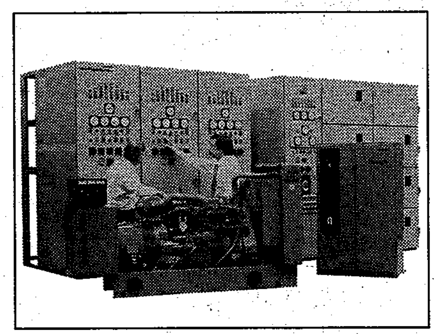
Onan

Technical Bulletin



Application Information

for Gaseous Fuels

2/87 T-015

PREFACE

This technical bulletin describes application information for Onan Spark Ignited Series GenSets using gaseous fuels.

The bulletin includes schematic diagrams to illustrate and an Appendix to list fuel system components and their associated parameters.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. Onan reserves the right to make changes at any time without notice.

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Gaseous Fuels

Information in this bulletin applies to natural gas, manufactured (city) gas and LP (liquified petroleum) liquid and vapor fuels. This bulletin is not intended to be an installation manual, but rather a design guide.

All types of installation problems cannot be covered because of the variety of requirements. Illustrations of installations are only typical and do not represent actual installations. They do represent recommendations of the manufacturer.

GAS AS A FUEL

Gas is a desirable fuel for internal combustion engines because of convenience. Although gaseous fuels generally have higher octane ratings than gasoline, some manufactured "city" gases have a lower octane rating. The type of fuel limits the compression ratio of an engine. However, natural gas and LP generally allow higher compression ratios.

Gaseous fuels have a low residue content and generally build up minimum carbon deposits. Gaseous fuels mix more thoroughly with air to produce a mixture which burns more completely and cleaner than gasoline mixtures.

Advantages of Gaseous Fuel Operation:

1. Minimum carbon formation.
2. Less sludge in oil.
3. Less valve burning.
4. No wash down of cylinder wall lubrication during engine starting.
5. No tetra-ethyl lead to foul spark plugs and other engine parts.
6. Excellent antiknock qualities.
7. Small amount of contaminating residues.
8. A nearly homogeneous mixture in cylinder.

TYPES OF GASEOUS FUELS

The selection of a particular gas fuel depends on (1) availability, (2) efficiency required, (3) engine application (mobile or not), (4) initial cost, and (5) cost of operation.

Natural gas is composed primarily of methane and varying amounts of other dry gases with a heat content of about 1000 BTU/cu.ft. (37.25 MJ/m^3). It is piped from the source to points of consumption. In localities situated far from the source, natural gas is comparatively expensive as a fuel. Localities not serviced by natural gas frequently have a manufactured gas system.

Manufactured gas is not greatly adaptable as a fuel for engine generator sets if efficiency is important because its heat value is so low the engine must be derated as much as 50 percent. While gas manufacturing cost is usually higher than for other types of fuels, there are no storage problems. Ambient temperature also have no effect on supplies.

LP is a commercial mixture of propane and butane. The ratio between the two varies with local temperatures and user requirements. While propane vaporizes at a lower temperature than butane, butane has a higher heat content. Stored and transported under pressure in tanks, LP at room temperature is a vapor. By increasing pressure or lowering the temperature, it remains in a liquified state. Liquid and vaporized LP are both used as fuel for engine-generator sets.

POWER COMPARISON

Basic fuel structure determines the amount of heat a fuel can produce. Dry gases vary in heat content as do gasoline or other fuels. For example, propane and butane have considerably higher heat values than do methane and ethane.

The amount of heat a fuel can produce is usually expressed in BTU (British Thermal Unit). Manufactured gas, composed primarily of methane, has a heat content of about 500 BTU/cu. ft. (18.6 MJ/m^3). An engine fueled with this gas would produce about 40 percent less power than the same engine fueled with gasoline. The heat content of butane, a minor component of LP gas is about 3260 BTU/cu. ft. (121.4 MJ/m^3). No derating would be necessary with this fuel.

An engine-generator set using LP (butane, propane, or a commercial mixture of both) will deliver nearly the same power as it would if gasoline were the fuel.

1. Using 1100 BTU (41 MJ/m^3) gas, a unit will deliver 90 to 95 percent of its gasoline rated power.
2. Using 850 BTU (32 MJ/m^3) gas, a unit will deliver 80 to 85 percent of its gasoline rated power.
3. Using 600 BTU (22 MJ/m^3) gas, a unit will deliver 70 to 75 percent of its gasoline rated power.
4. Using 450 BTU (17 MJ/m^3) gas, a unit will deliver 50 to 60 percent of its gasoline rated power.

CODES AND REGULATIONS

Gaseous fuel installations are governed by local or regional safety and building codes which, in turn, usually reference National Consensus Standards such as those written and published by National Fire Protection Association (NFPA), Uniform Fire Code (UFC), and American National Standards Institute (ANSI). These standards are continually being modified and amended, and thus it is important to follow the design guidance set forth in the same edition as will be used by local code enforcement authorities. It is especially important to investigate local requirements for hardware such as fuel lines, safety and protective devices, fuel storage systems, fuel pressure and flow controls, etc.

Two primary codes of interest are UFC and NFPA 37 "Stationary Engines and Gas Turbines". Each of these codes references other codes, including:

UFC Standard #82-1
UFC Standard #82-2
NFPA 37 - Combustion Engines
NFPA 54 - National Fuel Gas Code
NFPA 58 - Storage and Handling of LPG
ANSI B31.2 - Fuel Gas Piping

Note: This list is not complete.

TEMPERATURE AND PRESSURE

Temperature and pressure are interdependent. If gas temperature is changed, the pressure will change proportionally. Gas at room temperature can be changed to a liquid by compressing and storing it in a closed container.

A liquid at atmospheric pressure can be changed to a gas by raising the temperature to the liquid's boiling point. Vaporizing LP builds pressure within the container.

WORKING PRESSURE

The fuel system components must operate at various working pressures depending on the kind of gas/vapor, size and length of fuel lines, number of engine generator sets supplied by a given source, ambient temperature, etc. Components must have the strength to function properly under anticipated or calculated maximum working pressures. LP tanks, for example, must have a minimum design pressure of 250 psi (1724 kPa) per NFPA 58-1983.

There are several ways of measuring and expressing pressure. Pressure measured with a manometer is expressed in inches or millimetres of water or mercury. Refer to the pressure equivalents in Table 1. Pressure measured with a gauge is expressed in ounces or pounds per square inch (psi) or kilopascals (kPa).

SYSTEM COMPONENTS

Components depend on individual system requirements. However, the following components are usually standard.

Demand Regulator

The demand regulator in most systems regulates the gas flow by responding to pressure changes in the intake system of the engine. When the engine is shut down and there is no demand for fuel, the regulator stops gas flow. A solenoid valve should be installed in the line as a positive shutoff device. An additional primary regulator is used to reduce the supply pressure to a suitable level. Two regulators used in series are referred to as a "two-stage" regulation system.

Regulators are not always separate units. They may be integrated with a converter or carburetor but their function remains the same.

Onan recommends venting indoor regulators to the outside. Gas leakage could occur if the regulator diaphragm fails. Heavy industrial line regulators with a relief valve definitely need a vent.

⚠CAUTION ***A separate regulator must never be used between the tank and converter in a liquid withdrawal system.***

Regulators are designed to do a particular job in a particular system. A regulator designed for use in a vapor fuel system cannot be used in a liquid fuel system without modification. Regulators should be mounted where they will receive the least vibration. They should not be in areas of extreme heat.

Flow Regulator

On most large system engine-generator sets using IMPCO gaseous fuel carburetors, the recommended pressure to the carburetor is 5 in. H_2O (127 mm) for natural gas and a negative (-) 1/2 in H_2O (13 mm) for LP vapor. A flow regulator is installed at the carburetor to regulate this pressure. The flow regulator is suitable for inlet pressures up to 12 ounces/in^2 (5.2 kPa). For higher supply pressures, see Table 2 for selection of a primary regulator.

Converter (Vaporizer)

These components, used only in LP fuel withdrawal systems, provide heat for vaporizing LP fuel. Vent all LP vapor converters to the outside of a building.

Heat is usually supplied by the engine coolant, thermostatically controlled at about 180°F (82°C) maintaining a rather constant fuel temperture. The positive method of vaporizing liquefied fuel allows a constant fuel-air mixture despite changes in withdrawal rates and atmospheric temperature.

Where ambient temperatures fall below freezing engine-generator sets of 50 kW and higher capacity should employ a vaporizer which has a gas-fueled burner to supply heat for vaporization. An adequate supply of vaporized fuel will then be assured for starting and permitting the set to immediately carry the load.

Install a burner-type vaporizer outdoors and as close as permissible to the point of consumption. It can be used with either surface or subsurface tanks. The rate of vaporization is automatically controlled to meet vapor demands. Generated gas, storage gas or both can be supplied on demand. An anti-overflow valve prevents liquid fuel from reaching the service line.

The capacity of a converter is defined in terms of rate of flow, volume of water, horsepower it serves, and the volume of gas it can vaporize, etc. A converter should have a 20 percent reserve capacity for peak load operation.

The water flow through the converter must be great enough to vaporize enough fuel for peak demands. If water lines are obstructed or too small, so much heat loss can occur that it freezes. Moreover, if the fuel mixture becomes too lean, efficiency is lost and engine valves can burn. Not only does this apply to converters but to the size of fuel tanks in vapor withdrawal systems as well. Many converters have the primary and secondary regulator built into them.

Fuel Strainer

Foreign substances can cause failure of sensitive components in gaseous fuel systems. Natural gas contains a gummy substance with a sulfur base which is one of the chief contaminants. Rust, scale, etc. eventually find their way into fuel systems and may damage valves and/or clog orifices.

Moisture, usually present to some degree, must be eliminated or freezing may occur at the regulators or carburetor during peak loads. Mount the filter slightly lower than the regulator, between the tank and first system component (refer to typical installation illustrations).

Electric Shutoff Valve

Most local codes require the use of an electric fuel shutoff (solenoid) valve which shuts off the gas supply when the engine is stopped. Check applicable agency code requirements for electric shutoff valves for protection against potential fire hazards.

The final regulator in some instances is an acceptable shutoff valve, but a more positive shutoff is usually desired and may be required.

A solenoid valve should be installed at the carburetor intake to prevent fuel in the converter leaking out to the exhaust system when the set stops. A liquid solenoid valve is required at the inlet to the converter.

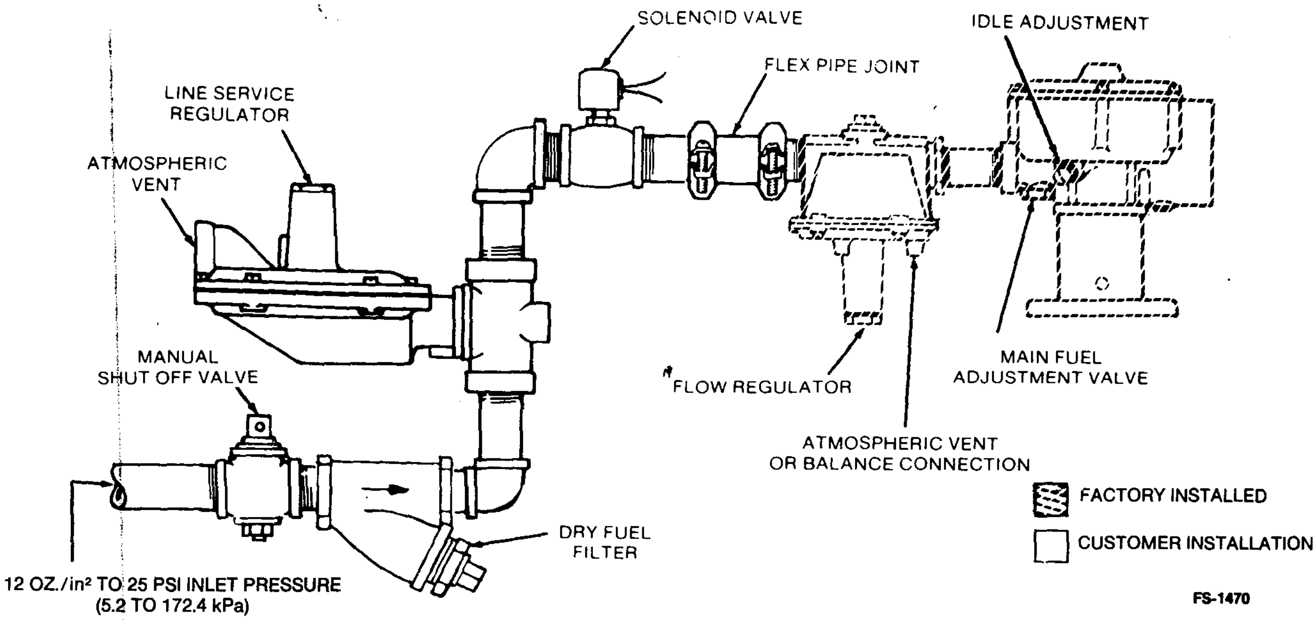

FIGURE 1. NATURAL GAS OR LPG VAPOR WITHDRAWAL TYPICAL FUEL SYSTEM SCHEMATIC

LP FUEL SYSTEMS

LP vapor withdrawn from the tank for consumption carries away a certain amount of heat from the liquid. This heat loss causes the temperature and pressure of the liquid within the tank to fall. Heat is normally absorbed through the tank wall to replace the lost heat. If heat can be replaced, the system will function as intended. If fuel consumption is high and ambient temperatures are low, heat cannot be replaced from around the tank and the system will not function efficiently.

There are two methods to assist heat transfer (tanks in vapor withdrawal systems absorb heat only through the portion which is in direct contact with the LP):

1. Use a suitable vaporizer for positive vaporization (liquid withdrawal).
2. Use a tank large enough to meet peak engine demands.

Surface and Subsurface LP Fuel Tanks

Select and size the LP fuel tanks according to the following requirements:

1. Type of withdrawal system (vapor or liquid).
2. Atmospheric (or design) temperature.
3. Vaporization characteristics of fuel.
4. Consumption

LP fuel temperature is critical and imposes several limitations. Full power cannot be obtained from engine-generator sets fueled by vapor withdrawal systems in which the fuel tanks are too small for the prevailing temperature. In many cases, it may be less expensive to purchase a vaporizer for positive vaporization than to purchase a larger tank to merely provide a greater area for heat transfer.

Burying tanks below the frost-line where temperatures never go below 35°F (2°C) is all right if adequate allowances are made for year-to-year variations. In northern climates, the frost line might be four feet (1.2 m) one year and eight feet (2.4 m) the next year, depending on snow cover, etc.

FUEL LINE SIZE

Fuel line size depends on the amount of fuel needed to run a unit at full load and the distance the fuel must be moved.

Tables 10 and 11 apply only to propane, the major component of LP gas. The vaporization rates are based on the average temperature over an eight-hour period. The temperature headings represent the lowest average winter temperature which is the average of the daily winter low temperatures. Use the table which pertains to the type of container used.

Determining Number of 20-Gallon (76 Litre) Cylinders Required

Assume that a model 5.0CCK generator set is installed using propane gas. The lowest average outdoor temperature is -10°F (-23°C). No other gas appliances will be used.

1. Refer to fuel consumption Table 12. Note that a series CCK uses approximately 50 cubic feet (1.4 m^3) of fuel per hour ar full-rated load.
2. Refer to cylinders required in Table 10. Note that at -10°F (-23°C), four cylinders will provide 50 cubic feet (1.4 m^3) of vapor fuel per hour. This will be sufficient for unit operation.

COMBINATION GASEOUS FUEL AND GASOLINE SYSTEMS

The combination fuel system can use either a gaseous fuel or gasoline to run the generator set. Conversion from one fuel to the other usually consists of shutting off one fuel supply and allowing the other fuel to flow to the carburetor. Most combination carburetors contain fuel shutoff valves and float locking devices for simple conversion. Idle and power adjustments for either fuel are also included in the carburetor for ease of maintanance. Refer to the generator set operator manuals and technical bulletins for installation techniques.

Gasoline supply lines and tanks are conventionally designed, installed and serviced as on straight gasoline fuel generator sets. The gaseous fuel (natural gas, LPG) installation is essentially the same as on straight gas fuel units. The selection of valves, regulators, filter, and other components is the same as in the preceding sections of this bulletin with the exception of the inlet pressure differences.

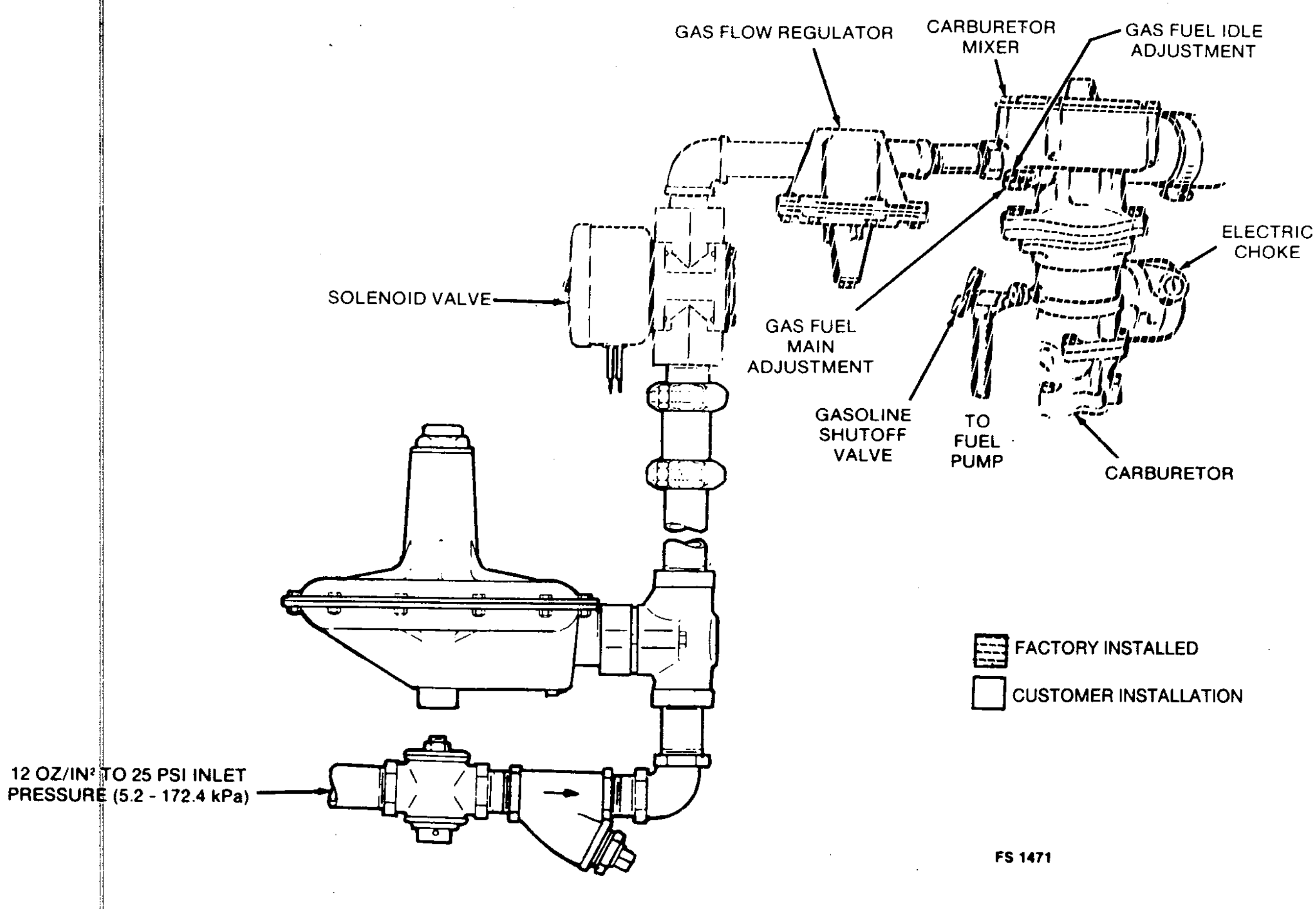

FIGURE 2. TYPICAL COMBINATION GAS/GASOLINE FUEL SYSTEM SCHEMATIC

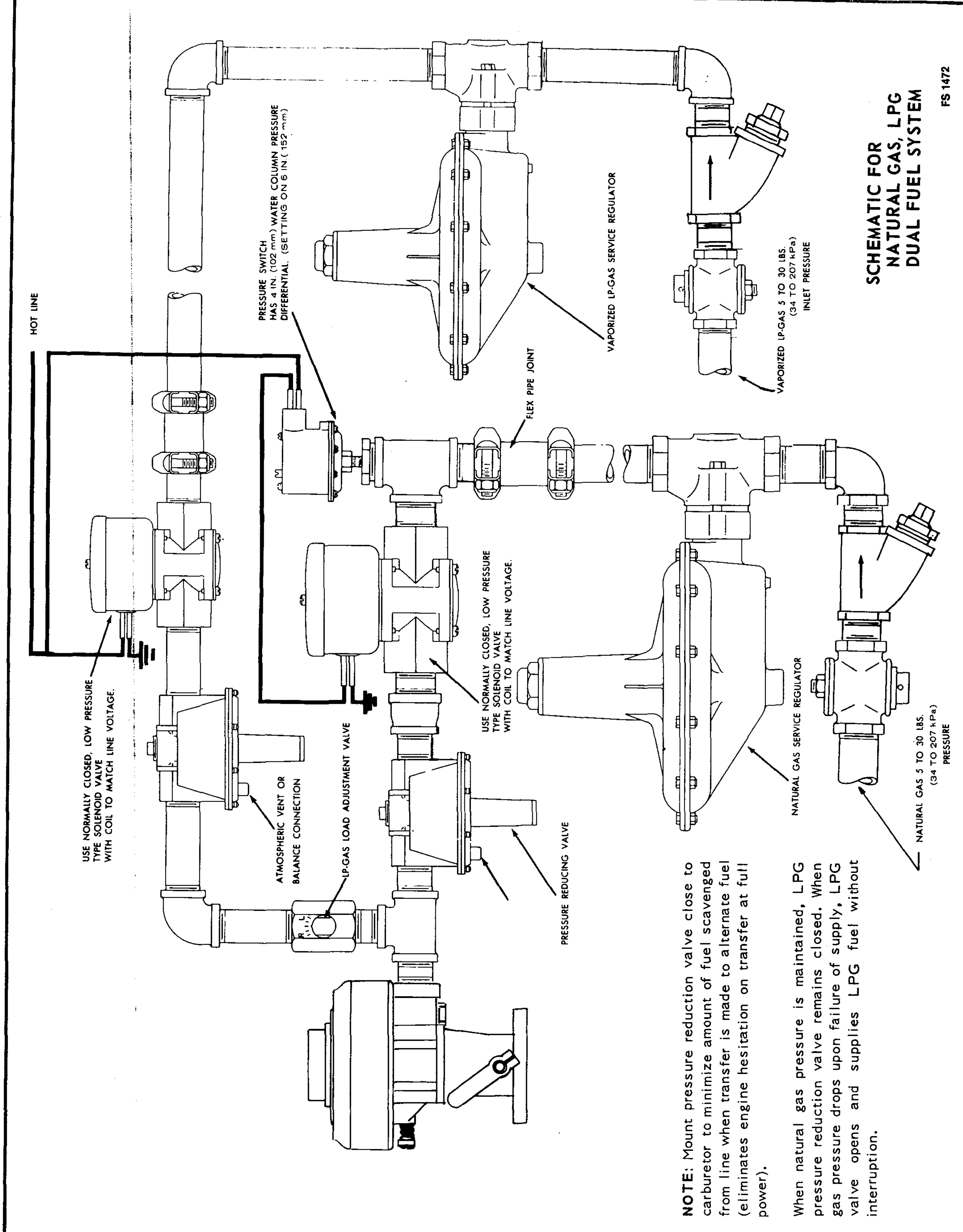

FIGURE 3. TYPICAL DUAL FUEL SYSTEM SCHEMATIC - LPG VAPOR AND NATURAL GAS

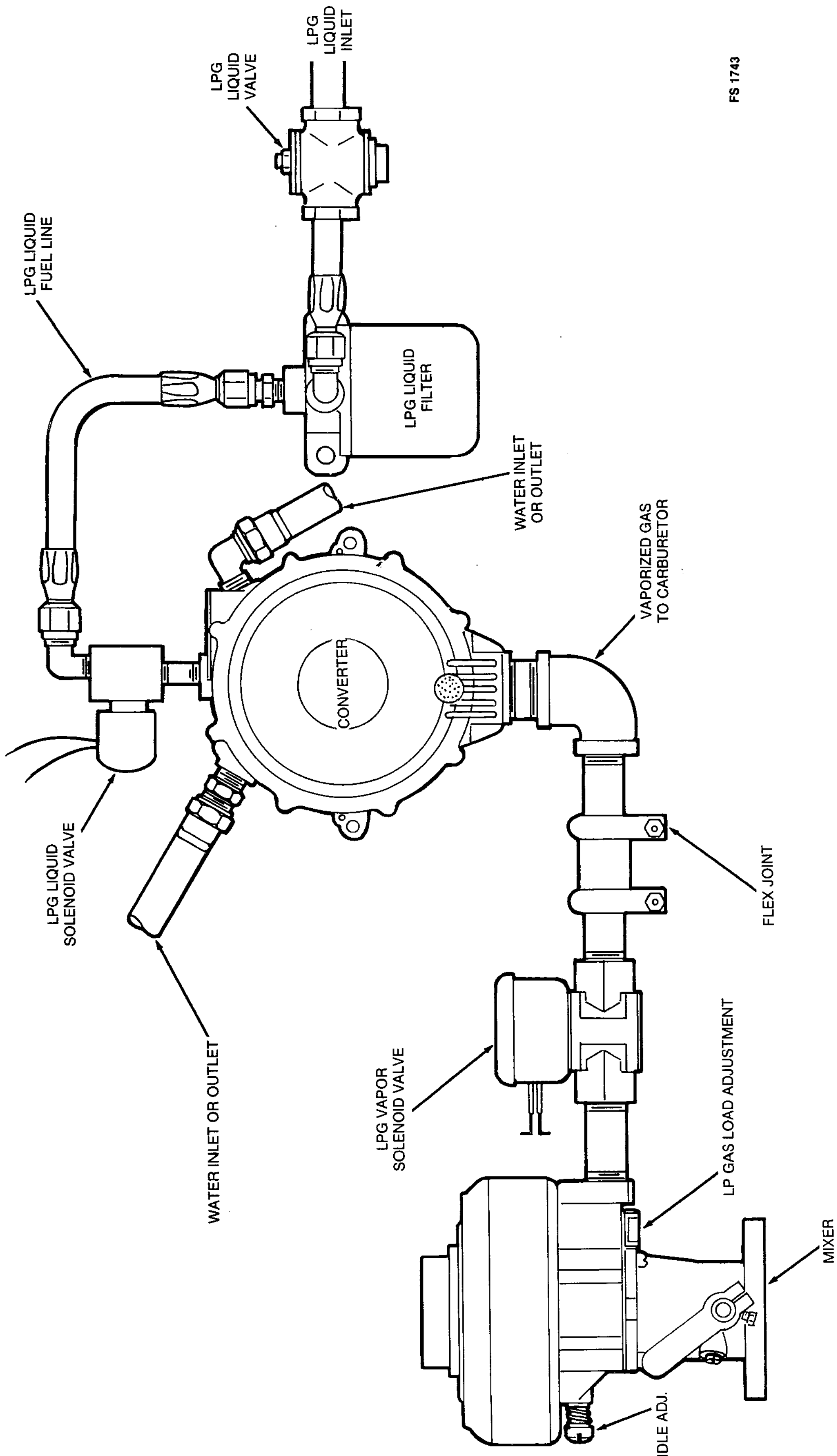

FIGURE 4. TYPICAL LPG LIQUID WITHDRAWAL FUEL SYSTEM

APPENDIX - A

This Appendix consists of twelve tables that list fuel system components and associated parameters for Onan Spark Ignited Engine-Generator Sets.

TABLE 1. PRESSURE EQUIVALENTS

ENGLISH	METRIC
1 inch H_20 = 0.58 ounces/in.^{2}	10 mm H_20 = 98.4 Pa
11 inch H_20 = 6.38 ounces/in.^{2}	280 mm H_20 = 2755 Pa
11 inch H_20 = 0.4 lb/in.^{2}	280 mm H_20 = 2.76 kPa
1 lb/in.^{2} = 27.71 inch H_20	1 kPa = 102 mm H_20
1 lb/in.^{2} = 16 ounces/in.^{2}	1 Pa = 0.1 mm H_20
1 lb/in.^{2} = 2.04 inch Hg	10 mm Hg = 1.33 kPa
1 inch Hg = 0.49 lb/in.^{2}	1 kPa = 7.5 mm Hg
1 standard atmosphere = 14.73 lb/in.^{2}	1mm Hg = 13.59 mm H_20
1 ounce/in.^{2} = 1.73 inch H_20	1 standard atmosphere = 102 kPa
1 inch Hg = 13.59 inch H_20	
LPG 1 Gallon = 36.5 ft^3	1 litre = 0.273 m^3
1 Pound = 8.5 ft^3	1 kg = 0.53 m^3

TABLE 2. PRIMARY GASEOUS FUEL REGULATORS

MODELS	IF SOURCE PRESSURE IS: 6 to 11 Oz. (2.6 to 4.7 kPa)	11 Oz. to 1 Lb. (4.7 to 6.9 kPa)	1 to 2 Lbs. (6.9 to 14 kPa)	2 to 4 Lbs. (14 to 27 kPa)	4 Lbs. to Over (27 kPa or Over)
AK, AJ, LK	1	1	1	1	1
CCK, JB, CCKB, NH	5	5	5	5	5
JC, RJC	2	2	2	2	2
*ES	None	2	2	2	2
*SK	None	2	2	2	2
*EK	None	3	3	3	3
*SJB	None	4	3	3	3
*EM	None	4	3	3	3
EN	None	4	3	3	3
*SKB	None	4	3	3	3
ENT, ENTX	None	4	4	3	3
*WA	**	4	4	4	4

Regulator Selection: Code numbers refer to KEY column for pressure reducing regulator part number and identification.

KEY	PART NUMBER	ORIFICE INCH (mm)	INLET SIZE INCH (mm)	OUTLET SIZE INCH (mm)	INLET PRESS PSI (kPa)	OUTLET PRESS IN H_2O (kPa)	MAX. CAPACITY CFH (m^3/hr)
1	148-0033	9/64 (3.57)	1/4 (6.35)	1/2 (12.7)	250 (1724)	11 (2.739)	190 (5.38)
2	148-0034	1/4 (6.35)	3/4 (19.05)	3/4 (19.05)	200 (1379)	11 (2.739)	680*** (19.25)
3	148-0343	1/2 (12.7)	1-1/4 (31.75)	1-1/4 (31.75)	25 (172)	7 (1.743)	1800 (50.97)
4	148-0363	1 (25.4)	1-1/2 (38.1)	1-1/2 (38.1)	25 (172)	11 (2.739)	7750 (219.45)
5	148-0523	1/4 (6.35)	1/2 (12.7)	3/4 (19.05)	200 (1379)	11 (2.739)	330 (9.34)

* - Flow regulator is standard on SK, EK, EM, EN, ES, ENT, ENTX, SJB and SKB sets with IMPCO fuel system. Maximum supply pressure to flow regulator is 12 ounces (5.2 kPa). Flow regulator outlet pressure is 3 ounces for 100 BTU gas (1.3 kPa for 3.7 MJ/m^3 gas).

** - Combination natural gas-gasoline systems can use regulator in next column. For natural gas, no regulator is needed up to 11 ounces (4.7 kPa).

*** - Maximum capacity is 1075 cfh (30.4 m^3/hr) for natural gas.

TABLE 3. INLET PRESSURE TO SECONDARY REGULATOR (Straight Gaseous Fuel Only)

MODEL	PRESSURE PSI (kPa)
AJ, AK, NH, CCK, CCKB, JB, JC, RJC (Models with 148-0311 Regulator)	2-8 oz/in² (0.86-3.4)
EK, EM, ENT, ENTX, SK, ES, WA, SJB, SKB	12 oz/in² (5.2) Max.

TABLE 4. FUEL STRAINERS

PART NUMBER	PIPE SIZE INCH (mm)	TYPE	TYPE OF FUEL
149-0558	3/4 (19)	Y	Natural or LP Gas Vapor
149-0624	1-1/4 (31.7)	Y	Natural Gas
149-0625	1/4 (6.35)	Cone	LP Gas Liquid
149-0751	2 (50.8)	Y	Natural Gas
149-0752	1 (25.4)	Y	Natural Gas
149-1241	3 (76.2)	Y	Natural Gas

TABLE 5. ELECTRIC SHUTOFF VALVES

MODEL OR UNIT SIZE	LINE PRESSURE PSI (kPa)	12 VOLT	24 VOLT	MAX OPER PRESS PSI (kPa)	PIPE SIZE INCH (mm)
15kW and Smaller	Under 8 oz/in² (3.4)	307-0312		8 oz/² (3.4)	3/4 (19.0)
15 kW and Smaller	To 25 lb/in² (170)	307-0834	307-0863	25 lb/in² (170)	3/4 (19.0)
EK, EM, SK, ES	25 lb/in² (170)	307-0836	307-0865	25 lb/in² (170)	1 (25.4)
EN, ENT	25 lb/in² (170)	307-0837		25 lb/in² (170)	1-1/4 (31.7)
WA	15 lb/in² (100)	307-0840		15 lb/in² (100)	2 (50.8)
SJB, SKB	25 lb/in² (170)	307-0837		25 lb/in² (170)	1-1/4 (31.7)
Liquid Fuel		307-0268	307-0757	25 lb/in² (170)	1/4 (6.35)

TABLE 6. LPG LIQUID FUEL LINE SIZE - vs - FUEL LINE LENGTH (Required to Maintain 1.0 PSI Pressure Drop for a 5 to 15 psi Supply Pressure)

(NOTE: Two Stage Regulation is Required)

UNIT	kW	CFH * (m^3/hr)	15 FT (4.6 m)	25 FT (7.6 m)	50 FT (15 m)	75 FT (23 m)	100 FT (30 m)	150 FT (46 m)	200 FT (61 m)	300 FT (91 m)
AJ	2.5	25 (0.71)	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +
LK	2.5	23 (0.65)	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +
CCK	4	40 (1.13)	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	3/8 £	3/8 £
CCK	5	47 (1.33)	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	1/4 +	3/8 £	3/8 £
NH	6.5	60 (1.70)	1/4 +	1/4 +	3/8 £	3/8 £	3/8 £	3/8 £	3/8 £	3/8 £
JB	7.5	63 (1.78)	1/4 +	1/4 +	3/8 £	3/8 £	3/8 £	3/8 £	3/8£	3/8 £
CCKB	10	100 (2.83)	3/8 £	3/8 £	3/8 £	1/2 †	1/2 †	1/2 †	1/2 †	1/2 †
JC, RJC	12.5	92 (2.60)	3/8 £	3/8 £	3/8 £	1/2 †	1/2 †	1/2 †	1/2 †	1/2 †
JC, RJC	15	110 (3.11)	3/8 £	3/8 £	3/8 £	1/2 †	1/2 †	1/2 †	1/2 †	1/2 †
ES	20	120 (3.39)	3/8 £	3/8 £	1/2 †	1/2 †	1/2	1/2	1/2	3/4
SK	30	211 (5.97)	3/8 £	3/8 £	1/2 †	1/2 †	1/2	1/2	1/2	3/4
EK	30	245 (6.94)	3/8 £	3/8 £	1/2 †	1/2 †	1/2	1/2	1/2	3/4
SJB	35	272 (7.62)	3/8 £	3/8 £	1/2 †	1/2 †	1/2	1/2	1/2	3/4
EM	45	290 (8.21)	3/8 £	1/2 †	1/2 †	1/2	1/2	3/4	3/4	3/4
EN	55	355 (10.05)	3/8 £	1/2 †	1/2 †	1/2	1/2	3/4	3/4	3/4
SKB	55	425 (11.9)	1/2	1/2 +	3/4	3/4	1	1	1	1-1/4
ENT	75	400 (11.3)	1/2	1/2	3/4	3/4	1	1	1	1-1/4
WA	115	730 (20.7)	1/2	3/4	3/4	1	1	1	1	1-1/4

* - Full load fuel consumption.
\+ - 3/8 inch (9.525 mm) outside diameter tubing can be used.
£ - 1/2 inch (12.7 mm) outside diameter tubing can be used.
† - 5/8 inch (15.9 mm) outside diameter tubing can be used.

TABLE 8. NATURAL GAS FUEL LINE SIZE - vs - FUEL LINE LENGTH (Required to Maintain 0.5 inch H_2O Pressure Drop for an 11 inch H_2O Supply Line)

UNIT	kW	CFH * (m^3/hr)	15 FT (4.6 m)	25 FT (7.6 m)	50 FT (15 m)	75 FT (23 m)	100 FT (30 m)	150 FT (46 m)	200 FT (61 m)	300 FT (91 m)
AJ	1	33 (0.93)	1/2	1/2	1/2	3/4	3/4	3/4	1	1-1/4
LK	2.5	54 (1.53)	1/2	3/4	3/4	3/4	3/4	1	1	1-1/4
CCK	4	90 (2.55)	3/4	3/4	3/4	1	1	1	1-1/4	1-1/4
CCK	5	115 (3.26)	3/4	3/4	3/4	1	1	1-1/4	1-1/4	1-1/4
NH	6.5	150 (4.25)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	2
CCKB	10	200 (5.66)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	2
JB	7.5	126 (3.57)	3/4	3/4	3/4	1-1/4	1-1/4	1-1/4	1-1/4	1
JC/RJC	12.5	230 (6.5)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	2
JC/RJC	15	255 (7.22)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	2
ES	18.5	317 (8.97)	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	2	2	2
EK	30	600 (17.0)	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	2	2	2
SJB	35	539 (15.1)	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	2	2	2
SK	25	402 (11.38)	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	2	2	2
EM	45	690 (19.0)	1-1/4	1-1/2	1-1/2	2	2	2	2-1/2	2-1/2
EN	55	890 (25.19)	2	2	2	2-1/2	2-1/2	2-1/2	3	3
SKB	55	1071 (29.9)	2	2	2	2-1/2	2-1/2	2-1/2	3	3
ENT	75	1,000 (28.3)	2	2	2	2	2-1/2	2-1/2	2-1/2	3
ENTX	100	1560 (44.15)	2	2-1/2	2-1/2	3	3	3	3-1/2	3-1/2
WA	115	1,800 (51.0)	2	2-1/2	2-1/2	3	3	3	3-1/2	3-1/2

* - Full load fuel consumption.

TABLE 7. LPG VAPOR FUEL LINE SIZE - vs - FUEL LINE LENGTH
(Required to Maintain 0.5 inch H_2O Pressure Drop for an 11 inch H_2O Supply Pressure)

UNIT	kW	CFH # (m³/hr)	15 FT (4.6 m)	25 FT (7.6 m)	50 FT (15 m)	75 FT (23 m)	100 FT (30 m)	150 FT (46 m)	200 FT (61 m)	300 FT (91 m)
AJ	1	13 (0.37)	1/2*	1/2*	1/2*	1/2 £	1/2£	1/2†	1/2†	3/4†
LK	2.5	25 (0.71)	1/2	1/2	1/2	1/2£	1/2£	3/4£	3/4	3/4
CCK	4	40 (1.13)	1/2£	1/2†	3/4†	3/4†	3/4	3/4	1	1
CCK	5	47 (1.33)	3/4£	3/4†	3/4†	1	1	1	1	1-1/4
NH	6.5	60 (1.70)	3/4	3/4†	3/4	1	1	1	1-1/4	1-1/4
CCKB	10	100 (2.83)	3/4	1	1	1	1-1/4	1-1/4	1-1/2	1-1/2
JB	7.5	63 (1.78)	3/4	3/4†	3/4	1	1	1	1-1/4	1-1/4
JC/RJC	12.5	92 (2.6)	3/4	3/4	3/4	3/4	1	1	1-1/4	1-1/4
JC/RJC	15	110 (3.11)	3/4	1	1	1	1-1/4	1-1/4	2	1-1/2
ES	20	128 (3.6)	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2
SK	30	211 (5.97)	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2
EK	30	245 (6.94)	1	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2
SJB	35	272 (7.62)	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	2	2
ENT	75	400 (11.3)	1-1/2	1-1/2	1-1/2	2	2	2	2-1/2	2-1/2
EM	45	290 (8.21)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	2	2
EN	55	355 (10.05)	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	2	2
SKB	55	425 (11.9)	1-1/2	1-1/2	1-1/2	2	2	2	2-1/2	2-1/2
WA	115	730 (20.7)	1-1/2	2	2	2	2	2-1/2	2-1/2	2-1/2

\# - Full load fuel consumption.
* - 1/2 inch (12.7 mm) outside diameter tubing can be used.
£ - 5/8 inch (15.9 mm) outside diameter tubing can be used.
† - 3/4 inch (19.05 mm) outside diameter tubing can be used.

NOTE: Never use tubing smaller than 1/2 inch (12.7 mm) outside diameter.

TABLE 9. LINE SIZING CHART FOR LIQUID PETROLEUM

Based on Pressure Drop of 1 PSI (6.9 kPa)

Liquid Petroleum Flow CFH (m^3/hr)	Liquid Petroleum Flow GPH (litre/hr)	Pipe Length - Feet (m)							
		1/4 In. Schedule		3/8 In. Schedule		1/2 In. Schedule		3/4 In. Schedule	
		40	80	40	80	40	80	40	80
360 (10.2)	10 (38)	729 (222)	416 (127)						
540 (15.3)	15 (57)	324 (98)	185 (56)						
720 (20.4)	20 (76)	182 (55)	104 (32)	825 (251)	521 (159)				
1440 (40.8)	40 (152)	46 (14)	26 (8)	205 (62)	129 (39)	745 (227)	504 (154)		
2160 (61.1)	60 (227)	20 (6.1)	11 (3.4)	92 (28)	58 (18)	331 (101)	224 (68)		
2880 (81.5)	80 (303)	11 (3.4)	6 (1.8)	51 (16)	32 (10)	187 (57)	127 (39)	735 (224)	537 (164)
3600 (101.9)	100 (378)	7 (2.1)	4 (1.2)	33 (10)	21 (6.4)	119 (36)	81 (25)	470 (143)	343 (105)

To Use Chart:

1. Having determined the required flow at point of use, locate this flow in the left hand column. If this falls between two figures, use the larger of the two.
2. Determine total length of piping required from source to point of use.
3. Read across chart from left (required flow) to right to find the total length which is equal to or exceeds the distance from source to use.
4. From this point read up to find the correct size of pipe required.

TABLE 10. 20-GALLON (76-LITRE) PROPANE CYLINDERS REQUIRED FOR INDICATED TEMPERATURES WHEN KEPT AT LEAST 1/2 FULL

WITHDRAWAL RATE	LOWEST AVERAGE WINTER TEMPERATURE						
	32°F (0°C)	20°F (-7°C)	10°F (-12°C)	0°F (-18°C)	-10°F (-23°C)	-20°F (-29°C)	-30°F (-34°C)
10 cfh-25,000 BTU/hr (0.28 m³/hr-26.4 MJ/hr)	1	1	1	1	1	1	2
25 cfh-62,500 BTU/hr (0.71 m³/hr-65.9 MJ/hr)	1	1	1	2	2	3	4
50 cfh-125,000 BTU/hr (1.4 m³/hr-131.9 MJ/hr)	2	2	3	3	4	5	9
100 cfh-250,000 BTU/hr (2.8 m³/hr-263.8 MJ/hr)	4	4	5	6	7	10	20

TABLE 11. REQUIRED PROPANE TANK SIZE IN GALLONS (LITRES) FOR INDICATED TEMPERATURES WHEN KEPT AT LEAST 1/2 FULL

WITHDRAWAL RATE	LOWEST AVERAGE WINTER TEMPERATURE						
	32°F (0°C)	20°F (-7°C)	10°F (-12°C)	0°F (-18°C)	-10°F (-23°C)	-20°F (-29°C)	-30°F (-34°C)
50 cfh-125,000 BTU/hr 1.4 m³/hr-131.9 MJ/hr	115 (435)	115 (435)	115 (435)	250 (945)	250 (945)	400 (1515)	600 (2270)
100 cfh-250,000 BTU/hr 2.8 m³/hr-263.8 MJ/hr	250 (945)	250 (945)	250 (945)	400 (1515)	500 (1890)	1000 (3785)	1500 (5675)
150 cfh-375,000 BTU/hr 4.2 m³/hr-395.6 MJ/hr	300 (1135)	400 (1515)	500 (1890)	500 (1890)	1000 (3785)	1500 (5675)	2500 (9460)
200 cfh-500,000 BTU/hr 5.7 m³/hr-527.5 MJ/hr	400 (1515)	500 (1890)	750 (2840)	1000 (3785)	1200 (4540)	2000 (7570)	3500 (13250)
300 cfh-750,000 BTU/hr 8.5 m³/hr-791.2 MJ/hr	750 (2840)	1000 (3785)	1500 (5675)	2000 (7570)	2500 (9460)	4000 (15140)	5000 (18925)

TABLE 12. AVERAGE FUEL CONSUMPTION AT FULL LOAD IN CU FT/HR (m^3/HR)

MODELS	RPM	NATURAL GAS	LPG
1.0AJ	18,000	33 (0.93)	13 (0.37)
2.5AJ	3,600	62 (1.76)	25 (0.71)
2.5LK	1,800	54 (1.53)	23 (0.65)
4.0CCK	1,800	90 (2.55)	40 (1.13)
5.0CCK	1,800	115 (3.26)	47 (1.33)
6.5NH	1,800	150 (4.25)	60 (1.70)
7.5JB	1,800	126 (3.57)	63 (1.78)
10.0CCKB	3,600	200 (5.66)	100 (2.83
12.5JC	1,800	230 (6.51)	92 (2.60)
12.5RJC	1,800	230 (6.51)	92 (2.60)
15.0JC	1,800	255 (7.22)	110 (3.11)
15.0RJC	1,800	255 (7.22)	110 (3.11)
20.0ES	1,800	317 (8.98)	128 (3.62)
30.0SK	1,800	403 (11.41)	222 (6.29)
30.0EK	1,800	600 (17.0)	245 (6.94)
35.0SJB	1,800	539 (16.6)	272 (7.4)
45.0EM	1,800	690 (17.0)	290 (8.21)
55.0EN	1,800	890 (25.2)	355 (10.0)
55.0SKB	1,800	1071 (32.5)	425 (12.1)
75.0ENT	1,800	1188 (33.6)	436 (12.3)
100.0ENTX	1,800	1560 (41.6)	N.A.
115.0WA	1,800	1500 (42.5)	600 (17.0)

N.A. - ENTX not available for LPG operation.