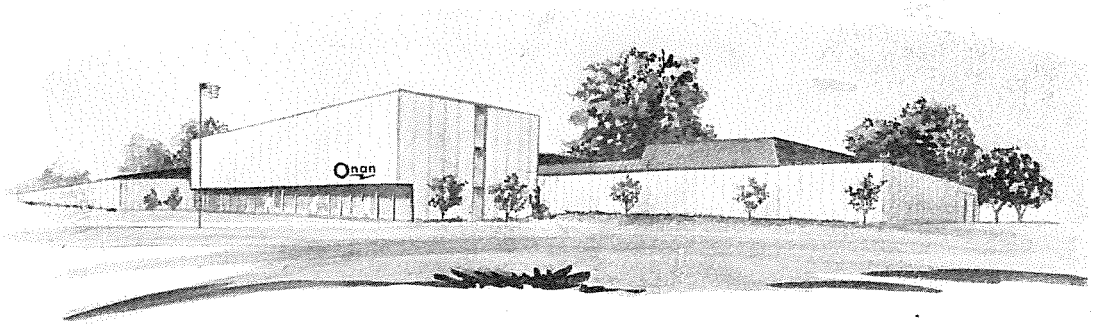
T-015

# technical bulletin

## USE OF GASEOUS FUEL
## WITH
## ONAN ELECTRIC GENERATING SETS

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**WARNING** Onan uses this symbol throughout this manual to warn of possible personal injury.

**CAUTION** This symbol refers to possible equipment damage.

**WARNING** Natural gas and liquid Petroleum gases are highly combustible therefore extreme safety precautions should be observed.

1. Do not smoke in the vicinity of gas tanks, or while servicing installation.

2. Do not use naked flame or weld in the vicinity of fuel installations or systems until the fuel has been evacuated and the tank or system purged.

3. Keep all fuel line connections tight and check system frequently to prevent leaks.

## SCOPE

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

The various types of installation problems cannot all 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.

Consult a reputable local gas distributor and NFPA (National Fire Protection Association) Pamphlet 58 for more specific information.

## EXCERPTS FROM NFPA PAMPHLET 58

ONAN recommends that the installer or architect become familiar with the current NFPA Standard 58.

1. All piping, tubing, fittings and valves for use with vapor LP gas shall be suitable for a working pressure of 125 psig.
2. LP gas vapor at pressures exceeding 20 psig shall not be piped into any building for fuel purposes, except buildings or separate fire divisions of buildings, used exclusively for housing internal combustion engines and for research and experimental laboratories.
3. Cast iron pipe fittings (ells, tees, crosses, couplings, flanges or plugs) shall not be used.
4. Flexible connectors, or hose complying with section 235 of NFPA 58 may be used between the container and regulator, or between the regulator and the gas-air mixer, with the approval for this application, of any of the authorities listed in section 1200 of NFPA 58.
5. All piping, tubing and hose shall be tested after assembly and proved free from leaks at not less than normal operating pressures. Tests shall not be made with a flame.
6. Piping outside buildings may be buried, above ground, or both, but shall be well supported and protected against physical damage. Where soil conditions warrant, all piping shall be protected against corrosion. Where condensation may occur, the piping shall be pitched back to the container, or suitable means shall be provided for revaporization of the condensate.
7. Provisions shall be made for expansion, contraction, jarring, vibration and settling. This may be accomplished by flexible connections.

**NFPA requires that all standby generating sets be installed in a fireproof room or separate building. Fuel line sizes are determined by individual unit requirements and must include approved shutoff devices. All hardware, such as lines and fittings, must meet local codes.**

## GAS AS A FUEL

Gas is a desirable fuel for internal combustion engines even though there may be a slight loss in power. Although gaseous fuels generally have higher octane ratings than gasoline, some manufactured "city" gases have a poor octane rating. The combustion efficiency of an engine may be increased without producing more heat by increasing the compression ratio. Compression ratio of an engine is limited by the type of fuel used. Generally, natural gas and propane allow using 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 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 for fuel depends on several important factors: (1) availability, (2) efficiency required, (3) engine application (mobile or not), (4) initial cost and (5) cost of operation.

The amount of heat any fuel is capable of producing depends on the basic structure of the fuel. Dry gases vary in regard to heat content as do gasoline, diesel fuel or other fuels. Propane and butane have considerably higher heat values than do methane and ethane.

The amount of heat a given fuel is capable of producing is usually expressed in BTU (British Thermal Unit). Manufactured gas, composed primarily of methane (marsh gas), has a heat content of about 500 BTU/cu ft. 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. No derating would be necessary with this fuel. Refer to Technical Bulletin T-017 for "Rating Factors for Electric Generating Sets." If propane is used, it is recommended that type HD-5 be used.

## POWER COMPARISON

A unit using butane, propane or a commercial mixture of both will deliver nearly the same power as when using gasoline.

1. Using 1100 BTU gas, a unit will deliver 80 to 95 percent of its gasoline rated power.
2. Using 850 BTU gas, a unit will deliver 80 to 85 percent of its gasoline rated power.
3. Using 600 BTU gas, a unit will deliver 70 to 75 percent of its gasoline rated power.
4. Using 450 BTU gas, a unit will deliver 50 to 60 percent of its gasoline rated power.

Natural gas is composed primarily of methane and varying amounts of other dry gases with a heat content of about 1000 BTU/cu. ft. 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 generating sets when efficiency is important because the heat value is so low the engine must be derated as much as 50 percent. Also, the gas manufacturing cost is usually higher than for other types of fuels. On the other hand, there are no storage problems such as with LP gas. Ambient temperature also has no effect on supplies.

LP gas refers to liquefied petroleum gas, a commercial mixture of propane and butane. The ratio between them 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 gas at normal temperatures is a vapor. By increasing pressure and lowering the temperature, it remains in a liquefied state until withdrawn from its storage tanks.

## TEMPERATURE AND PRESSURE

Temperature and pressure are interdependent. If gas temperature is changed, the pressure will change proportionally. A gas at room temperature can be changed to a liquid by compression and stored in a closed container. This is how LP gas is liquefied and stored.

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

## WORKING PRESSURE

The fuel system components must operate at various working pressures depending on the kind of gas, size and length of fuel lines, number of units to be supplied by a given source, ambient temperature, etc. Components must have the strength to function properly under anticipated or calculated maximum working pressures. LP gas tanks, for example, must be able to withstand a working pressure of 250 psi as specified in Pamphlet 58, National Fire Protection Association. Regulators must conform to the applicable specifications of the same agency in addition to performing the functions for which they are designed. The final regulator in a system must be able to maintain a constant pressure within a prescribed range which may be from 3 ounces to 5 pounds at the inlet.

**Some codes prohibit the use of high pressure accumulator tanks within the building or high pressure fuel supply piping to natural gas units of 350 KW and larger. For these installations, the gas supply must enter the building under low pressure and be "boosted" by the generating set. Onan has factory-mounted booster pumps available for these generating sets.**

There are several ways of measuring and expressing pressure. Pressure measured with a manometer is expressed in inches of water or mercury. Pressure measured with a gauge is expressed in ounces or pounds per square inch (psi). Because both systems are used and to convert calculations into like units of measure, refer to the pressure equivalents in Table 1.

### TABLE 1. PRESSURE EQUIVALENTS

| | | |
|---|---|---|
| 1 inch water column | equals | .58 ounces/sq. in. |
| 11 inch water column | equals | 6.38 ounces/sq. in. |
| 11 inch water column | equals | .4 lb./sq. in. |
| 1 lb./sq. in. | equals | 27.71 inch water column |
| 1 lb./sq. in. | equals | 16 ounces |
| 1 lb./sq. in. | equals | 2.04 inch mercury |
| 1 inch mercury | equals | .49 lb./sq. in. |
| 1 standard atmosphere | equals | 14.73 lb./sq. in. |
| 1 ounce/sq. in. | equals | 1.73 inch water column |
| 1 inch mercury | equals | 13.59 inch water |

## TABLE 2. AVERAGE FUEL CONSUMPTION AT FULL LOAD IN CU. FT./HR.

| MODELS | RPM | NATURAL GAS | LPG* |
|---|---|---|---|
| 1.0AJ | 1,800 | 33 | 13 |
| 2.5AJ | 3,600 | 62 | 25 |
| 2.5LK | 1,800 | 54 | 23 |
| 4.0CCK | 1,800 | 90 | 40 |
| 5.0CCK | 1,800 | 115 | 47 |
| 6.5NH | 1,800 | 150 | 60 |
| 7.5JB | 1,800 | 126 | 63 |
| 10.0CCKB | 3,600 | 200 | 100 |
| 12.5JC | 1,800 | 230 | 92 |
| 12.5RJC | 1,800 | 230 | 92 |
| 15.0JC | 1,800 | 255 | 110 |
| 15.0RJC | 1,800 | 255 | 110 |
| 30.0EK | 1,800 | 600 | 245 |
| 45.0EM | 1,800 | 690 | 290 |
| 55.0KB | 1,800 | 840 | 330 |
| 70.0KR | 1,800 | 1,000 | — |
| 85.0KR | 1,800 | 1,400 | 400 |
| 115.0WA | 1,800 | 1,800 | 730 |
| 140.0WE | 1,800 | 1,450 | 730 |
| 150.0WE | 1,800 | 1,450 | 730 |
| 170.0WB | 1,800 | 2,500 | 1,000 |
| 250.0FT | 1,800 | 3,000 | — |
| 350.0WF | 1,800 | 3,850 | — |
| 400.0WK | 1,800 | 4,200 | — |

***LPG:** 1 gallon = 36.5 cu. ft., 1 lb. = 8.5 cu. ft.

## SYSTEM COMPONENTS

Components depend on individual requirements. Usually the following components are standard.

**Regulators:** Gaseous fuel is metered to the carburetor on a demand basis. A regulator (demand or secondary type) is supplied with fuel at an inlet pressure only slightly above atmospheric pressure. If supply pressures are high (above 6 ounces), an additional primary regulator is used to reduce the supply pressure to a suitable level. Two primary regulators used in series are referred to as a "two-stage" regulation system.

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 prevents gas flow. A solenoid valve should be installed in the line as a positive shutoff device.

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

**Onan recommends venting regulators in buildings to the outside. Gas leakage could occur if the regulator has diaphragm failure. 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 gas system cannot be used in a liquid gas system without modification. Regulators should be mounted where they will receive least vibration. They should not be in areas of extreme heat.

On most late model systems using IMPCO gaseous fuel carburetors, the recommended pressure to the carburetor is 3 ounces. A THERMAC regulator is installed at the carburetor to regulate this pressure. The THERMAC regulator is suitable for pressures up to 12 ounces. For regulator selection of higher supply pressures, see Table 3.

**Models WF and WK shouldn't require an additional regulator for natural gas. The WF and WK require a 20 psi natural gas supply and therefore do not use a THERMAC valve.**

## TABLE 3. REGULATOR SELECTION

| MODELS | IF SOURCE PRESSURE IS: | | | | |
|---|---|---|---|---|---|
| | 6 to 11 Oz. | 11 Oz. to 1 Lb. | 1 to 2 Lbs. | 2 to 4 Lbs. | 4 Lbs. or Over |
| AK, AJ, LK | 1 | 1 | 1 | 1 | 1 |
| CCK, JB, CCKB, NH | 6 | 6 | 6 | 6 | 6 |
| JC, RJC | 2 | 2 | 2 | 2 | 2 |
| *EK | None | 3 | 3 | 3 | 3 |
| *EM | None | 4 | 3 | 3 | 3 |
| *KB | None | 4 | 3 | 3 | 3 |
| *KR | None | 4 | 4 | 3 | 3 |
| *WA, WE | ** | 4 | 4 | 4 | 4 |
| *WB | ** | 7 | 4 | 4 | 4 |
| *FT | None | 7 | 4 | 4 | 4 |

*Thermac regulator standard on EK, EM, KB, KR, WA, WB, WE and FT gas fuel IMPCO system. Maximum supply pressure to Thermac is 12 ounces. Thermac outlet pressure is 3 ounces for 1000 BTU gas.

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

**NOTE:** Code numbers refer to KEY column in Table 5 for regulator part number and identification.

**Converter (Vaporizer):** These components, used only in LP gas liquid withdrawal systems, provide heat for vaporizing liquefied fuel. All LP gas converters should be vented to outside of building.

Heat is usually supplied by the engine coolant, thermostatically controlled at about 170° F, maintaining a rather constant fuel temperature. This 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, generating 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.**

A burner-type vaporizer must be installed outdoors and as close as permissible to the point of consumption. It may 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 may 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 and volume of water, horsepower it serves, the volume of gas it is capable of vaporizing, etc. A converter should have a 20 percent reserve capacity for peak load operation.

The flow of water 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 will be taken from the water that it freezes. Moreover, if the fuel mixture becomes too lean, efficiency is lost and engine valves may become susceptible to burning. 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.

## TABLE 4. INLET PRESSURE TO SECONDARY REGULATOR (Straight Gaseous Fuel Only)

| MODEL | PRESSURE | MODEL | PRESSURE | MODEL | PRESSURE | MODEL | PRESSURE |
|---|---|---|---|---|---|---|---|
| AJ, AK, NH<br>CCK, CCKB<br>JB, JC<br>RJC (Begin Spec P) | 2 oz.<br>to<br>6 oz. | JC<br>RJC (Spec A through N) | 6 oz.<br>to<br>5 psi | EK<br>EM | 12 oz. maximum (to thermac) | KB, KR<br>WA, WB<br>WE | 12 oz. maximum (to thermac) |
| | | | | | | WF, WK* | 20 psi |

*Usually only require one regulator (see text).

## TABLE 5. PRIMARY GASEOUS FUEL REGULATORS

| PART NUMBER | FUNCTION | ORIFICE | INLET SIZE | OUTLET SIZE | INLET PRESSURE | OUTLET PRESSURE | MAXIMUM CAPACITY | KEY |
|---|---|---|---|---|---|---|---|---|
| 148-0033 | Pressure Reducing | 9/64" | 1/4" | 1/2" | 250 lbs | 11" wc | 190 cfh | 1 |
| 148-0034 | Pressure Reducing | 1/4" | 3/4" | 3/4" | 200 lbs | 11" wc | 680 cfh | 2 |
| 148-0343 | Pressure Reducing | 1/2" | 1-1/4" | 1-1/4" | 35 lbs | 11" wc | 1,800 cfh | 3 |
| 148-0363 | Pressure Reducing | 1" | 1-1/2" | 1-1/2" | 25 lbs | 11" wc | 7,750 cfh | 4 |
| 148-0427 | Pressure Reducing | 3/8" | 1" | 1" | 200 lbs | 10 lbs | 26,600 cfh | 5 |
| 148-0523 | Pressure Reducing | 1/4" | 1/2" | 3/4" | 200 lbs | 11" wc | 330 cfh | 6 |
| 148-0605 | Pressure Reducing | 2" | 2" | 2" | 5 lbs | 11" wc | 35,600 cfh | 7 |

## TABLE 6. FUEL STRAINERS

| PART NUMBER | PIPE SIZE (in.) | TYPE | TYPE OF FUEL |
|---|---|---|---|
| 149-0558 | 3/4 | Y | Natural or LP Gas Vapor |
| 149-0624 | 1-1/4 | Y | Natural |
| 149-0625 | 1/4 | Cone | LP Gas Liquid |
| 149-0751 | 2 | Y | Natural |
| 149-0752 | 1 | Y | Natural |
| 149-1241 | 3 | Y | Natural |

**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 the fuel system and damage valves and 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 lockoff valves for protection against potential fire hazards.

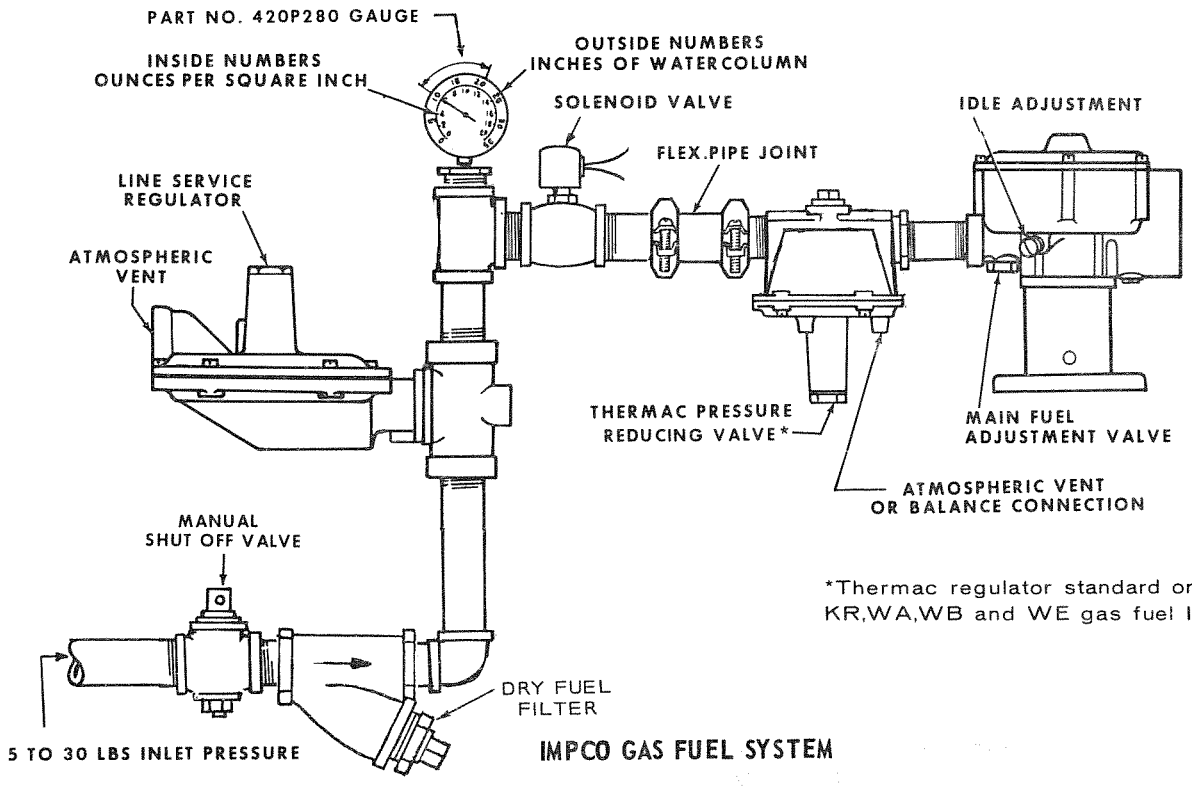
The final regulator in some instances is an acceptable shutoff valve, but a more positive lockoff is usually desired and may be required. See the shutoff valve selection Table 7 for characteristics and usage.

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.

## TABLE 7. ELECTRIC SHUTOFF VALVE SELECTIONS

| MODEL OR UNIT SIZE | LINE PRESSURE | 12 VOLT | 24 VOLT | MAXIMUM OPERATING PRESS | PIPE SIZE (in.) |
|---|---|---|---|---|---|
| 15 KW and Smaller | Under 8 Ounces | 307-0312 | | 8 Ounces | 3/4 |
| 15 KW and Smaller | To 25 Pounds | 307-0834 | 307-0863 | 25 Pounds | 3/4 |
| EK, EM | 15 Pounds | 307-0836 | 307-0865 | 25 Pounds | 1 |
| KB, KR | 15 Pounds | 307-0837 | | 25 Pounds | 1-1/4 |
| WA, WE | 15 Pounds | 307-0840 | | 15 Pounds | 2 |
| WB, FT | 15 Pounds | | 307-0841 | 15 Pounds | 2 |
| FT | 15 Pounds | | 307-1048 | 5 Pounds | 3 |
| WF, WK | 20 Pounds | | 307-0866 | 25 Pounds | 1-1/4 |
| Liquid Fuel | | 307-0268 | 307-0757 | | 1/4 |




IMPCO GAS FUEL SYSTEM

*Thermac regulator standard on EK,EM,KB, KR,WA,WB and WE gas fuel Impco systems.

## VAPOR WITHDRAWAL

LP gas 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, for example, so much heat is lost that it 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 through only the portion which is in direct contact with the liquefied gas):

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 Gas Tanks:** Select and size the LP gas tanks according to the following requirements:

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

LP gas temperature is critically important and imposes several limitations. Full power cannot be obtained from generating 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 frost line where the temperature never goes below 35° F is all right if adequate allowances are made for year to year variation. In northern climates, the frost line might be four feet one year and eight feet the next year, depending on snow cover, etc.

Following are some representative figures for tanks buried at least two feet below the frost line when used in vapor withdrawal systems: a 500-gallon tank half full will vaporize 8-1/2 gallons per hour (300 cu. ft/hr) at 40° F and a 1000-gallon tank half full will vaporize 15 gallons per hour (540 cu. ft./hr) at 40° F. See Table 10 for vaporization rate of propane from tanks above ground.

The following tables apply only to propane, the major component of LP gas. The vaporization rates are based on the average temperature over an 8-hour period. The column temperatures heading 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.

TABLE 8. NUMBER OF 20-GALLON PROPANE CYLINDERS REQUIRED AT THE VARIOUS INDICATED TEMPERATURES WHEN KEPT AT LEAST 1/2 FULL

| WITHDRAWAL RATE | LOWEST AVERAGE WINTER TEMPERATURE | | | | | | |
|---|---|---|---|---|---|---|---|
| | 32° F | 20° F | 10° F | 0° F | -10° F | -20° F | -30° F |
| 10 cfh - 25,000 BTU/hr | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 25 cfh - 62,500 BTU/hr | 1 | 1 | 1 | 2 | 2 | 3 | 4 |
| 50 cfh - 125,000 BTU/hr | 2 | 2 | 3 | 3 | 4 | 5 | 9 |
| 100 cfh - 250,000 BTU/hr | 4 | 4 | 5 | 6 | 7 | 10 | 20 |

**Determining Number of 20-Gallon Cylinders Required:** Assume that a model 5.0CCK-1R generating set is to be installed using propane gas. The lowest average outdoor temperature is found to be -10° F. No other gas appliances will be used.

1. Refer to fuel consumption Table 2. Note that a series CCK uses approximately 50 cubic feet of fuel per hour at full-rated load.
2. Refer to cylinders required in Table 8. Note that at -10° F, four cylinders will provide 50 cubic feet 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 generating 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 maintenance. Refer to the generating set's operator manuals and technical bulletins for installation techniques.

Gasoline supply lines and tanks are conventionally designed, installed and serviced as on straight gasoline fuel generating 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.

TABLE 9. SIZE OF PROPANE TANK (IN GALLONS) REQUIRED AT THE VARIOUS INDICATED TEMPERATURES WHEN KEPT AT LEAST 1/2 FULL

| WITHDRAWAL RATE | LOWEST AVERAGE WINTER TEMPERATURE | | | | | | |
|---|---|---|---|---|---|---|---|
| | 32° F | 20° F | 10° F | 0° F | -10° F | -30° F | -30° F |
| 50 cfh - 125,000 BTU/hr | 115 | 115 | 115 | 250 | 250 | 400 | 600 |
| 100 cfh - 250,000 BTU/hr | 250 | 250 | 250 | 400 | 500 | 1000 | 1500 |
| 150 cfh - 375,000 BTU/hr | 300 | 400 | 500 | 500 | 1000 | 1500 | 2500 |
| 200 cfh - 500,000 BTU/hr | 400 | 500 | 750 | 1000 | 1200 | 2000 | 3500 |
| 300 cfh - 750,000 BTU/hr | 750 | 1000 | 1500 | 2000 | 2500 | 4000 | 5000 |

RATE OF VAPORIZATION OF PROPANE FROM
ABOVE GROUND TANKS

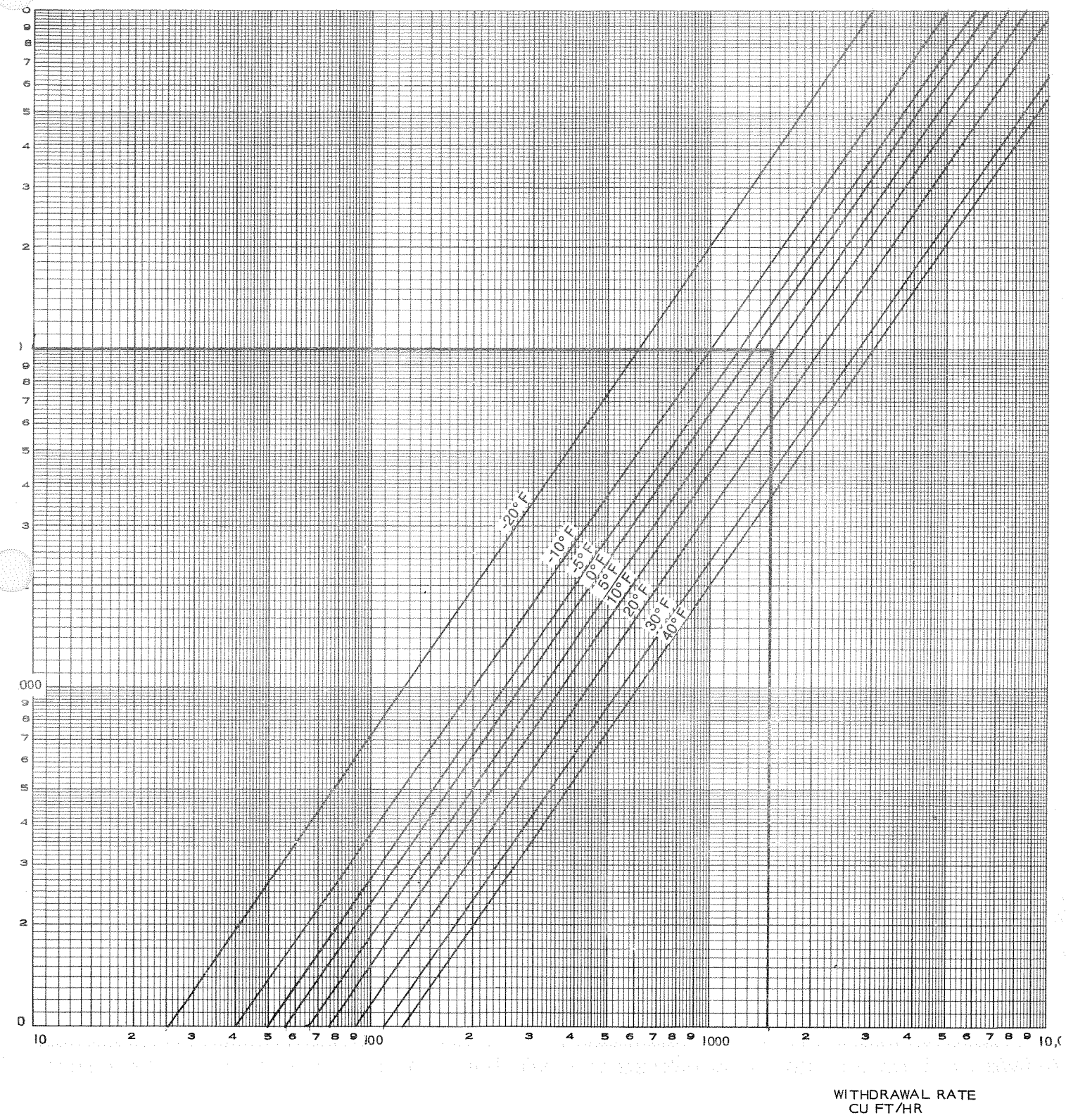
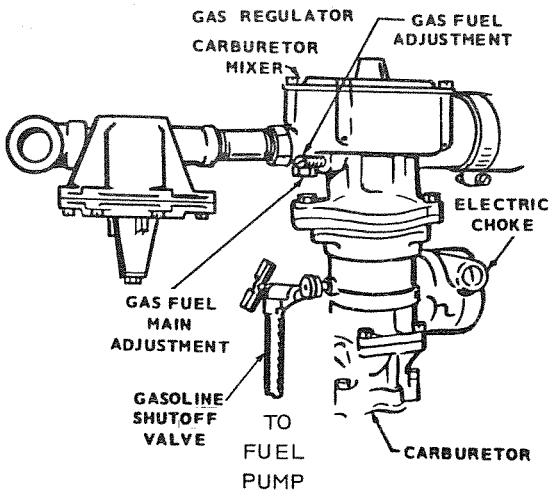



TABLE 10. BATCH VAPORIZATION - WINTER
MIN TANK PRESS. 5 PSIG
TANK 50% FULL

## 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.




TYPICAL COMBINATION FUEL SYSTEM

### TABLE 11. PROPANE FUEL TWO STAGE REGULATION (2 REGULATORS) (5 to 15 LB. — ALLOWING PRESSURE DROP OF 1 PSI) DIAMETER OF FUEL LINE IN INCHES FOR THE VARIOUS LENGTHS OF PIPE

| UNIT | KW | CFH | 15 FT. | 25 FT. | 50 FT. | 75 FT. | 100 FT. | 150 FT. | 200 FT. | 300 FT. |
|---|---|---|---|---|---|---|---|---|---|---|
| AJ | 1,2.5 | 13,25 | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * |
| LK | 2.5 | 23 | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * |
| CCK | 4 | 40 | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 3/8 £ | 3/8 £ |
| CCK | 5 | 47 | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 1/4 * | 3/8 £ | 3/8 £ |
| NH | 6.5 | 60 | 1/4 * | 1/4 * | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ |
| JB | 7.5 | 63 | 1/4 * | 1/4 * | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ | 3/8 £ |
| CCKB | 10 | 100 | 3/8 £ | 3/8 £ | 3/8 £ | 1/2 † | 1/2 † | 1/2 † | 1/2 † | 1/2 † |
| JC, RJC | 12.5 | 92 | 3/8 £ | 3/8 £ | 3/8 £ | 1/2 † | 1/2 † | 1/2 † | 1/2 † | 1/2 † |
| JC, RJC | 15 | 110 | 3/8 £ | 3/8 £ | 3/8 £ | 1/2 † | 1/2 † | 1/2 † | 1/2 † | 1/2 † |
| EM | 45 | 290 | 3/8 £ | 1/2 † | 1/2 † | 1/2 | 1/2 | 3/3 | 3/4 | 3/4 |
| EK | 30 | 245 | 3/8 £ | 3/8 £ | 1/2 † | 1/2 † | 1/2 | 1/2 | 1/2 | 3/4 |
| KB | 55 | 330 | 1/2 † | 1/2 † | 1/2 | 1/2 | 3/4 | 3/4 | 3/4 | 3/4 |
| KR | 85 | 400 | 1/2 | 1/2 | 3/4 | 3/4 | 1 | 1 | 1 | 1-1/4 |
| WA | 115 | 730 | 1/2 | 3/3 | 3/4 | 1 | 1 | 1 | 1 | 1-1/4 |
| WE | 140 | 730 | 3/4 | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/4 |
| WE | 150 | 730 | 3/4 | 3/4 | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 |
| WB | 170 | 1,000 | 3/4 | 3/4 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/4 |

* 3/8 outside diameter tubing may be used.
£ 1/2 outside diameter tubing may be used.
† 5/8 outside diameter tubing may be used.

## TABLE 12. LPG VAPOR—11 INCH WATER COLUMN, 0.5 INCH PRESSURE DROP DIAMETER OF FUEL LINE IN INCHES FOR THE VARIOUS LENGTHS OF PIPE

| UNIT | KW | CFH★ | 15 FT. | 25 FT. | 50 FT. | 75 FT. | 100 FT. | 150 FT. | 200 FT. | 300 FT. |
|---|---|---|---|---|---|---|---|---|---|---|
| AJ | 1 | 13 | 1/2 * | 1/2 * | 1/2 * | 1/2 £ | 1/2 £ | 1/2 † | 1/2 † | 3/4 † |
| LK | 2.5 | 25 | 1/2 + | 1/2 + | 1/2 + | 1/2 £ | 1/2 £ | 3/4 £ | 3/4 | 3/4 |
| CCK | 4 | 40 | 1/2 £ | 1/2 † | 3/4 † | 3/4 † | 3/4 | 3/4 | 1 | 1 |
| CCK | 5 | 47 | 3/4 £ | 3/4 † | 3/4 † | 1 | 1 | 1 | 1 | 1-1/4 |
| NH | 6.5 | 60 | 3/4 | 3/4 † | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 |
| CCKB | 10 | 100 | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 |
| JB | 7.5 | 63 | 3/4 | 3/4 † | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 |
| JC | 12 | 110 | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 |
| EM | 45 | 290 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 2 | 2 |
| EK | 30 | 245 | 1 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 |
| KB | 55 | 330 | 1 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 1-1/2 | 2 | 2 |
| KR | 85 | 400 | 1-1/2 | 1-1/2 | 1-1/2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 |
| WA | 115 | 730 | 1-1/2 | 2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 | 2-1/2 |
| WB | 170 | 1000 | 2 | 2-1/2 | 3 | 3 | 4 | 4 | 4 | 4 |
| WE | 150 | 730 | 2 | 2-1/2 | 2-1/2 | 3 | 3 | 3 | 4 | 4 |

★ These values are only representative; refer to Table 2 for all specific values.
* 1/2 outside diameter tubing may be used.
£ 5/8 outside diameter tubing may be used.
\+ These engines require 15 psi natural gas fuel supply.
† 3/4 outside diameter tubing may be used.

**Note:** Never use smaller than 1/2 outside diameter tubing.

## TABLE 13. NATURAL GAS — 11 INCH WATER COLUMN, 0.5 INCH PRESSURE DROP DIAMETER OF FUEL LINE IN INCHES FOR THE VARIOUS LENGTHS OF PIPE

| UNIT | KW | CFH* | 15 FT. | 25 FT. | 50 FT. | 75 FT. | 100 FT. | 150 FT. | 200 FT. | 300 FT. |
|---|---|---|---|---|---|---|---|---|---|---|
| AJ | 1 | 33 | 1/2 | 1/2 | 1/2 | 3/4 | 3/4 | 3/4 | 1 | 1-1/4 |
| LK | 2 | 54 | 1/2 | 3/4 | 3/4 | 3/4 | 3/4 | 1 | 1 | 1-1/4 |
| CCK | 4 | 90 | 3/4 | 3/4 | 3/4 | 1 | 1 | 1 | 1-1/4 | 1-1/4 |
| CCK | 5 | 115 | 3/4 | 3/4 | 3/4 | 1 | 1 | 1-1/4 | 1-1/4 | 1-1/4 |
| NH | 6.5 | 150 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 1-1/2 | 2 |
| CCKB | 10 | 200 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 1-1/2 | 2 |
| JB | 7.5 | 126 | 3/4 | 3/4 | 3/4 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/4 | 1 |
| JC | 15 | 255 | 1 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 1-1/2 | 2 |
| EK | 30 | 600 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/2 | 1-1/2 | 2 | 2 | 2 |
| EM | 45 | 690 | 1-1/4 | 1-1/2 | 1-1/2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 |
| KB | 55 | 840 | 1-1/2 | 1-1/2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 | 2-1/2 |
| KR | 70 | 1,000 | 2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 | 2-1/2 | 3 |
| KR | 85 | 1,400 | 2 | 2 | 2 | 2 | 2-1/2 | 2-1/2 | 2-1/2 | 3 |
| WA | 115 | 1,800 | 2 | 2-1/2 | 2-1/2 | 3 | 3 | 3 | 3-1/2 | 3-1/2 |
| WE | 150 | 1,450 | 2 | 2-1/2 | 2-1/2 | 3 | 3 | 3 | 3-1/2 | 3-1/2 |
| WB | 170 | 2,500 | 2-1/2 | 2-1/2 | 3 | 3 | 3-1/2 | 3-1/2 | 3-1/2 | 4 |
| FT | 250 | 3,000 | 2-1/2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 |
| WF† | 350 | 3,850 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/4 | 2 | 2 | 2 | 2 |
| WK† | 400 | 4,200 | 1-1/4 | 1-1/4 | 1-1/4 | 1-1/4 | 2 | 2 | 2 | 2 |
| WF†† | 350 | 3,850 | 2-1/2 | 3 | 3 | 4 | 4 | 4 | 4 | 6 |
| WK†† | 400 | 4,200 | 3 | 4 | 4 | 4 | 4 | 6 | 6 | 6 |

* These values are only representative; refer to Table 2 for all specific values.
† These engines require 20 psi natural gas fuel supply.
†† Generating sets with gas boosters on engines . . . for low pressure incoming fuel line.

## TABLE 14. LINE SIZING CHART FOR LIQUID PROPANE
### (Based on Pressure Drop of 1 PSI)

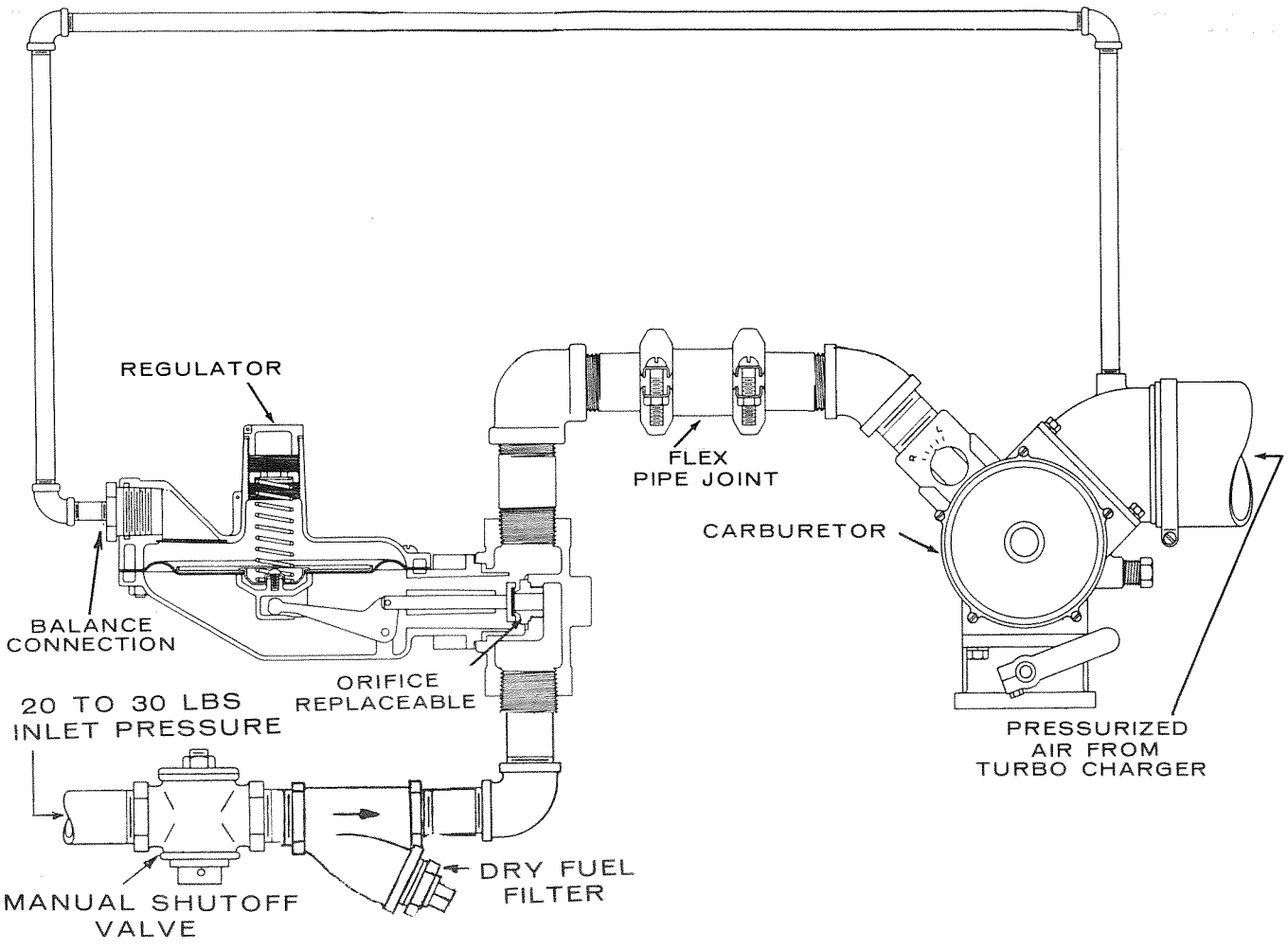
| Liquid Propane Flow CFH | Liquid Propane Flow GPH | PIPE LENGTH (FEET) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1/4" | | 3/8" | | 1/2" | | 3/4" | | 1" | | 1-1/4" | | 1-1/2" | | 2" | |
| | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | |
| | | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 |
| 360 | 10 | 729 | 416 | | | | | | | | | | | | | | |
| 540 | 15 | 324 | 185 | | | | | | | | | | | | | | |
| 720 | 20 | 182 | 104 | 825 | 521 | | | | | | | | | | | | |
| 1440 | 40 | 46 | 26 | 205 | 129 | 745 | 504 | | | | | | | | | | |
| 2160 | 60 | 20 | 11 | 92 | 58 | 331 | 224 | | | | | | | | | | |
| 2880 | 80 | 11 | 6 | 51 | 32 | 187 | 127 | 735 | 537 | | | | | | | | |
| 3600 | 100 | 7 | 4 | 33 | 21 | 119 | 81 | 470 | 343 | | | | | | | | |

**TO USE CHART:**

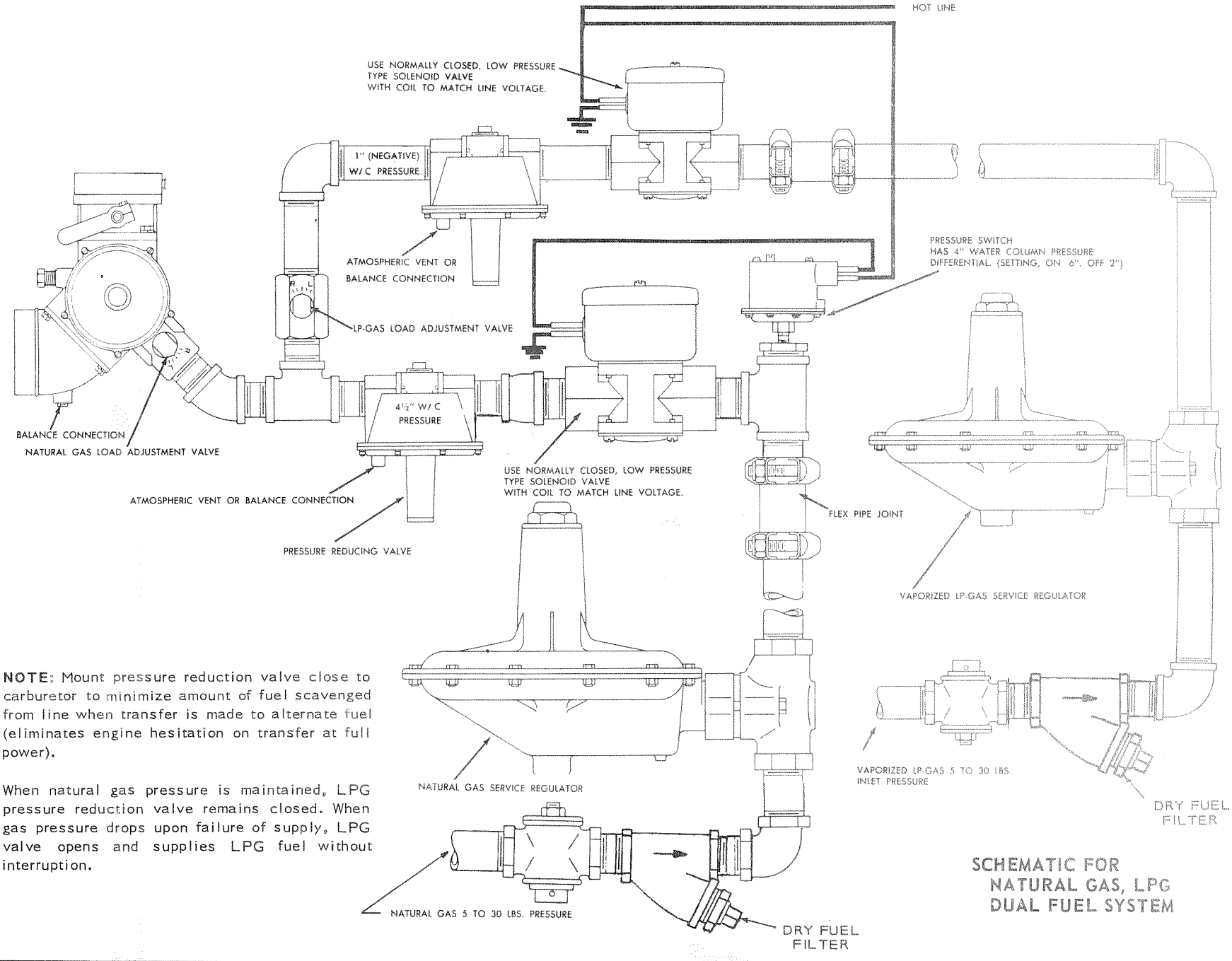
1. Having determined the required flow at point of use, locate this flow in the left hand column. If this falls between two figures, use the larger of the two.
2. Determine total length of piping required from source to point of use.
3. Read across chart from left (required flow) to right to find the 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 15.
## INLET PRESSURE TO SECONDARY REGULATOR OR THERMAC REGULATOR
### (Combination Fuel with Impco System)

| UNIT | PRESSURE |
|---|---|
| EK, EM | 12 oz. |
| WA, WB, WE | 12 oz. |
| KB, KR | 12 oz. |




NATURAL GAS FUEL SYSTEM FOR WF AND WK

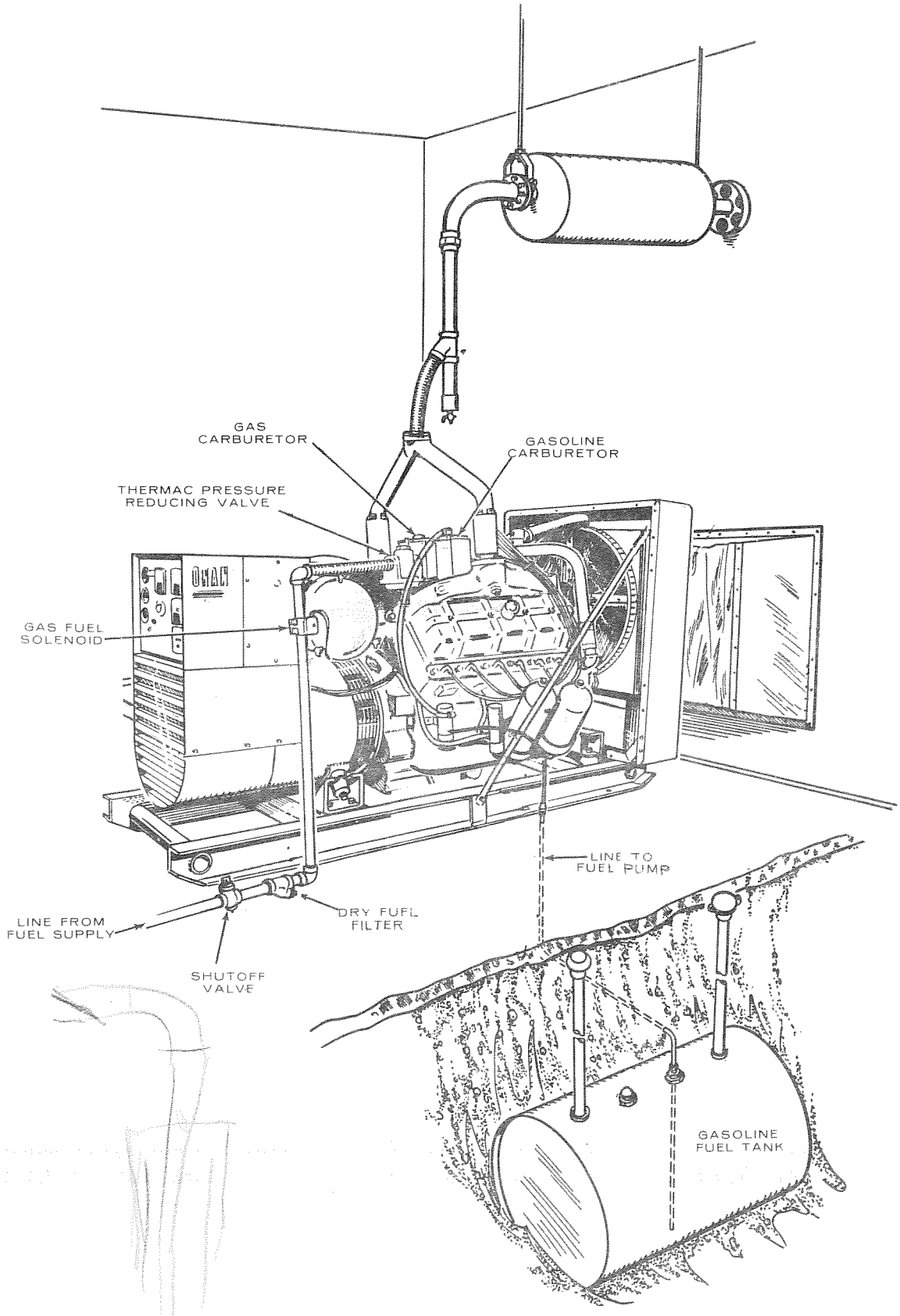



**NOTE:** Mount pressure reduction valve close to carburetor to minimize amount of fuel scavenged from line when transfer is made to alternate fuel (eliminates engine hesitation on transfer at full power).

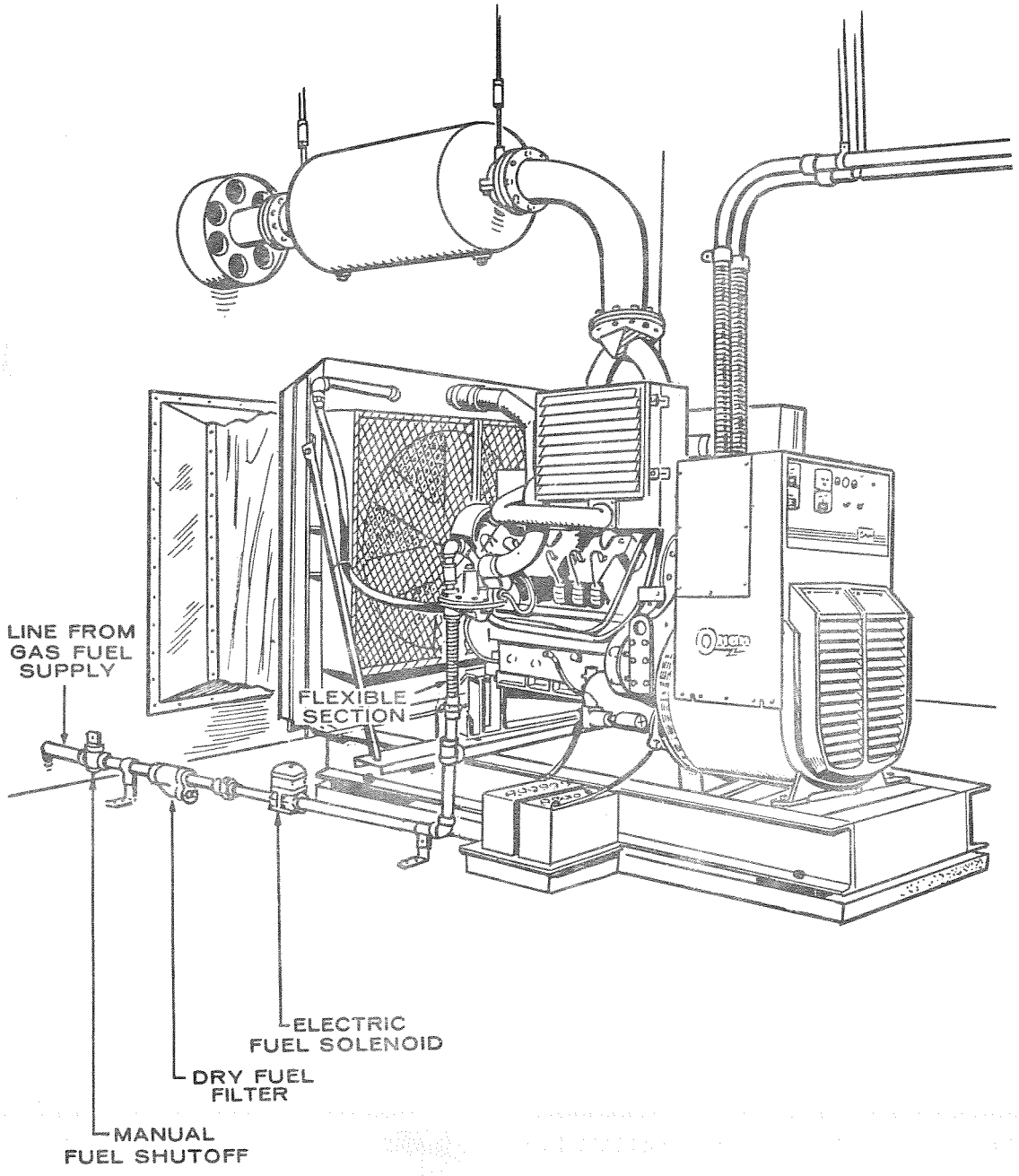
When natural gas pressure is maintained, LPG pressure reduction valve remains closed. When gas pressure drops upon failure of supply, LPG valve opens and supplies LPG fuel without interruption.

## SCHEMATIC FOR NATURAL GAS, LPG DUAL FUEL SYSTEM

# TYPICAL GAS-GASOLINE FUEL SYSTEM

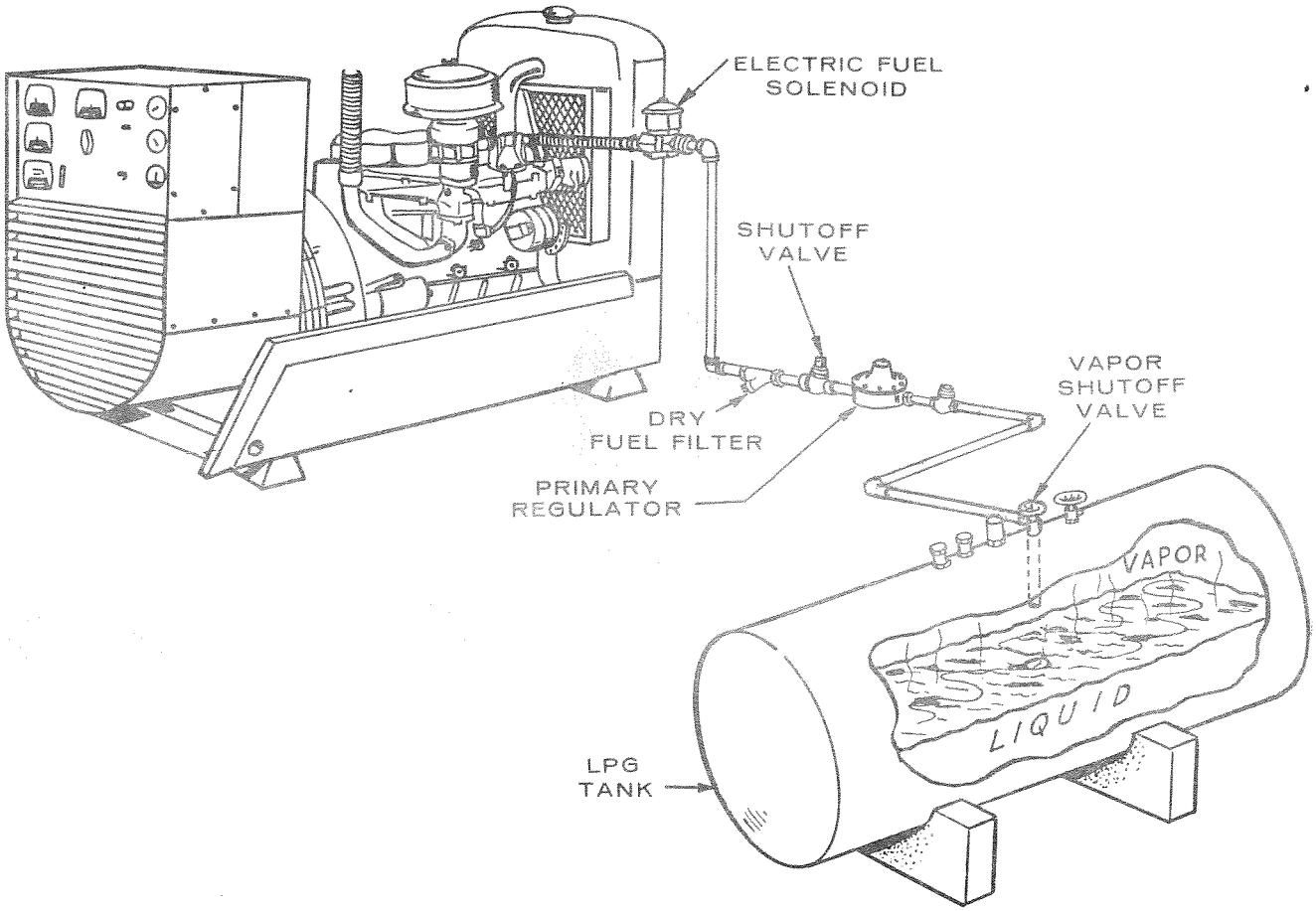


# TYPICAL NATURAL OR MANUFACTURED CITY GAS SYSTEM

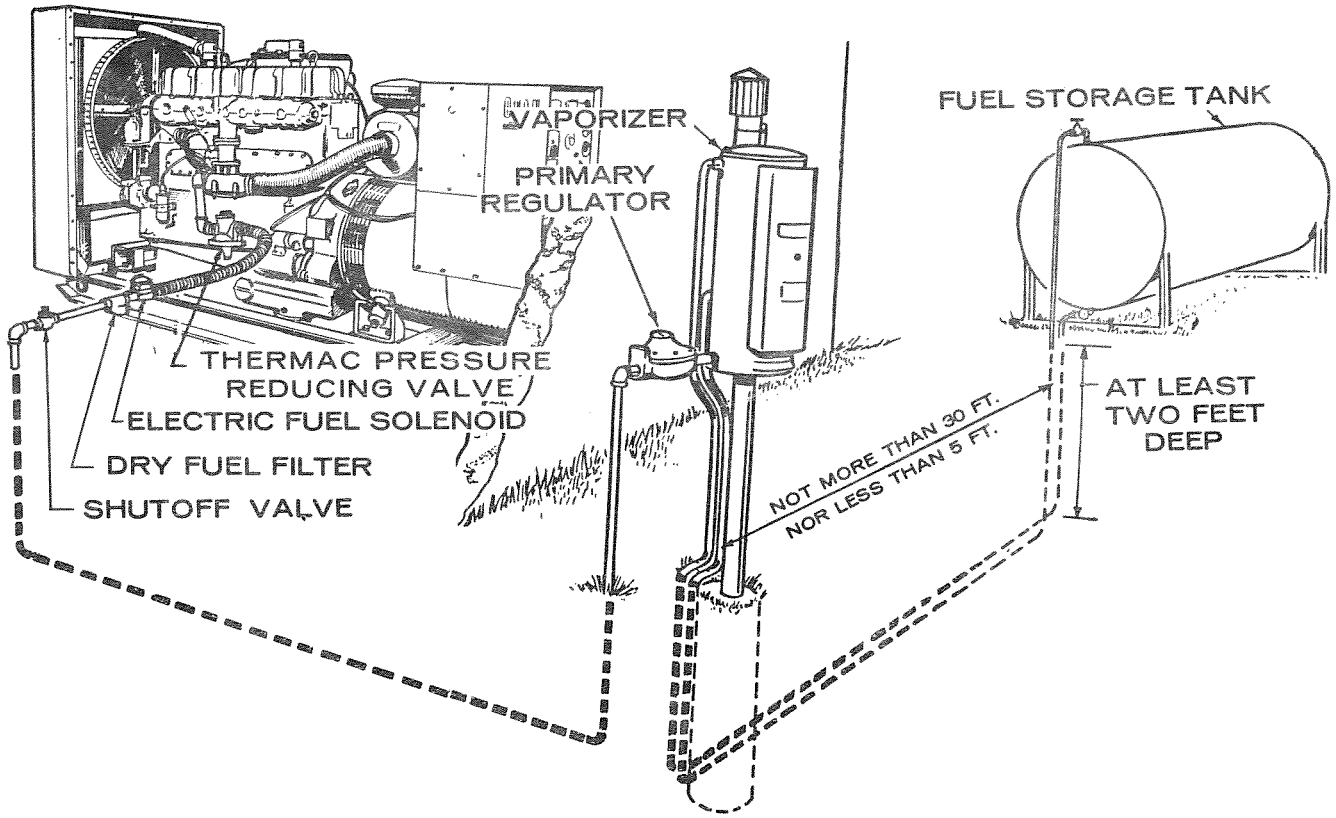



NOTE: WF and WK do not use two-step regulation.

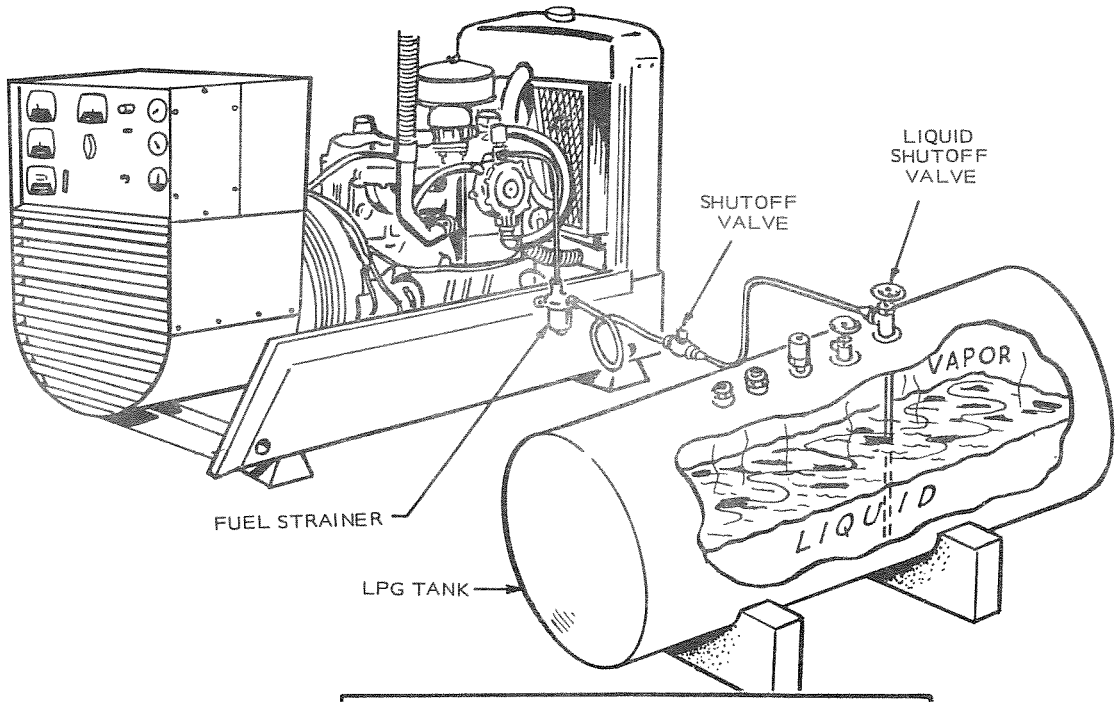
# TYPICAL LPG VAPOR WITHDRAWAL SYSTEM

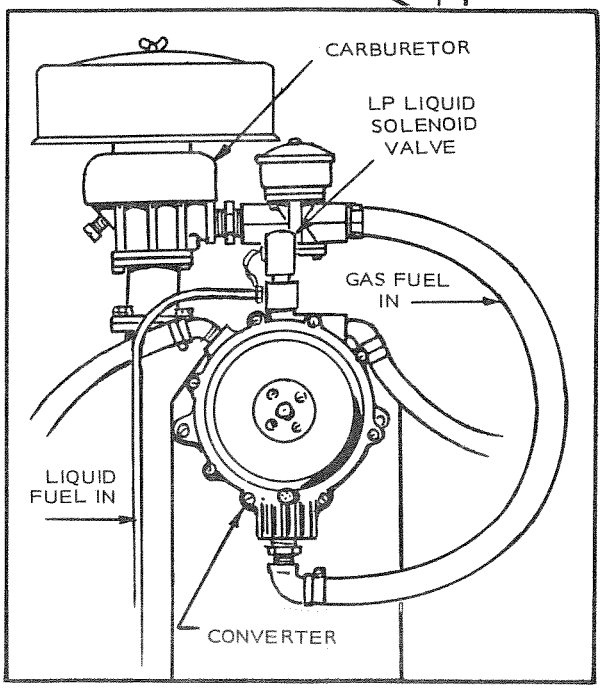


## TYPICAL LPG SYSTEM WITH GAS BURNER VAPORIZER



# TYPICAL LPG SYSTEM WITH LIQUID WITHDRAWAL




NEVER INSTALL REGULATOR BETWEEN TANK AND CONVERTER IN LIQUID WITHDRAWAL.

Onan manufactures a complete line of electric power systems from 1 to 500 KW (generator sets • automatic transfer switches • industrial engines), gas-, gasoline- or diesel-driven. For standby power in homes, industrial plants, commercial buildings and institutions. For auxiliary or portable power in boats, recreational vehicles, service trucks and construction equipment.