LPG

BASIC PRINCIPLES AND PRACTICES

Hardi Siwaily

One\ LPG physical and chemical properties

Two \ LPG System components

LP gas Tanks

- Codes of Design & Manufacturing , ASME versus EN

Regulators

- 1st Stage & 2nd Stage regulators.

Vaporizers

- Direct Fire
- Electrical

Safety Equipment

Three \ Design Elements of LP-Gas System

Introduction to the international standards and codes regarding the use of gas. (NFPA 58 \ NFPA 54 \ Gas Transmission pipe lines) in term of:

- Container Locations & preparations.
- Cylinder & Tank Manifolding
- Pipe Selection
- Pipe Sizing
- Regulator selection
- 2 Stage Regulation
- Safety Precautions and measures including safety equipment and accessories.(anti seismic valves, excess flow , fused , solenoid valves, gas leakage detectors, change over panels, gas meters, relief valves)
- Testing methods

Four \ Natural Gas Vs. LPG , applications and characteristics

- NG \ SNG \ LPG & the wobbe Index
- Shaving systems & LPG - Air mixers
- Cost analysis for several types of fuel (Diesel , LPG, NG & SNG)

Five \ Designing complete LPG \ SNG \ NG system – Case Study & site visit

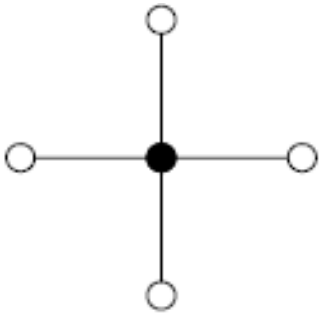
Part one

LPG

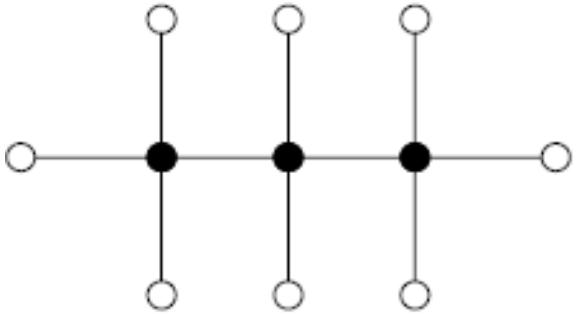
PHYSICAL & Chemical Properties

Hardi Siwaily

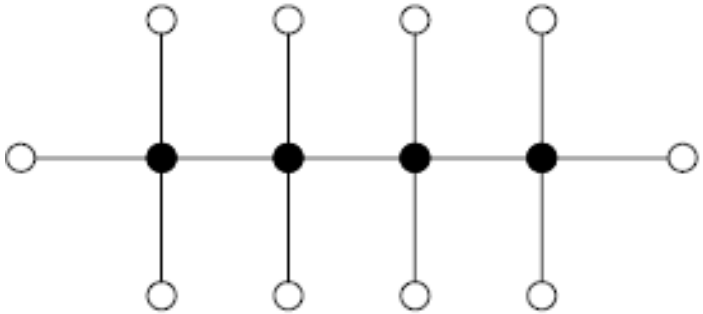
HYDROCARBONS



METHANE CH_4
(NATURAL GAS)



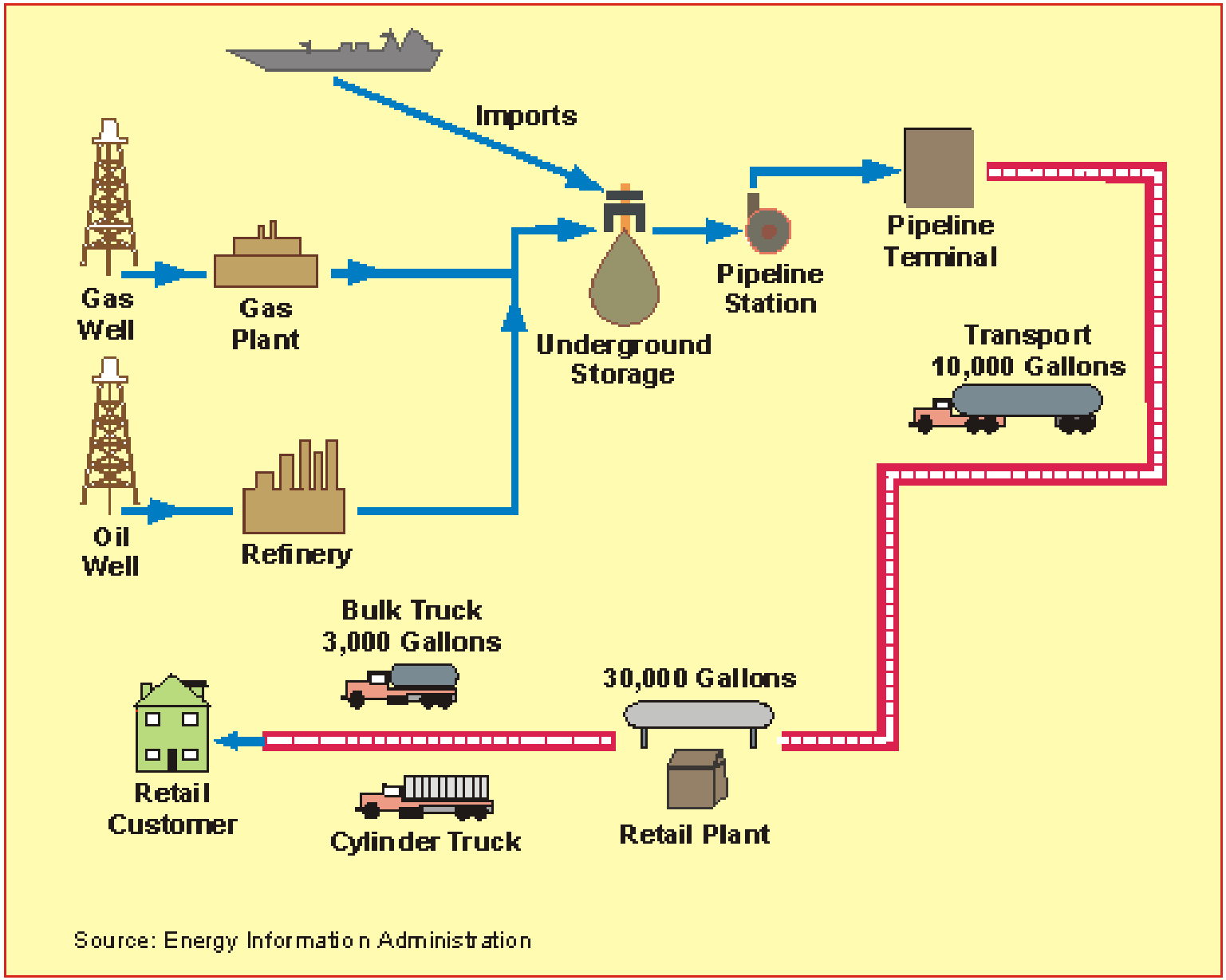
PROPANE C_3H_8



BUTANE C_4H_{10}

● CARBON
○ HYDROGEN

Processing & Refining LP-Gases



commercial Propane & Butane?
Ideally products referred to as "propane" and "butane" consist very largely of these saturated hydrocarbons; **but during the process of extraction/production certain allowable unsaturated hydrocarbons like ethylene, propylene, butylenes etc. may be included in the mixture along with pure propane and butane**. The presence of these in moderate amounts would not affect LPG in terms of combustion but may affect other properties slightly (such as corrosiveness or **gum formation**).

Kilojoules = 0.9478 BTU

Kcal = 3.968 BTU

Watt = 3.414 BTU

APPROXIMATE PROPERTIES OF LP-GASES

Table 1 (Metric)	PROPANE	BUTANE
Formula	C_3H_8	C_4H_{10}
Initial Boiling Point, °C	-42	-1
Specific Gravity of Liquid (Water = 1.0) at 15.56°C	0.504	0.582
Weight per Cubic Meter of Liquid at 15.56°C, kg	504	582
Specific Heat of Liquid, Kilojoule/Kilogram at 15.56°C	1.464	1.276
Cubic Meter of Vapor per Liter at 15.56°C	0.271	0.235
Cubic Meter of Vapor per Kilogram at 15.56°C	0.539	0.410
Specific Gravity of Vapor (Air = 1.0) at 15.56°C	1.50	2.01
Ignition Temperature in Air, °C	493-549	482-538
Maximum Flame Temperature in Air, °C	1,980	2,008
Cubic Meters of Air Required to Burn 1 Cubic Meter of Gas	23.86	31.02
Limits of Flammability in Air, % of Vapor in Air-Gas Mix:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) Kilojoule per Kilogram	428	388
(b) Kilojoule per Liter	216	226
Total Heating Values After Vaporization:		
(a) Kilojoule per Cubic Meter	92,430	121,280
(b) Kilojoule per Kilogram	49,920	49,140
(c) Kilojoule per Liter	25,140	28,100
KW / Kg	**13.86**	**13.64**

-Similar Properties

-Do not react with each other

-Propane is volatile and boils at -42deg C while Butane is less volatile and boils at 0.6 deg C.

- Both can be stored and transported at moderate pressure.

-Calorific value are almost equal.

-Both are mixed together to attain the vapor pressure that is required.

TEMPERATURE		TABLE 2 APPROXIMATE VAPOR PRESSURE, PSIG PROPANE → TO → BUTANE						
°F	°C	100%	80/20	60/40	50/50	40/60	20/80	100%
-40	-40	3.6	—	—	—	—	—	—
-30	-34.4	8	4.5	—	—	—	—	—
-20	-28.9	13.5	9.2	4.9	1.9	—	—	—
-10	-23.3	20	16	9	6	3.5	—	—
0	-17.8	28	22	15	11	7.3	—	—
10	-12.2	37	29	20	17	13	3.4	—
20	-6.7	47	36	28	23	18	7.4	—
30	-1.1	58	45	35	29	24	13	—
40	4.4	72	58	44	37	32	18	3
50	10	86	69	53	46	40	24	6.9
60	15.6	102	80	65	56	49	30	12
70	21.1	127	95	78	68	59	38	17
80	26.7	140	125	90	80	70	46	23
90	32.2	165	140	112	95	82	56	29
100	37.8	196	168	137	123	100	69	36
110	43.3	220	185	165	148	130	80	45

الاستهلاك اليومي كغم	عدد الاسطوانات	الاستهلاك اليومي لتر	الاستهلاك الشهري كغم	الاستهلاك السنوي كغم	تكلفة الاستهلاك السنوي لنظام لاسطوانات JD	تكلفة الستهلاك السنوي لنظام JD LPG tanks	التوفير JD
50	1	89.3	1500	18000	6120	5385.6	734.4
100	2	178.6	3000	36000	12240	10771.2	1468.8
150	3	267.9	4500	54000	18360	16156.8	2203.2
200	4	357.2	6000	72000	24480	21542.4	2937.6
250	5	446.5	7500	90000	30600	26928	3672
300	6	535.8	9000	108000	36720	32313.6	4406.4
350	7	625.1	10500	126000	42840	37699.2	5140.8
400	8	714.4	12000	144000	48960	43084.8	5875.2
500	10	893	15000	180000	61200	53856	7344

Odorization :

LP- Gases should be odorized prior to delivery to the bulk plant.

The warding added agent should be detected down to a concentration in air of one-fifth the lower flammability limit LFL or LEL

The most common is : Ethyl Mercaptan.

Combustion:

Complete Combustion

- Water Vapor
- Carbon Dioxide

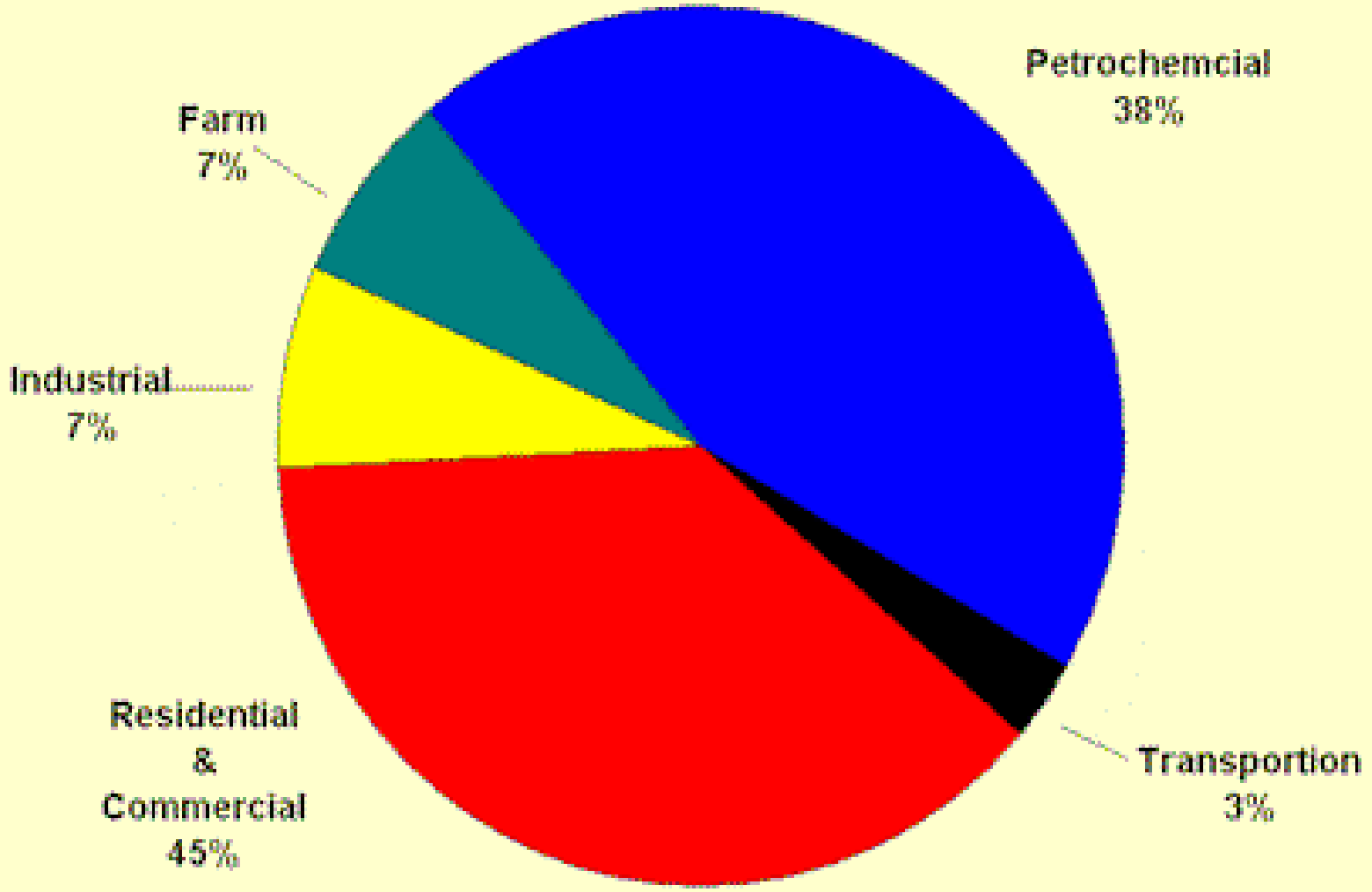
Incomplete Combustion

- Carbon Monoxide (CO)
- Excessive Water Vapor
- Aldehydes
- Soot

Concentration of CO in Air	Physical Effect
9 ppm (0.0009%)	The Maximum allowable concentration for a short term exposure.
35 ppm (0.0035%)	The Maximum allowable concentration for continuous exposure for in any 8-hour period
200 ppm (0.02%)	Slight headache, tiredness, dizziness, nausea after 2-3H
400 ppm (0.04%)	Frontal Headache within 1-2 Hrs, Life threatening after 3Hrs
800 ppm (0.08 %)	Dizziness, nausea, and convulsions within 45minuts, Unconsciousness within 2 hours, Death within 1 hour
1600 ppm (0.16%)	Headache, dizziness and nausea within 20 minutes, Death within 1Hr
3200ppm (0.32%)	Headache, dizziness and nausea within 5-10 minutes, Death within 30 minutes.
6400 ppm (0.64%)	Headache, dizziness and nausea within 1-2 minutes, Death within 10-15 minutes
12800 ppm (1.28%)	Death within 1-3 minutes

10000 ppm = 1% by volume

SOURCE	HEAT POWER	UNIT OF MEASUREMENT	USE OUTPUT	NET CALORIES PER UNIT OF MEASUREMENT	TOTAL CALORIES PER 1000 NET CALORIES	QUANTITY OF PRODUCT REQUIRED TO BE EQUAL TO 1KG OF PROPANE	UNIT OF MEASUREMENT
Propane	12.000	Cal/Kg	91	10.920	1.099	1	Kg
Natural Gas	9.000	Cal/mc	91	8.190	1.099	1,35	mc
Air-Prop.	12.000	Cal/mc	91	10.920	1.099	1	mc
Comb. Oil 3-5°E	10.300	Cal/Kg	75	7.725	1.333	1,45	Kg
Diesel	9.000	Cal/l	85	7.650	1.176	1,45	l
Kerosene	8.600	Cal/l	75	6 450	1.333	1,70	l
Wood	3.600	Cal/Kg	40	1.440	2.500	7,5	Kg
Dry wood	5.000	Cal/Kg	45	2 250	2.220	4,8	Kg
Carbon coke	7.000	Cal/Kg	50	3.500	2.000	3,1	Kg
Anthracite	8.000	Cal/Kg	50	4.000	2.000	2,7	Kg
Electricity	860	Cal/Kwh	100	860	1.000	12,7	kW

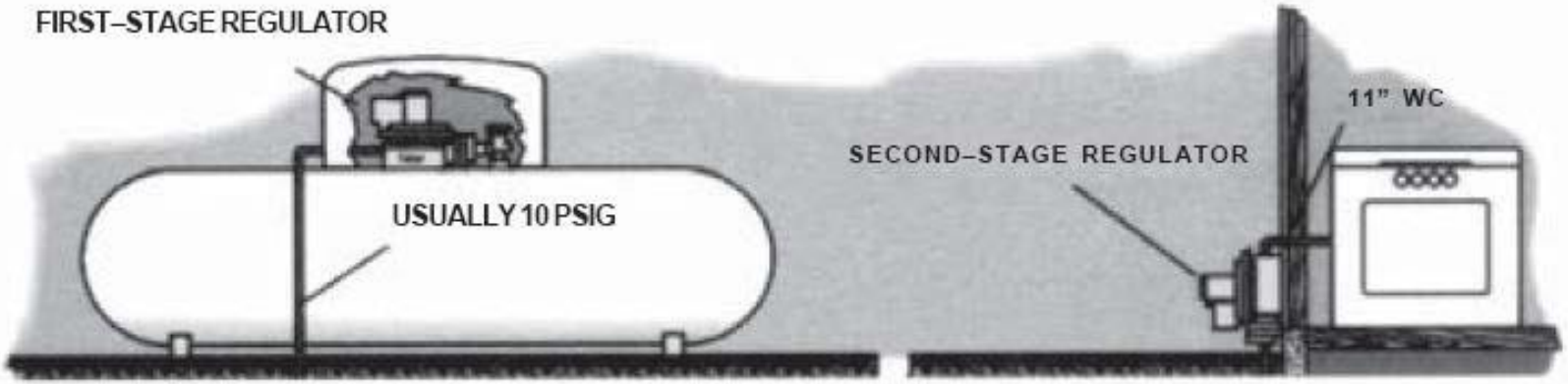


Source: American Petroleum Institute, *2000 Sales of*

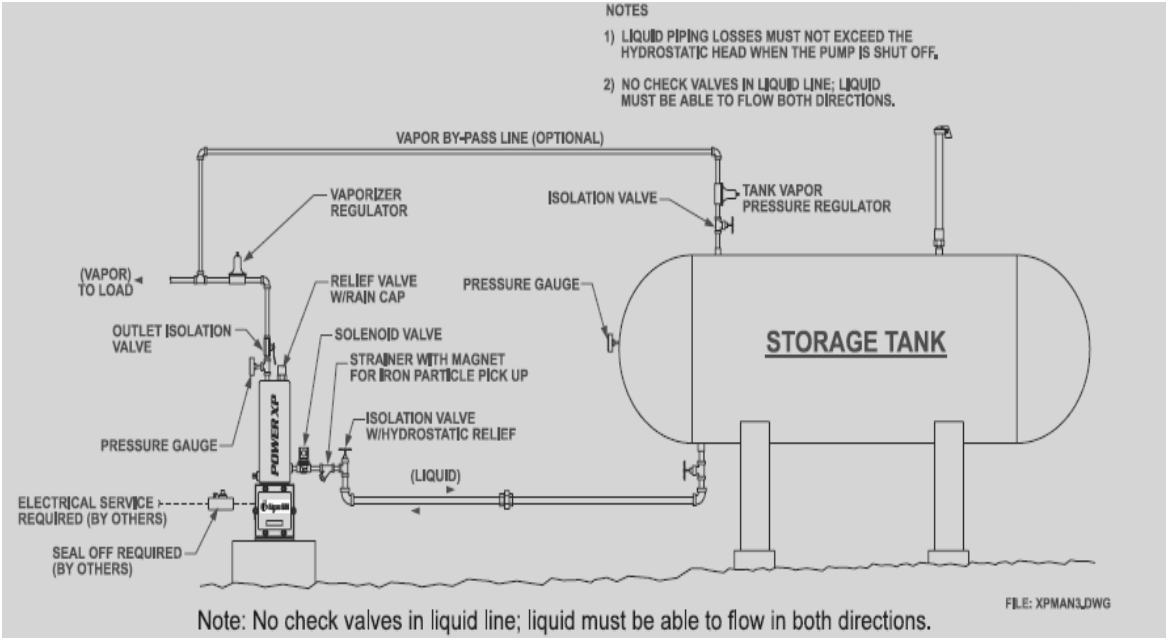
Part Two

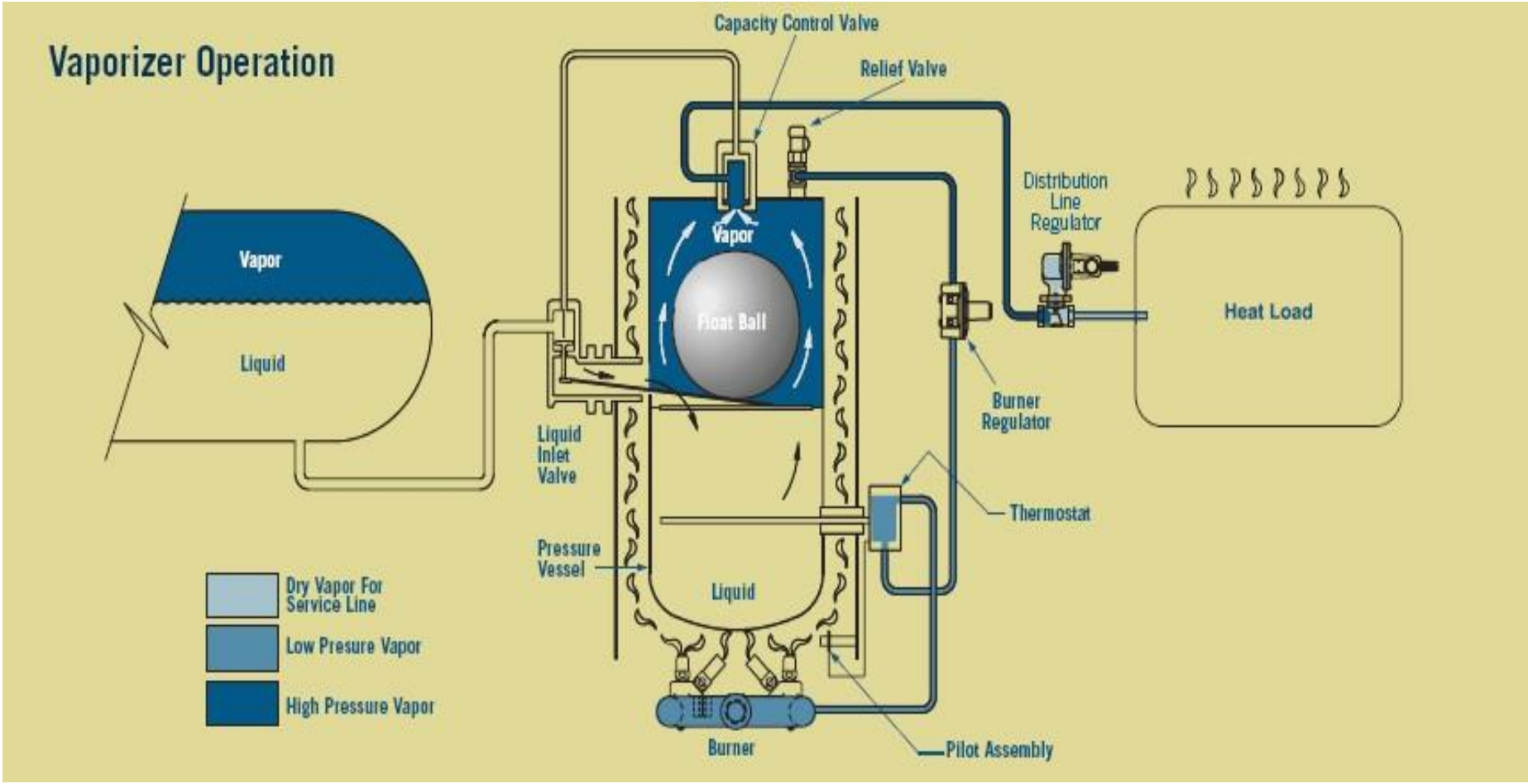
LPG System Components

Hardi Siwaily

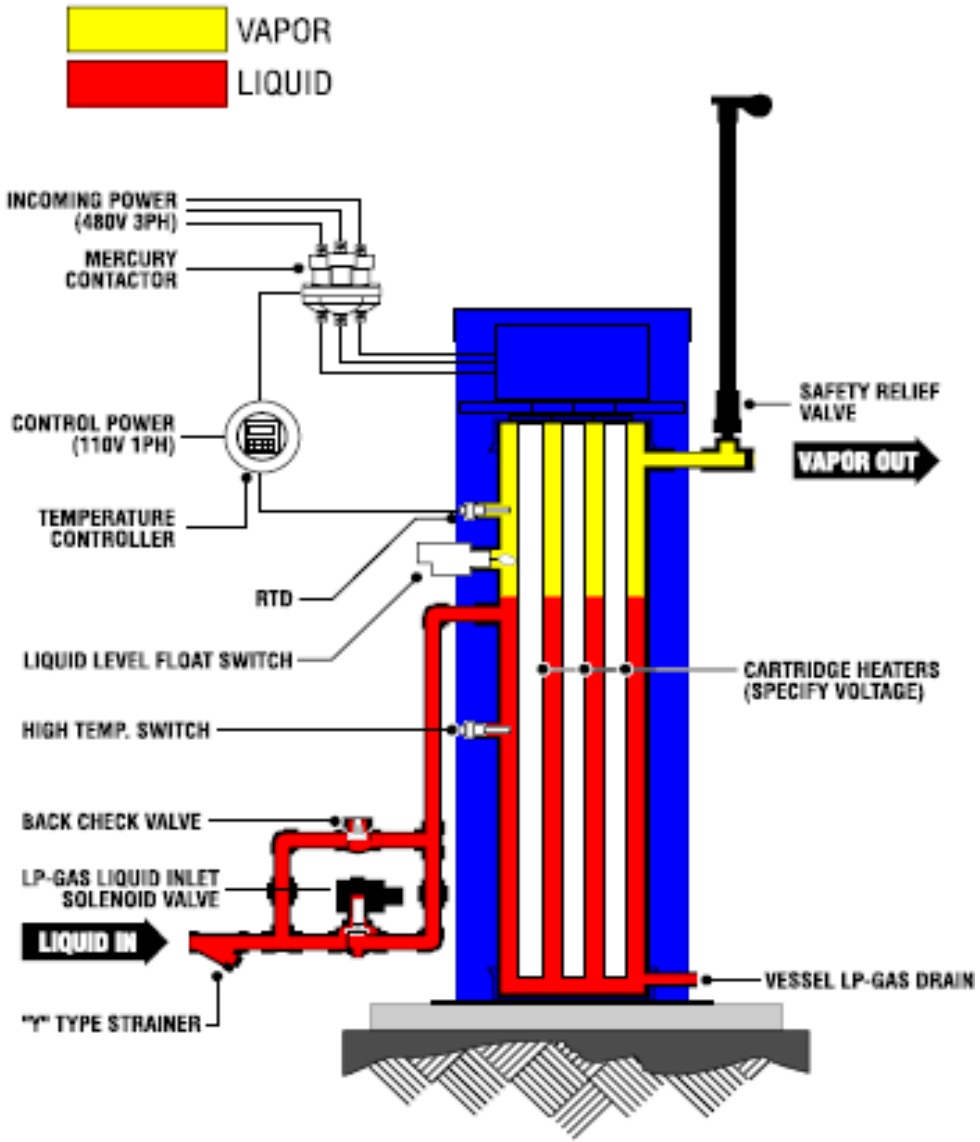


- LPG Tank / Cylinder
- Vaporizer
- 1st Stage Regulator
- LPG Feeding Pipe
- 2nd Stage Regulator
- Appliance
- Safety Equipment
  - Excess Flow Valves.
  - Relief Valves.
  - Anti- Seismic Valves.
  - Gas Leakage Detectors & Solenoid Valves.



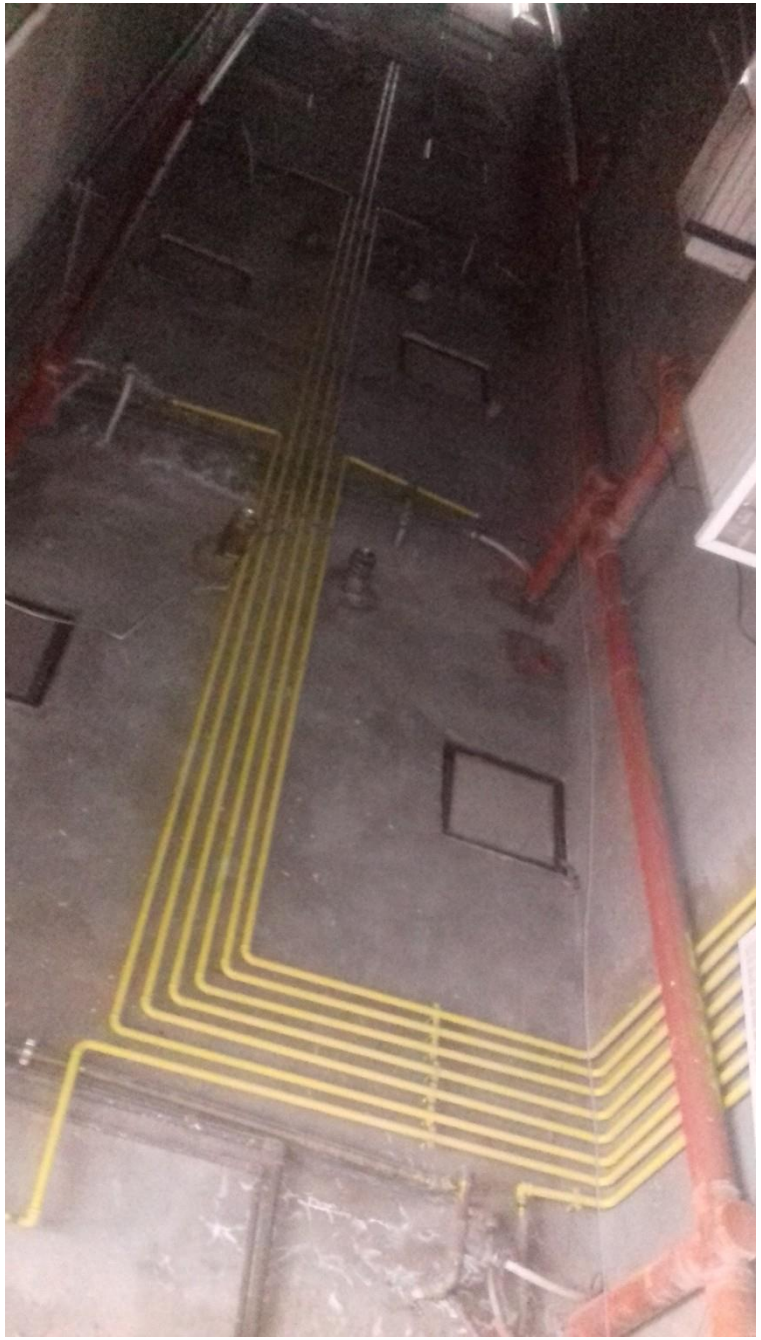


RE Series Electric Vaporizer



RANSOME MANUFACTURING
3695 South Maple Avenue • Fresno, California 93725 • 559-485-0979 • Fax 559-485-8869

Hardi Siwaily



Hardi Siwaily

Hardi Siwaily

Hardi Siwaily