inc, Copyright 1959.

FUNDAMENTALS OF GASEOUS FUELS

ANSI TEST GASES

CHARACTERISTICS OF ANSI TEST GASES

	HEATING VALUE		
	Btu/Ft^3)	MJ/ M^3)	Specific Gravity
GAS A (Natural)	1075	40.1	0.650
GAS B (Manufactured)	535	19.9	0.380
GAS C (Mixed)	800	29.8	0.500
GAS D (N-Butane)	3200	119.2	2.000
GAS E (Propane HD5)	2500	93.1	1.550
GAS F (Propane-Air)	700	26.1	1.160
GAS G (Butane-Air)	1400	52.2	1.420
GAS H (Propane-Air)	1400	52.2	1.300

THESE TEST GASES ARE TAKEN FROM ANSI Z21.1 FOR HOUSEHOLD COOKING APPLIANCES. OTHER PRODUCTS REQUIRING CSA OR INTERNATIONAL APPROVAL MAY HAVE DIFFERENT TEST GASES.

ANSI GAS TEST PRESSURES

ANSI INLET TEST PRESSURES Table 1.4		TEST PRESSURE Inches W.C.(kPa)	
	REDUCED	NORMAL	INCREASED
GAS A (Natural)	3.5(0.87)	7.0(1.74)	10.5(2.61)
GAS B (Manufactured)	3.0(0.75)	6.0(1.49)	9.0(2.24)
GAS C (Mixed)	3.0(0.75)	6.0(1.49)	9.0(2.24)
GAS D (N-Butane)	8.0(1.99)	11.0(2.74)	13.0(3.23)
GAS E (Propane HD5)	8.0(1.99)	11.0(2.74)	13.0(3.23)
GAS F (Propane-Air)	3.0(0.75)	6.0(1.49)	9.0(2.24)
GAS G (Butane-Air)	3.5(0.87)	7.0(1.74)	10.5(2.61)
GAS H (Propane-Air)	3.0(0.75)	6.0(1.49)	9.0(2.24)

THESE TEST PRESSURES ARE TAKEN FROM ANSI Z21.1 FOR HOUSEHOLD COOKING APPLIANCES. OTHER PRODUCTS REQUIRING CSA OR INTERNATIONAL APPROVAL MAY HAVE DIFFERENT TEST GASES.

NATURAL GAS

There are six basic areas of our country in which Natural Gas is Found

1.) Appalachian
2.) Indiana
3.) Mid-continent
4.) Texas
5.) Rocky Mountains
6.) California

GROUP CLASSIFICATIONS FOR NATURAL GAS

Table 1.1

GROUP	NITROGEN (%)	SPECIFIC GRAVITY	% METHANE	HEATING VALUE
High Inert Type	6.3--16.20	0.660--0.708	71.9--83.2	958--1051
High Methane Type	0.10--2.39	0.590--0.614	87.6--95.7	1008--1071
High Btu Type	1.20--7.50	0.620--0.719	85.00--90.10	1071--1124

The “High Inert” classification comes from the percentage of Nitrogen in the sample.

MAJOR CONSTITUENTS

TYPICAL COMPOSITION OF NATURAL GAS

Table 2.2

SAMPLE NUMBER	PERCENT OF VARIOUS COMPONENTS				
	CH(4) (METHANE)	C(2)H(6) ETHANE	N(2) NITROGEN	CO(2) CARBON DIOXIDE	0(2) OXYGEN
1	88.20	3.20	7.68	0.16	0.14
2	81.91	17.51	0.11	0.31	0.16
3	98.59	0.00	0.94	0.31	0.16
4	82.56	16.51	0.16	0.31	0.16
5	94.73	2.64	1.89	0.30	0.44
6	66.31	31.70	1.21	0.47	0.31
7	89.04	5.63	4.68	0.21	0.44
8	90.52	4.56	4.29	0.21	0.42
9	98.40	1.00	0.50	0.00	0.10
10	82.60	7.20	7.10	2.70	0.40
11	74.20	18.50	7.30		
12	67.90	26.10	6.00		

LIQUIFIED PETROLEUM

AVERAGE PROPERTIES OF COMMERCIAL LPG
Table 2.3

	Propane	Butane
Vapor Pressure, psig		
70 deg F	124	31
90 deg F	167	49
100 deg F	192	59
105 deg F	206	65
130 deg F	286	97
Specific Gravity of Liquid	0.509	0.582
Initial Boiling Point (14.7 psia),F	-51	15
Weight/gal liquid @ 60 deg F, lbs	4.24	4.84
Dew Point @14.7 psia, F	-46	24
Specific Heat of Gas, C(p)	0.404	0.382
Specific Gravity (air = 1)	1.52	2.01
Ignition Temperature, F	920-1020	900-1000
Max. Flame Temp, F	3595	3615
Max. Rate of Flame Velocity		
Cm /sec	84.9	87.1
In/ sec	33.4	34.3
Limits of Flammability, %gas-air		
Lower Limit	2.40	1.90
Higher Limit	9.60	8.60
Required for Complete Comb (%)		
cu ft O(2)/cu ft gas	4.90	6.30
cu ft air / cu ft gas	23.40	30.00
lbs O(2)/lb gas	3.60	3.54
lbs air / lb gas	15.58	15.30
Products of Complete Comb		
cu ft CO(2) / cu ft gas	3.00	3.90
cu ft H(2)O / cu ft gas	3.80	4.60
cu ft N(2) / cu ft gas	18.50	23.70
Ultimate CO by Vol.	13.90	14.10
Total Heating Values after Vap		
Btu/cu ft	2522	3261
Btu/ lb	21560	21180
Btu/gal	91500	102591

MANUFACTURED GAS

MANUFACTURED GASES--TYPICAL ANALYSES

Table 2.4

GAS TYPE	SOURCE	SPECIFIC GRAVITY	GROSS HEATING VALUE
Acetylene	Calcium carbide & water	0.91	1499
Blast Furnace	By-product, pig iron	1.04	81
Blue	Coke	0.54	300
Blue	Bituminous Coal	0.55	335
Blue	Coke,steam, oxygen	0.75	262
Butane	Natural gas	2.07	3371
Butane	Refinery gas	2.03	3310
Carbureted Water	Low gravity back run	0.54	536
Carbureted Water	High Btu	0.69	850
Coal	Continuous vertical retort	0.47	358
Coal	Horizontal retort	0.42	532
Coal	Inclined retort	0.47	542
Coke Oven	By-product	0.36	567
Coke Oven	By-product	0.40	580
Coke Oven	9 Hr. charging	0.31	502
Refinery Oil	Blain down blast	0.45	586
Refinery Oil	Coke-fire	0.66	970
Refinery Oil	Twin generator	0.80	1000

MANUFACTURERED GAS TYPICALLY HAS A LOWER HEATING VALUE THAN NATURAL GAS AND CERTAINLY LOWER THAN LP GAS.

GAS FACTS—NATURAL GAS

SPCEIFIC GRAVITY = 0.56

HEATING VALUE = VARIES BUT TYPICALY AROUND 1000 BTU/FT^3

FLAME TEMPERATURE = 3416 ° F

FLAME SPEED PROPAGATION = 26.00 INCHES / SECOND

LIMITS OF FLAMMABILITY = 5 TO 15 %

IGNITION TEMPERATURE = 1202 ° F

AIR REQUIRED FOR COMPLETE COMBUSTION = 9.6 FT^3 AIR / FT^3 GAS

GAS FACTS--LP

PROPANE GAS

SPCEIFIC GRAVITY = 1.55

HEATING VALUE = 2588 BTU/FT^3

FLAME TEMPERATURE = 3497 ° F

FLAME SPEED PROPAGATION = 32.00 INCHES / SECOND

LIMITS OF FLAMMABILITY = 2.57 TO 9.5 %

IGNITION TEMPERATURE = 932 ° F

AIR REQUIRED FOR COMPLETE COMBUSTION = 26.3 FT^3 AIR / FT^3 GAS

GAS FACTS--LP

BUTANE GAS

SPCEIFIC GRAVITY = 2.00

HEATING VALUE = 3184 BTU/FT^3

FLAME TEMPERATURE = 3443 ° F

FLAME SPEED PROPAGATION = 33.00 INCHES / SECOND

LIMITS OF FLAMMABILITY = 1.86 TO 8.41 %

IGNITION TEMPERATURE = 896 ° F

AIR REQUIRED FOR COMPLETE COMBUSTION = 31.1 FT^3 AIR / FT^3 GAS

ALTITUDE CONSIDERATIONS

ALTITUDE:

Altitude is actually not a problem but leads to several problems. As the altitude increases, the atmospheric pressure decreases and the availability of primary air decreases. Generally, there are no corrections for input at altitudes less than 2,000 feet above sea level. As per the National Fuel Gas Code (ANSI Z223.1/ NFPA 54) "above 2,000 feet, the appliance must be derated 4% for every 1,000 feet above sea level". Also, pressure switches and other components do not react the same at higher elevations.

Effect of Elevation on Normal Barometric Pressure		
Elevation (Feet)	Decrease in pressure per foot of added elevaton in inches of mercury	Normal barometric pressure a start of zone of elevations in inches of mercury
Sea level to 1,000	0.00112	29.92
1,000 to 2,000	0.00108	29.82
2,000 to 3,000	0.00104	27.78
3,000 to 4,000	0.00100	26.77
4,000 to 5,000	0.00096	25.81
5,000 to 6,000	0.00920	24.87

CHARACTERISTICS OF GASEOUS FUELS MOST USED IN USA

GAS	IGNITION TEMPERATURES (ºF)	FLAME TEMPERATURES (ºF)	FLAME SPEED INCHES/SEC	FLAMMAILITY LIMITS (HIGHER %)	%AIR FT^3/FT^3GAS	HEATING VALUE BTU/FT^3
NATUTRAL	1202	3416	26	15	9.6	1022
PROPANE	920--1020	3497	33.4	9.5	23.9	2522
BUTANE	900--1000	3443	34.3	8.44	31.1	3261

LOWER LIMIT OF FLAMMABILITY = 5.00%
UPPER LIMIT OF FLAMMABILITY = 15.00%

The limits of flammability are always given as the percentage of **gas** in the **gas-air** mixture.

GASEOUS MIXTURES

It is not uncommon to find combustible gaseous fuels that do not fit neatly into the Natural, LP (Propane and Butane) or Manufactured categories. In dealing with vendors in South America, the Caribbean, the Middle-East and Asia, I have found a remarkable variety of combustible mixtures that exhibit significant differences in specific gravity and heating value relative to the "gas facts" given earlier. It is very important to know as much about the combustible mixture as possible but certainly the HEATING VALUE and the SPECIFIC GRAVITY. The simple excel chart following this slide will give a quick method for determining those two values. The real problem lies in getting the vendor or bottler to declare the constituents in the mixture. This may take some persuasion and time. GE always required a letter of declaration from the primary supplier.

PHYSICAL PROPERTIES OF PARAFFIN SUBSTANCES

Substance	lb/lb of Comb Req O(2)/AIR	Ignition Temp (F)	Limits of Flammability % gas in air LOWER/UPPER	Flame Temp (F)
Methane	4.049/17.195	1301	5.00/15.00	3484
Ethane	3.688/15.899	968-1166	3.00/12.50	3540
Propane	3.537/15.246	871	2.10/10.10	3573
n-Butane	3.476/14.984	761	1.86/8.41	3583
iso-Butane	3.476/14.984	864	1.80/8.44	3583
n-Pentane	3.554/15.323	588	1.40/7.80	N/A
iso-Pentane	3.554/15.323	788	1.32/N/A	N/A
Neopentane	3.554/15.323	842	N/A/N/A	N/A
n-Hexane	3.535/15.238	478	1.25/6.90	N/A
Neohexane	3.535/15.238	797	N/A/N/A	N/A
n-Heptane	N/A	433	1.00/6.00	N/A
Triptane	N/A	N/A	N/A/N/A	N/A
n-Octane	N/A	428	0.95/3.20	N/A
iso-Octane	N/A	N/A	N/A/N/A	N/A

CALCULATION FOR TOTAL HEATING VALUE AND SPECIFIC GRAVITY OF GASEOUS MIXTURES

GAS	MIXTURE %	HEATING VALUE Btu/Ft^3	CONTRIBUTION TO FINAL MIX Btu/Ft^3	SP.GR	CONTRIBUTION TO FINAL MIX SP.GR
METHANE	0.70	1012	708.4	0.554	0.3878
ETHANE	0.10	1786	178.6	1.038	0.1038
PROPANE	0.10	2563	256.3	1.552	0.1552
NITROGEN	0.10	0	0	0.967	0.0967
TOTAL MIXTURE			1143.3		0.7435

Table 2.5 Table for Computing Total Heating Value and Total Specific Gravity

1.) The individual constituents for the gaseous “mix” must be known along with their heating values and specific gravities.
2.) Using an Excel spreadsheet, construct the table as show in the example above.
3.) Multiply the contents of columns two and three and put the results in column four.
4.) Multiply the contents of columns two and five and put the results in column six.
5.) Add the values in column four to get the TOTAL HEATING VALUE.
6.) Add the values in column six to get the TOTAL SPECIFIC GRAVITY.

INTERCHANGEABILITY OF GASES

Two gases may be regarded as interchangeable if their flame characteristics are satisfactory after substitution of one gas for another. A flame which does not lift, yellow tip, produce carbon (sooting), produce carbon monoxide in excess percentages or flash back, is considered satisfactory in this frame of reference. One way to look at interchangeability is to check for similarities of flow through an orifice. Interchangeability is very important due to the need to substitute one gas for another during periods of increased demand. (This is not to be confused with "peak shaving".)

There are several mathematical models used to evaluate the interchangeability of gases. These are as follows:

AGA Interchangeability Indexes:

- " C " Factor—Research involving 250 different gas mixtures.
- Lifting, Flashback and Yellow Tipping—How gases over 800 Btu/Ft^3 could supplement or be substituted for natural or high-Btu gases, where I(L) = lifting index, I(F) = flashback index and I(Y) = yellow tipping index.

INTERCHANGEABILITY OF GASES (CONTINUED)

Other Indexes:

- Knoy Formulas
- Weaver Indexes
- Bureau of Mines Interchangeability Studies
- Wobbe Index-- The Wobbe Index is the main indicator of interchangeability of fuel gases, such as natural gas, LPG, manufactured gas, etc. This index is not used that frequently in the United States or Canada but is used over the remainder of the world and provides a great comparison of fuel gas characteristics. It basically compares the heat input factor of a burner at constant pressure. The Wobbe Index is defined by the following equation.

$$\text{Wobbe Index} = HV / \sqrt{Sp.Gr.}$$

where HV = heating value and Sp Gr = the specific gravity of the gaseous fuel. The table below will indicate the Wobbe Index of several gases.

WOBBE INDEX OF VARIOUS GASES

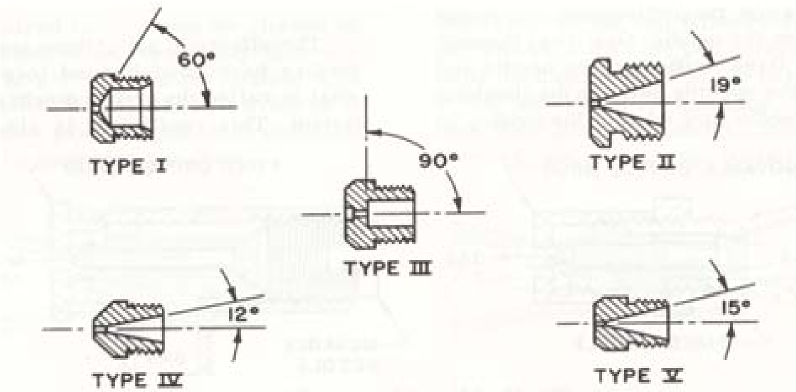
Table 5.1

WOBBE INDEX				
GAS	UPPER INDEX	LOWER INDEX	UPPER INDEX	LOWER INDEX
	kCAL/m^3	kCAL/m^3	Btu/Ft^3	Btu/Ft^3
Hydrogen	11,528	9,715	1295.7472	1091.966
Methane	12,735	11,452	1431.414	1287.2048
Ethane	16,298	14,931	1831.8952	1678.2444
Ethylene	15,253	14,344	1714.4372	1612.2656
Natural gas	12,837	11,597	1442.8788	1303.5028
Propane	19,376	17,817	2177.8624	2002.6308
Propylene	18,413	17,180	2069.6212	1931.032
n-butane	22,066	20,336	2480.2184	2285.7664
Iso-butane	21,980	20,247	2470.552	2275.7628
Butylene-1	21,142	19,728	2376.3608	2217.4272
LPG	20,755	19,106	2332.862	2147.5144
Acetylene	14,655	14,141	1647.222	1589.4484
Carbon monoxide	3,060	3,060	343.944	343.944

BURNER ORIFICES

q = 1658.5 KA √ H/d where

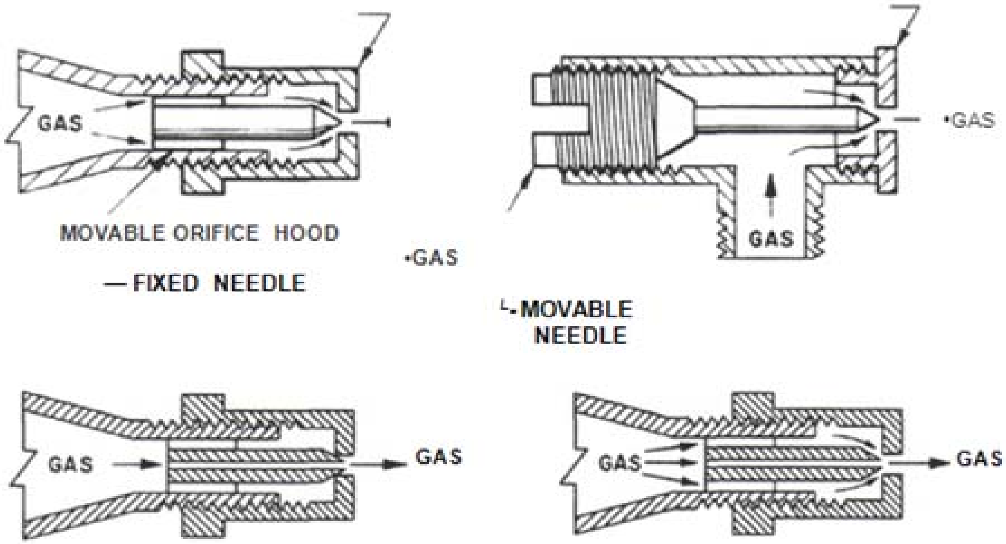
q = gas discharge in Ft^3 / hr
K = coefficient of discharge (This is dependent upon orifice design and is given in the following table.)
A = area of orifice in in^2
H = gas pressure in W.C.
d = specific gravity of gas



ORIFICE TYPE	ORIFICE DISCHARGE COEFFICIENT
I	0.80
II	0.82
III	0.65
IV	0.83
V	0.83

Each orifice type has a specific "K" factor. Please note that for approach angles up to 60 degrees, the "K" factor is roughly 0.80.

BURNER ORIFICES (CONTINUED)



ADJUSTABLE ORIFICES

These orifices are typically found in oven cavities where the change from natural to propane gas can occur.

CIELO TECHNOLOGIES, LLC

GOOD COMBUSTION

IDEAL BURNER CHARACTERISTICS:

1. Blue flame with possibly some yellow tips when using propane or butane as the fuel. **(NOTE: These burners are firing natural gas with a heating value of approximately 1075 Btu/Ft^3)**
2. Distinct individual flame pattern. You can count the number of ports by counting the number of individual flames emanating from those ports.
3. No blowing or lifting of flames; i.e., separation of the flame from the burner port.
4. No lazy flames. (This is an indication of too little primary or secondary air.)
5. No flash-back of burner flames.
6. No offensive noise during ignition, operation or extinction.
7. No offensive odors emanating from the combustion process.
8. Flame heights are uniform around the burner periphery. **(NOTE: In looking at the simmer burners below (smaller burners), you will notice that the flame heights are not equal. This is by design and involves the configuration of the burner grates mounted above the burners themselves.**)

BURNERS FIRING IMPROPERLY

1) Yellow flames—even for propane or butane—this would be a terrible flame pattern.
2) Flame heights very irregular.
3) No distinct flame patterns.
4) Indications that there are considerable issues with pressure or pressure drop through the system.
5) Lazy flames indicating issues with primary air.
6) Evidence of sooting (carboning) that will produce excessive CO.

CIELO TECHNOLOGIES, LLC

ISSUES

The following issues are very common to gas burners and burner systems. Proper burner design and application can alleviate many of the problems that can occur.

1.) TIME TO LIGHT

2.) FLAME CARRYOVER

3.) BLOWING OFF OR LIFTING OF BURNER FLAMES

4.) LAZY FLAME

5.) FLASHBACK

6.) PRESSURE LOSS IN GAS DELIVERY SYSTEM (A REAL ENEMY)

7.) ALIGNMENT OF BURNER ORIFICE WITH BURNER VENTURE

8.) YELLOW-TIPPING

PRIMARY AIR VS LIFTING

Percent Primary Air at Lifting Btu/Sq. In Port Area									
Port Size	Natural			Butane			Manufactured		
	15,000	20,000	25,000	15,000	20,000	25,000	15,000	20,000	25,000
50	57	52	48						
46	65	58	53	59	49	44	106	104	102
36	71	64	55	68	59	52	114	109	106
30	72	65	58						
75	67	60	74	65	57	118	112	108	
0.25	96	87	78	82	73	64	133	125	119

This chart shows that the smaller the port size the greater the tendency for flames to lift from burner ports. As port size is increased a higher percentage of primary air may be accommodated before lifting occurs. It also shows that butane has a slightly greater tendency to lift from ports than natural gas. On manufactured gas, the lifting limits are so high they are seldom reached on commercial burners.

LIFTING LIMITS VS PORT SIZE

	MFG Gas				Natural Gas				Butane Gas			
	% Primary Air at Yellow-Tip Limit			Rate Below Which Yellow-Tips Disappears No Primary Air Btu/Hr-Sq.In	% Primary Air at Yellow-Tip Limit			Rate Below Which Yellow-Tips Disappears No Primary Air Btu/Hr-Sq.In	% Primary Air at Yellow-Tip Limit			Rate Below Which Yellow-Tips Disappears No Primary Air Btu/Hr-Sq.In
Port Size	15M	20M	25M		15M	20M	25M		15M	20M	25M	
0.250	19	20	21		38	39	39		58	58	58	
26DMS	6	9	11	6500	24	26	28		48	50	52	
36DMS	2	5	7	12500	19	21	22		38	42	45	
46DMS				28000	11	13	15			32	38	
60DMS				95000				46500				

This table shows that as the port size is increased, a greater percentage of primary air is required to preclude yellow tips.

CIELO TECHNOLOGIES, LLC

CRITICAL BURNER RELATIONSHIPS

1.) AIR SHUTTER DESIGN

2.) THROAT TO PORT AREA RATIO

3.) DISTANCE OF GAS ORIFICE TO BURNER THROAT

4.) ANGLE OF DIVERGENCE FOR VENTURE TUBE DOWNSTREAM OF THROAT

5.) LENGTH OF MIXING TUBE

6.) PORT SIZE

7.) PORT DEPTH

8.) NUMBER OF PORTS, CONSEQUENTLY PORT LOADING

9.) PORT SPACING & NUMBER OF PORT ROWS

IGNITION SYSTEMS

IGNITION TYPES

1.) STANDING PILOT

2.) SPARK IGNITION

3.) HOT SURFACE

4.) HYBRID SYSTEMS

5.) FLAME FAILURE DEVICES (FFD)

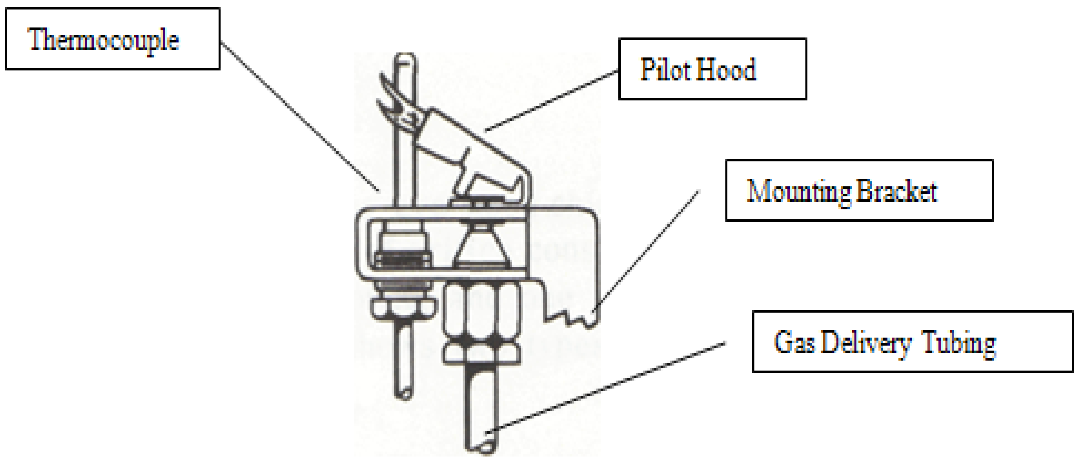
6.) PIEZOELECTRIC

7.) MAGNITO IGNITION SYSTEMS

8.) RE-IGNITION DEVICES

9.) MATCH LIGHT

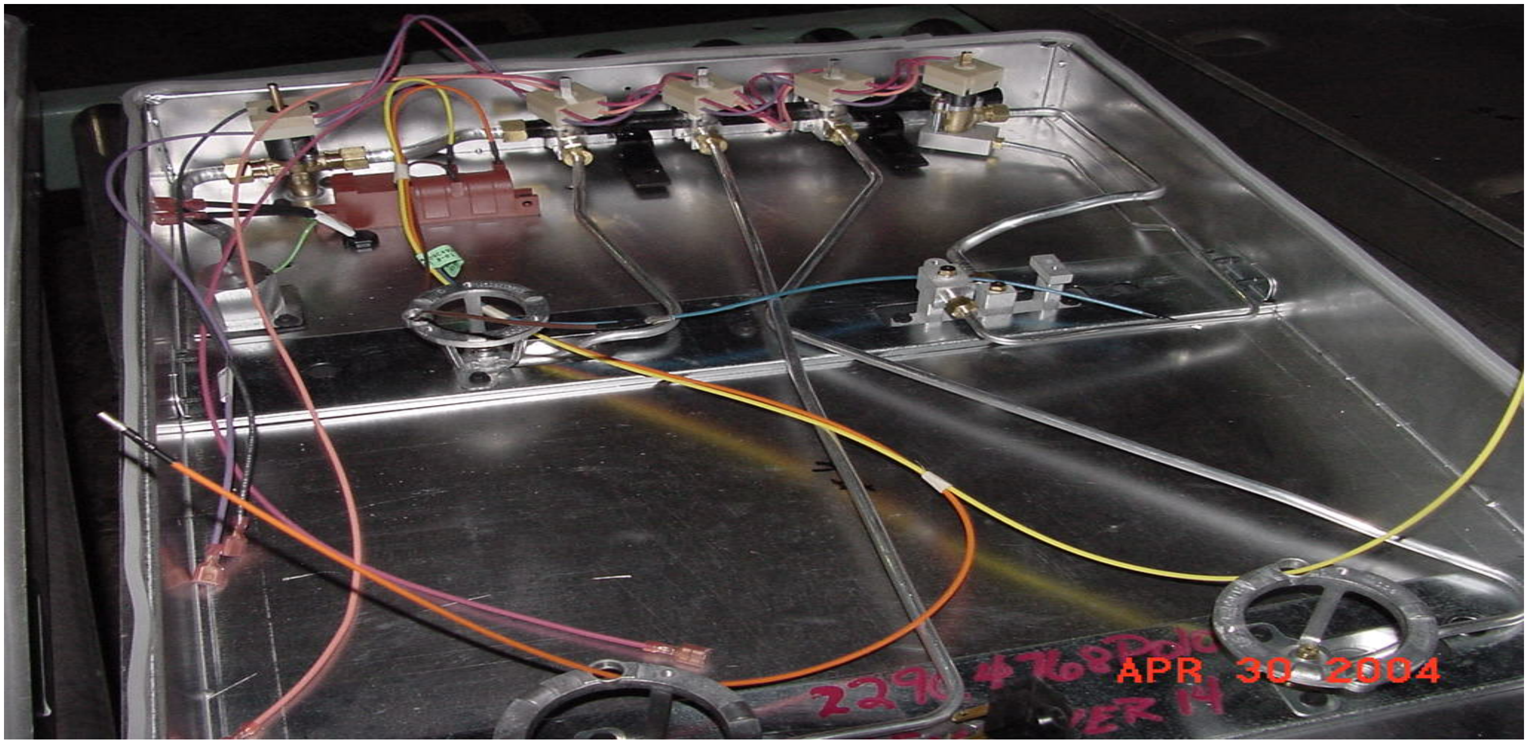
STANDING PILOT IGNITION SYSTEM



The standing pilot system has been around for years but is slowly being replaced by spark ignition or hot surface systems. The thermocouple and gas tubing are connected into a control device that allows gas to flow when a solenoid in the gas valve is “made”.

CIELO TECHNOLOGIES, LLC

SPARK IGNITION SYSTEM

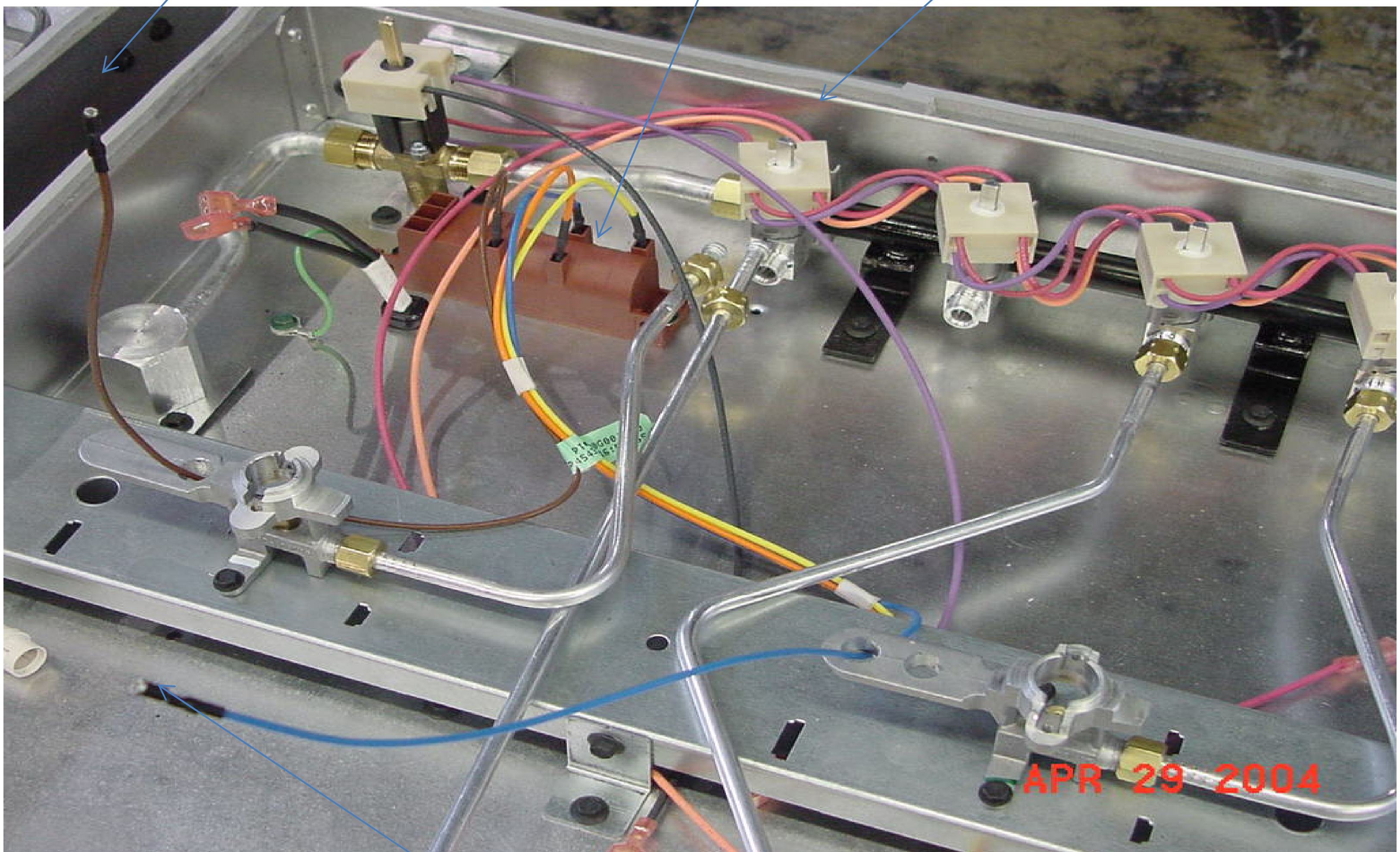


TYPICAL SPARK IGNITION COMPONENTS

1.) SPARK MODULE
2.) SPARK ELECTRODES
3.) IGNITION SWITCHES (VALVE SWITCHES)
4.) IGNITION WIRING
5.) IGNITION WIRING TERMINATIONS
6.) GAS TUBING AND FITTINGS

CIELO TECHNOLOGIES, LLC

SPARK IGNITION COMPONENTS



SPARK ELECTRODE PLACEMENT

BURNER BASE

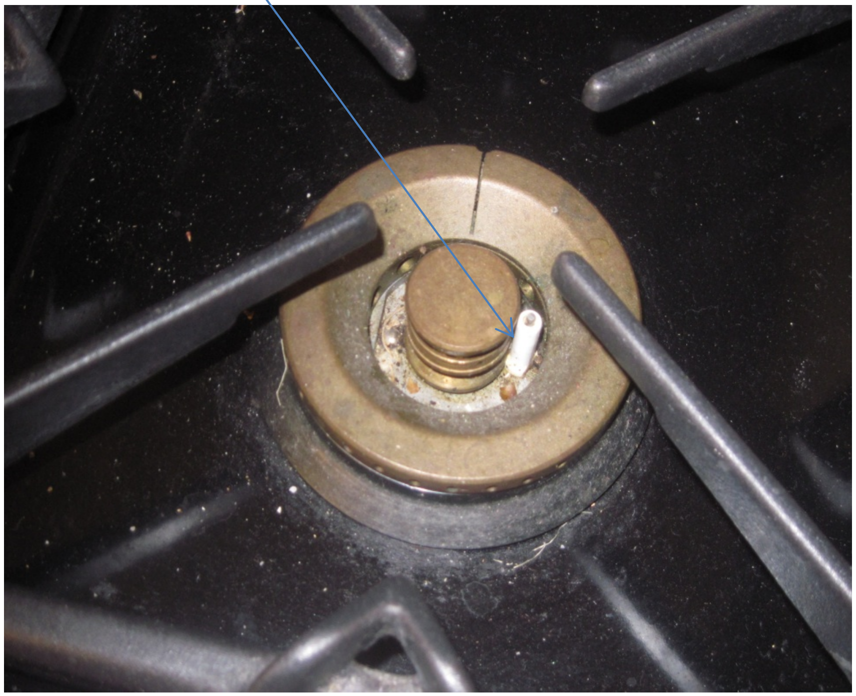
8:00 O'CLOCK POSITION

ELECTRODE

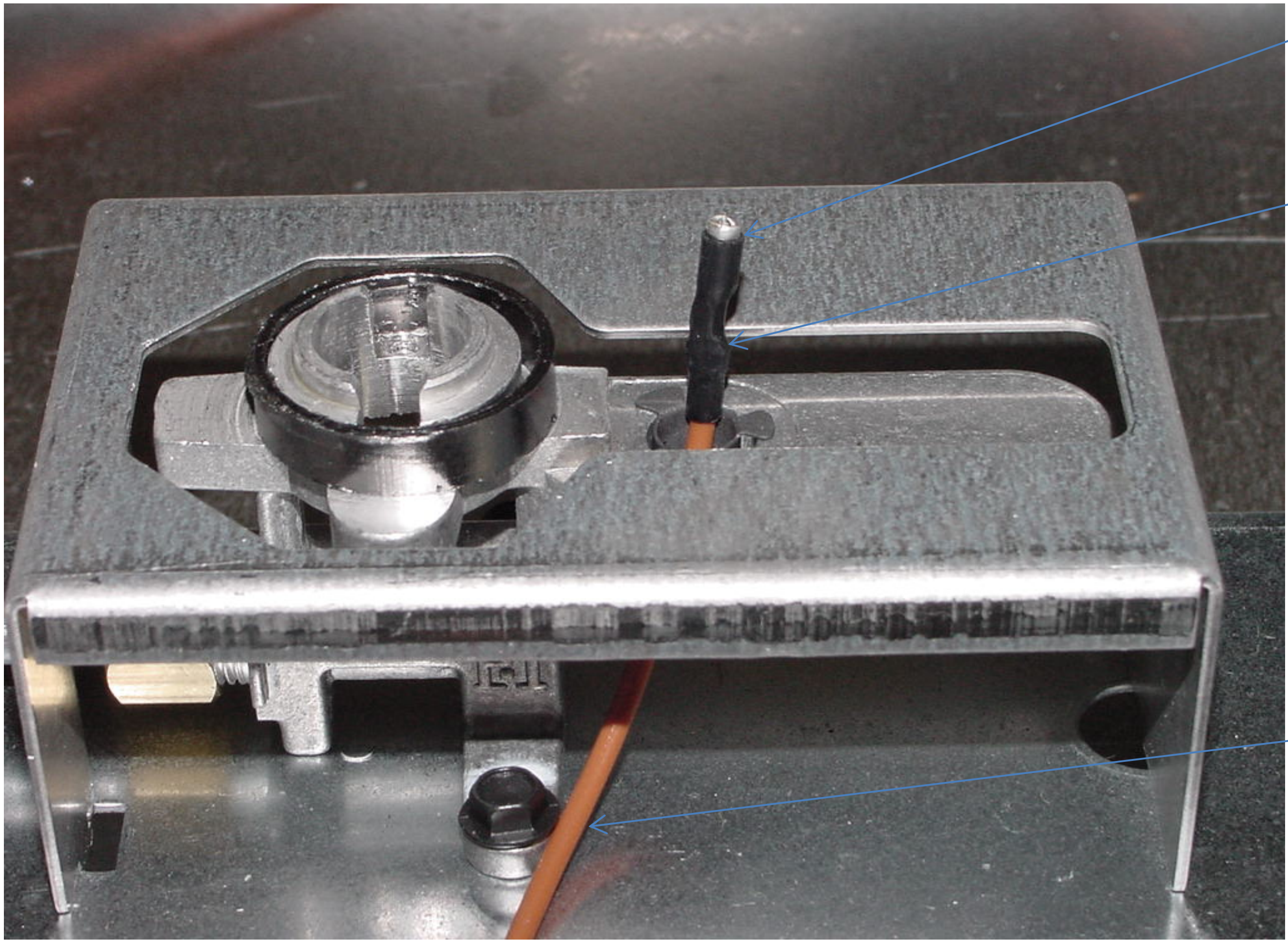
DEFENDI BURNER

ELECTRODE

4:00 O'CLOCK POSITION



ISPHORDING BURNER



TERMINATION

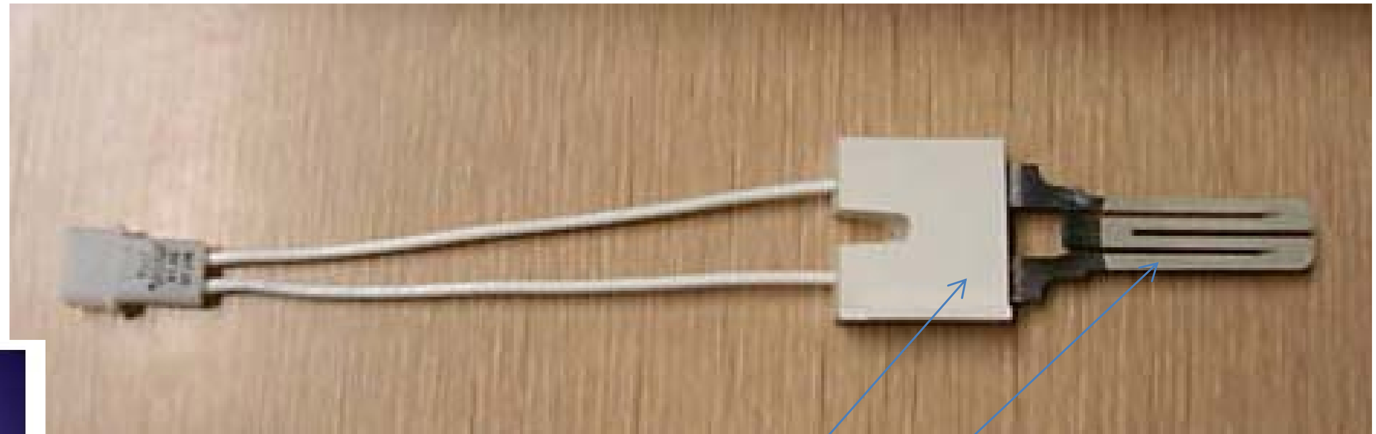
HIGH
TEMPERATURE
INSULATON

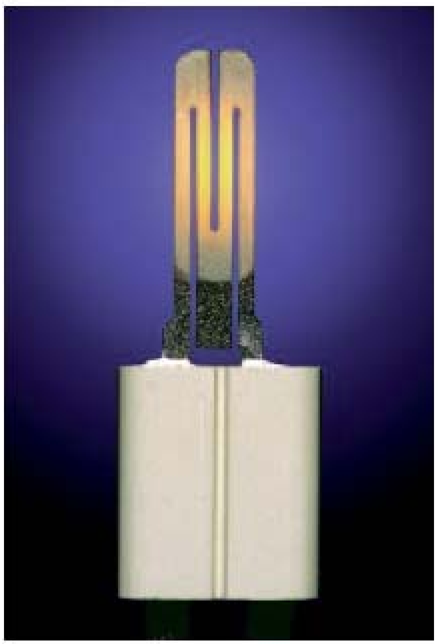
Supply Wiring

ELECTRODE TERMINATIONS & INSULATION

HOT SURFACE IGNITION

HOT SURFACE IGNITION



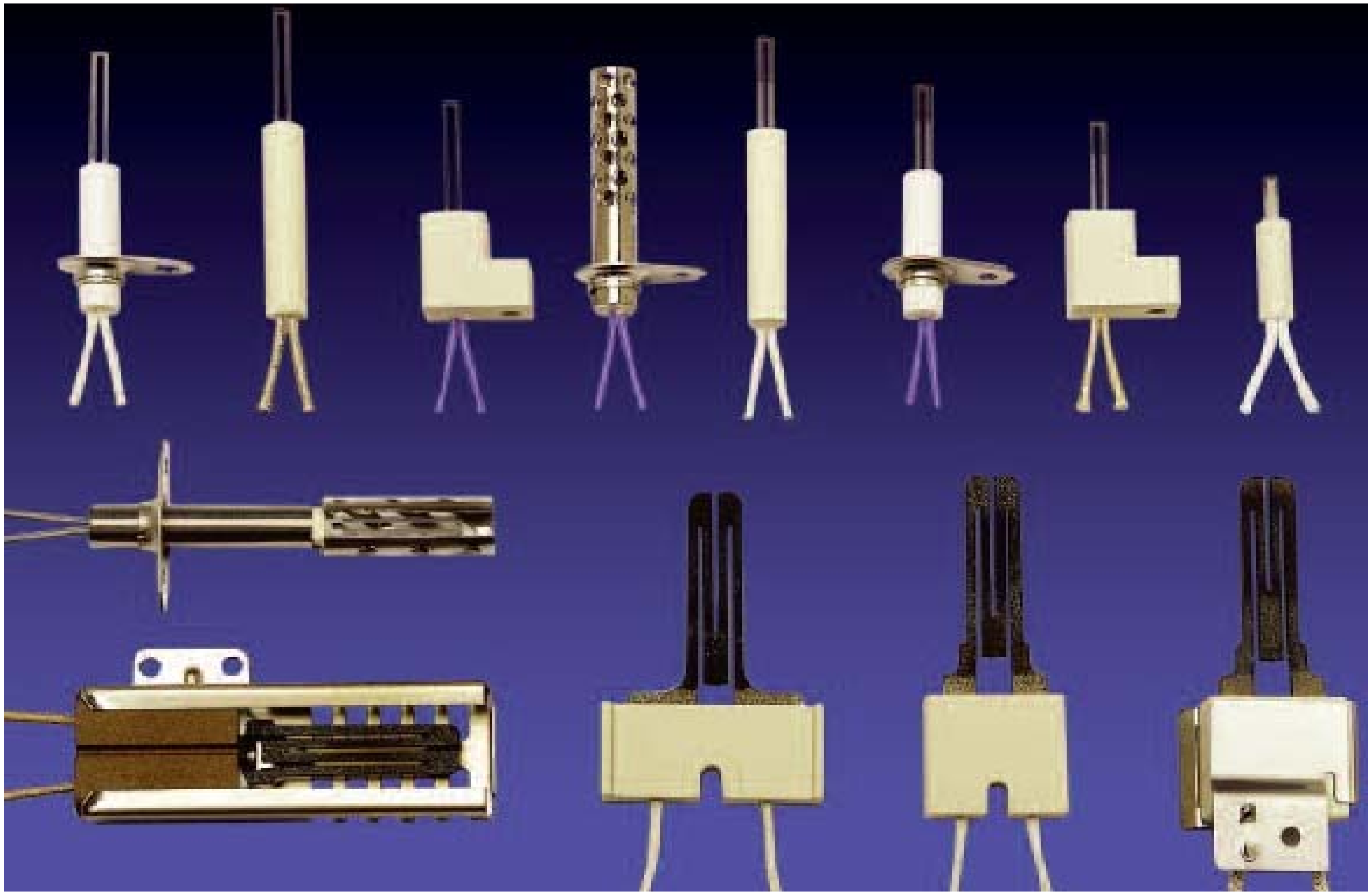


IGNITION SURFACE

CERAMIC BLOCK

CIELO TECHNOLOGIES, LLC

HOT SURFACE IGNITION



CIELO TECHNOLOGIES, LLC

HOT SURFACE IGNITON

MININUM REQUIREMENTS

1. MATERIALS AND APPLICATION REQUIREMENTS CRITICAL
2. VERY HIGH TEMPERATURES EXPERIENCED IN CONTINUOUS FLAME
3. MATERIAL MUST HAVE VERY RAPID HEAT-UP TIME. (UNDER 4 SECONDS FOR APPLIANCES.)
4. ACCEPTABLE SERVICE LIFE
5. MATERIAL SHOULD BE AS ROBUST AS POSSIBLE TO WITHSTAND SHIPMENTS
6. VOLTAGE COMPATIBLE-12V, 24V, 120V and 208-240V SYSTEMS AVAILABLE
7. NO ELECTRICAL NOISE
8. HOT SURFACE RE-IGNITION SYSTEM—SENSES FLAME AND TURNS ON CONTROL ONLY WHEN IGNITION IS REQUIRED

HOT SURFACE IGNITION

QUESTIONS TO ASK

1.) TIME TO TEMPERATURE

2.) ROOM TEMPERATURE RESISTANCE

3.) TEMPERATURE RANGE—MINIMUM AND MAXIMUM

4.) STEADY STATE CURRENT

5.) IGNITER MATERIAL

6.) MATERIAL OF HOLDER (CERAMIC BLOCK)—STEATITE OR CORDIERITE IS GENERALLY USED

7.) WHAT TERMINATIONS ARE AVAILABLE

8.) CONTROL SYSTEM COMPATABILITY

9.) AGENCY APPROVAL

10.) LEAD WIRE LENGTH AND INSULATING CAPABILITIES

FLAME FAILURE DEVICES

Flame Safety Devices

Flame safety devices (or flame failure devices) work by stopping the gas supply to the cooktop if the flame goes out.

The flame safety device works by utilising a thermocouple heated by the burner flame. The thermocouple generates a small electrical current which is connected to a small electromagnetic valve in the gas supply line. When the the thermocouple is hot, the valve continues to stay open. When the flame is extuinguished (by a draught or gust of air) the thermocouple goes cold and the electrical current no longer passes through it. The valve is then turned off automatically because the electromagnet has had its electrical current shut off.

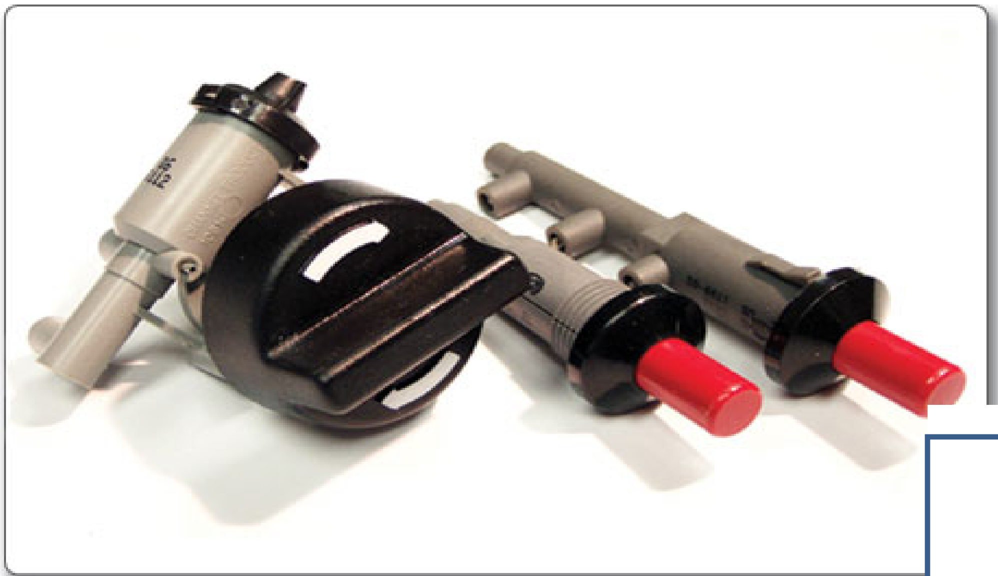
FLAME FAILURE DEVICE

THERMOCOUPLE

SPARK ELECTRODE

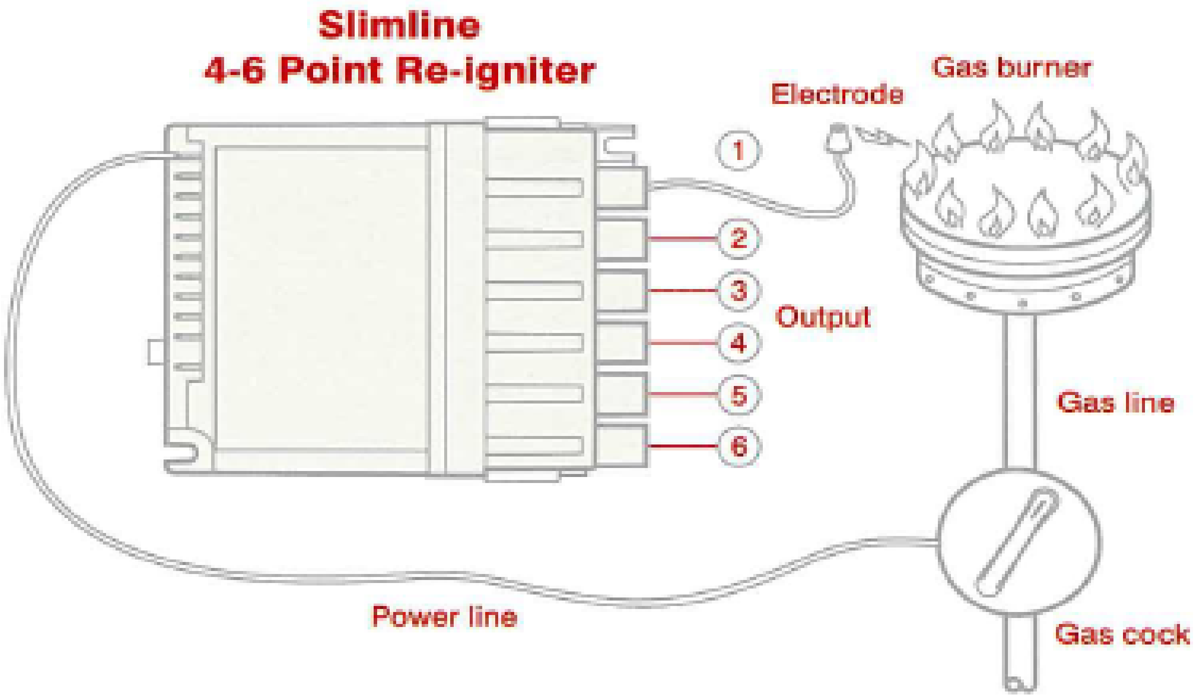
CIELO TECHNOLOGIES, LLC

PIEZOELECTRIC IGNITORS



A piezoelectric ignition system is one in which a spring loaded hammer impacts a quartz or PZT crystal. When the crystal is deformed, a voltage is created. This voltage is great enough to "jump a gap" thereby creating a spark and igniting a combustible gaseous mixture. One popular use is providing the ignition source for a barbeque grill.

RE-IGNITION SYSTEMS



RE-IGNITION SYSTEM IS DIFFERENT FROM FLAME FAILURE SYSTEMS IN THAT THERE IS AN EFFORT TO RE-LIGHT THE BURNER FLAME WITH ANY FLAME OUTAGE. AN FFD MERELY CLOSES THE FLOW OF GAS TO THE BURNER AFTER A LOSS OF FLAME WITHOUT TRYING FOR RE-IGNITION. RE-IGNITION SYSTEMS CONTINUOUSLY MONITOR THE PRESENCE OF THE BURNER FLAME.

TROUBLE-SHOOTING IGNITION SYSTEMS

1.) STANDING PILOT

2.) SPARK IGNITION

3.) HOT SURFACE IGNITION

4.) FLAME FAILURE DEVICES (FFD)

5.) RE-IGNITION SYSTEMS

TROUBLE-SHOOTING SPARK IGNITION SYSTEM

1.) GROUNDING

2.) POWER

3.) ELECTRODE SPACING

4.) BURNER CAP OR TARGET

5.) IMPROPER WIRE TERMINATIONS

6.) TERMINATION CRIMP HEIGHTS

7.) CRACKED ELECTRODE CERAMIC

8.) IMPROPER SPECIFICATION FOR WIRE INSULATION

9.) “DAISY-CHAIN” VS DIRECT WIRING

10.) VALVE SWITCHES NOT SEATED PROPERLY

11.) VALVE SWITCHES WITH CAM IN WRONG POSITION

TROUBLE-SHOOTING HOT SURFACE IGNITION SYSTEMS

1.) ELECTRICAL CONNECTIONS

2.) VISIBLE ABNORMAL AREAS ON SURFACE

3.) OILS AND /OR DIRT

4.) “GAP” BETWEEN IGNITOR AND BURNER IGNITION PORT(S)

5.) RESISTANCE

6.) CRACKS IN “HOLDING” CERAMIC

7.) ELECTRICAL TERMINATIONS

TROUBLE-SHOOTING STANDING PILOT SYSTEMS

1.) GAS LEAKAGE

2.) FERREL

3.) PILOT HOODS

4.) LINT AND DEBRIS

5.) SPACING

6.) THERMOCOUPLE

7.) INTERFACE BETWEEN THERMOCOUPLE AND CONTROL

8.) SOOTING

TROUBLESHOOING FLAME FAILURE DEVICES

1.) SOLENOID VIABILITY

2.) THERMOCOUPLE IMPROPERLY SPACED

3.) ELECTRICAL TERMINATIONS AND WIRING

4.) GAS PASSAGEWAYS

5.) PRESSURE DROP IN SYSTEM

6.) LOW SUPPLY VOLTAGE TO SPARK MODULE

7.) THERMOCOUPLE SEATED IMPROPERLY

TROUBLE-SHOOTING RE-IGNITION SYSTEMS

1.) VALVE SWITCHES SEATED IMPROPERLY

2.) LOW SUPPLY VOLTAGE TO SPARK MODULE

3.) HIGH RESISTANCE ELECTRICAL CONNECTIONS

4.) ELECTRODE OR HOT SURFACE SPACING IMPROPER

I WOULD LIKE TO THANK THE ASGE FOR MY INVITATION AND HOPE THE PRESENTATION WAS BENEFICIAL TO YOU ALL.