TECHNICAL BULLETIN

T-029

INSTALLATION INFORMATION FOR ONAN AIR-COOLED ELECTRIC GENERATING PLANTS

T-030 CONTAINS INSTALLATION INFORMATION FOR LIQUID-COOLED PLANTS. MOBILE INSTALLATIONS ARE DESCRIBED IN T-012.

OCTOBER 1968

ONAN
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A DIVISION OF STUDEBAKER CORPORATION
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Litho in U.S.A.

SCOPE

Information in this bulletin is based on extensive tests under favorable operating conditions. Use this bulletin as a general guide. Deviate from these recommendations to meet specific installation requirements.

Abide by codes of agencies having jurisdiction over the installation and operation of internal combustion engines. See bibliography for a list of reference publications.

LOCATION

Plant location is decided chiefly by related systems, such as ventilation, cooling, wiring, fuel, and exhaust. Provide adequate access for service and repair. Locate the plant near the main power fuse box.

Wood floors on which installations are made should be covered with sheet metal extending 12" beyond the extremeties of the plant. Provide adequate lighting facilities around the plant.

Protect plants from adverse weather. Avoid locations where ambient temperature extremes prevail. Special starting aids are available to ensure dependable starting aids are available to ensure dependable starting at low ambient temperatures. City water cooling systems give more effective cooling at high ambient temperatures.

MOUNTING

Mount the generating plant on a substantial, level base. Secure units not mounted on skids. Skid-mounted units should be secured, if on raised foundations. Foundations facilitate service and repair and protect the unit from seepage. Typical foundations are shown in Fig.1.

Foundations for small units may be of poured concrete with anchored mounting bolts. Steel beam sections make an acceptable alternate.

Mounting large units on foundations is optional, but recommended. Two or three tapered concrete blocks can be used instead of a solid concrete pad. Tapered blocks will permit easy removal of the engine oil pan if made high enough and placed crosswise to the plant.

Outline drawings with mounting hole dimensions are available for all Onan plants.

Vibration Dampers

Provisions for isolating vibration are available on all Onan units. The mounting cushion supplied with all J-Series units is shown in Figure 2. Figure 3 is an optional type. A vibration-mounted, pad-type cushion for large skid-mounted units is shown in Figure 4.

EXHAUST SYSTEM

Exhaust from internal combustion engines is poisonous. Pipe exhaust gases outside. Exhaust pipes must not terminate near inlet vents or combustible materials.

If exhaust gases are piped into a chimney, the point of entry must be above flues and vents.

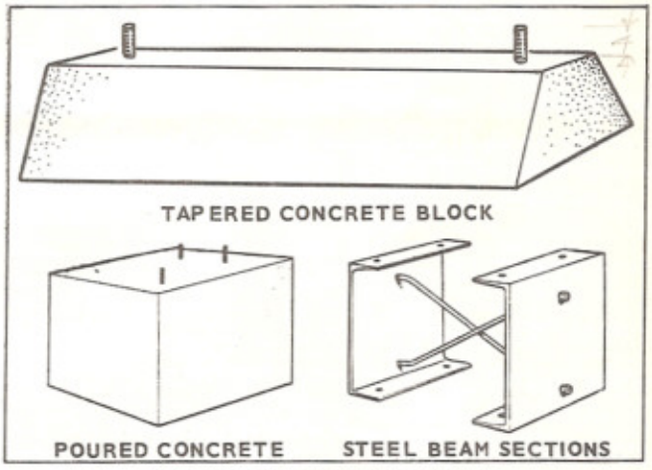

Figure 1. Mounting Foundations

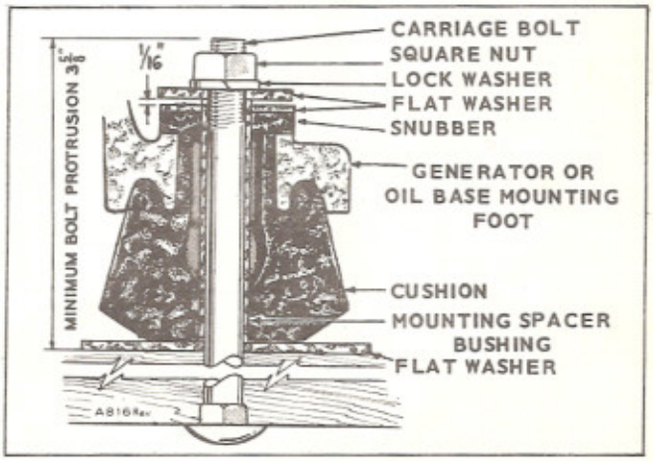

Figure 2. J-Series Mounting Cushions

7/16 dia bolts

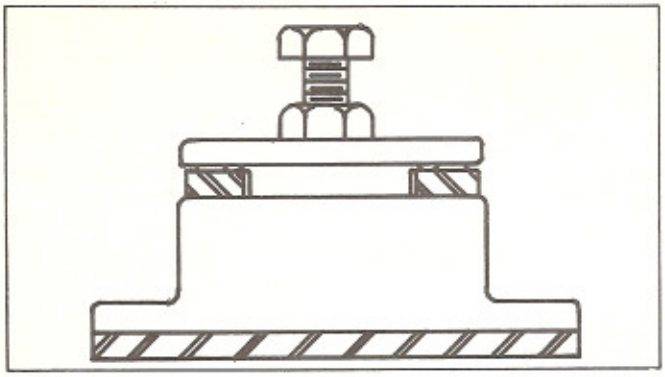

Figure 3. Optional Spring Mounting Cushion

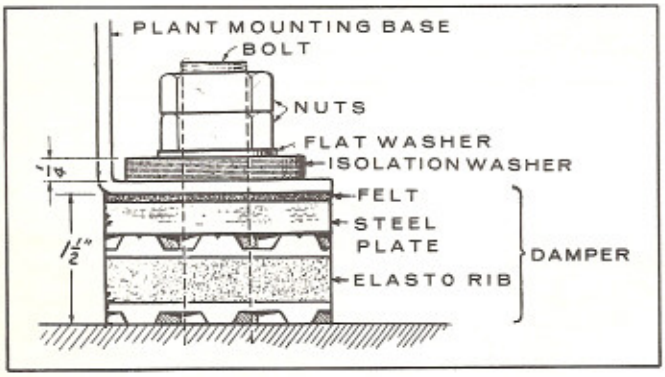

Figure 4. Pad-Type Vibration Damper

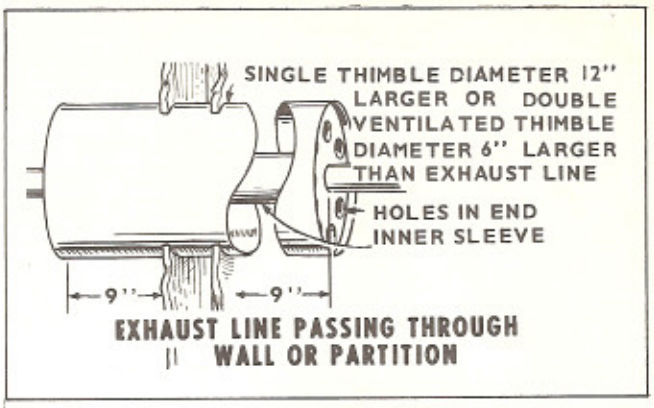

Figure 5. Exhaust Pipe Thimble

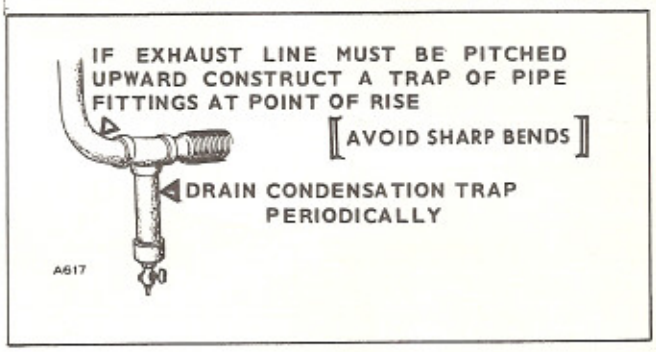

Figure 6. Condensation Trap

Exhaust pipes must not come closer than 9" to combustible materials. Walls and partitions must be protected from exhaust pipes which pass through them. Use an approved thimble, see Figure 5.

Pitch exhaust pipes downward, or install a condensation trap at the point where a rise in the exhaust system begins, (Figure 6).

Avoid sharp bends. Use sweeping, long-radius elbows. Use a section of seamless, flexible tubing between the engine and any rigid piping to restrict vibration. Use the next larger pipe size for each additional 10 feet of pipe length.

Exhaust pipesshould be of wrought iron or steel. The pipes should have adequate support and sufficient strength to withstand severe service.

Exhaust pipes should be as short as possible, with as few fittings as are necessary. The values in Table 1 represent the number of feet of straight pipe to which the various kinds and sizes of fittings are equivalent. These values must be added to the total length of straight pipe to determine whether an increase in pipe size is necessary.

TABLE 1. EXHAUST PIPE FITTINGS

TYPE OF FITTING	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
STANDARD ELL	1.2	1.6	2.2	2.6	3.6	4.4	5.7	7.9
LONG RADIUS ELL	57	.77	1.1	1.3	1.7	2.2	2.8	3.9
MEDIUM RADIUS ELL	.73	.98	1.4	1.6	2.2	2.8	3.6	5.0
STANDARD TEE	2.3	3.1	4.4	5.2	7.1	8.7	11.4	15.8

Mufflers

Cool mufflers collect undesirable carbon residues. Install mufflers as close as is practicable to the engine. Mufflers within air outlet ducts must be wrapped with asbestos to prevent "hot spots" from forming on the ducts. Increase duct size by an amount equal to the radial cross section of the muffler installation. For example, if Table 4 calls for an outlet vent of 1/2 sq.ft. (72 sq. in.), and the area of the muffler, with asbestos insulation, viewed end-wide is 60 sq. in., the outlet vent should be given an area of at least 132 sq. inches.

Muffler specifications are shown in Table 2. If quieter operation is needed, consult the proper column for the muffler number.

VENTILATION

Ventilating systems must be designed and installed to provide enough fresh air at the generating plant for efficient cooling and combustion. In addition to removing engine heat and replacing combustion air, heat produced by the generator and other equipment in the same general area has to be removed by the ventilating system. When designing the system, consider prevailing wind direction, ambient temperature, sound principles of duct design, and all other factors that might influence air flow and circulation.

Generally, there has to be an inlet and an outlet in the room for circulation. These vents must be so arranged in the room that air cannot escape without first passing through the immediate area of the installation. The outlet should be slightly higher than the inlet to allow for convection air-current flow.

Vents must be large enough to allow the required volume of air to flow in a given time. See Tables 3 and 4. Figure 7 shows a typical home or shed-type installation.

If free air flow is in any way inhibited by louvers or screens, the vents must be increased in area 1/4 to 1/2 times. Wind may also restrict free air flow if it blows directly into the outlet vent. However, unless the wind blows regularly, consider this factor to be of only marginal importance.

Control of air flow to maintain a desirable temperature range can be done with thermostatic shutters. They regulate air flow during operation, and close at shut-down. Closing at shut-down is especially important in cold climates where the natural draining of cold air into the outlet duct can lower the ambient temperature below a safe level for all engines, particularly diesels.

Of vital importance is avoiding a situation that leads to recirculation of cooling air. If inlet air is 10°F above ambient, there is a good possibility that cooling air is re-circulating. Take positive steps during installation planning to avoid this problem.

AIR COOLING SYSTEMS

All engines require air for combustion, but some engines use air for cooling purposes also. This bulletin covers air-cooled engines only.

Onan manufactures air-cooled plants with output capacities of from 500 to 15,000 watts. Two methods of air cooling are used in these plants, depending on the use to which they are to be put. The names given to these cooling systems by Onan are 1) pressure cooling and 2) Vacu-Flo.

The demand for an air cooling system well suited for compartment installations resulted in the development of the Vacu-Flo system. The more conventional cooling system was then called pressure cooling.

Tables 3 and 4 show air flow and vent-size requirements. Table 3 covers pressure-cooled plants and Table 4 covers Vacu-Flo plants.

Vacu-Flo Cooling

A centrifugal fan in a scroll housing pulls cooling air in at the generator. As air flows through the generator and around cooling fins, it picks up the excess heat of combustion and the heat produced by the generator in normal operation. This heated air is then forced from a single discharge, either into a duct or away from the installation area. This is shown in Fig. 8. A Vacu-Flo installation is shown in Figure 20.

TABLE 2. MUFFLER SPECIFICATIONS

PLANT MODEL	PIPE SIZE ENGINE	MUFFLER	INDUSTRIAL	RESIDENTIAL	CRITICAL
AJ, AK	3/4"	1"	Included	155P518	155P518
LK,LKB	1"	1"	Included	155P518	155P518
CCK	1"	1"	Included	155P518	155P518
DJA	1"	1"	Included	155P518	155P518
CCKB	1-1/4"	1-1/2"	Included	155P360	155P360
All JB	1-1/4"	1-1/2"	Included	155P360	155P360
All JC	1-1/2"	1-1/2"	Included	155P360	155P360

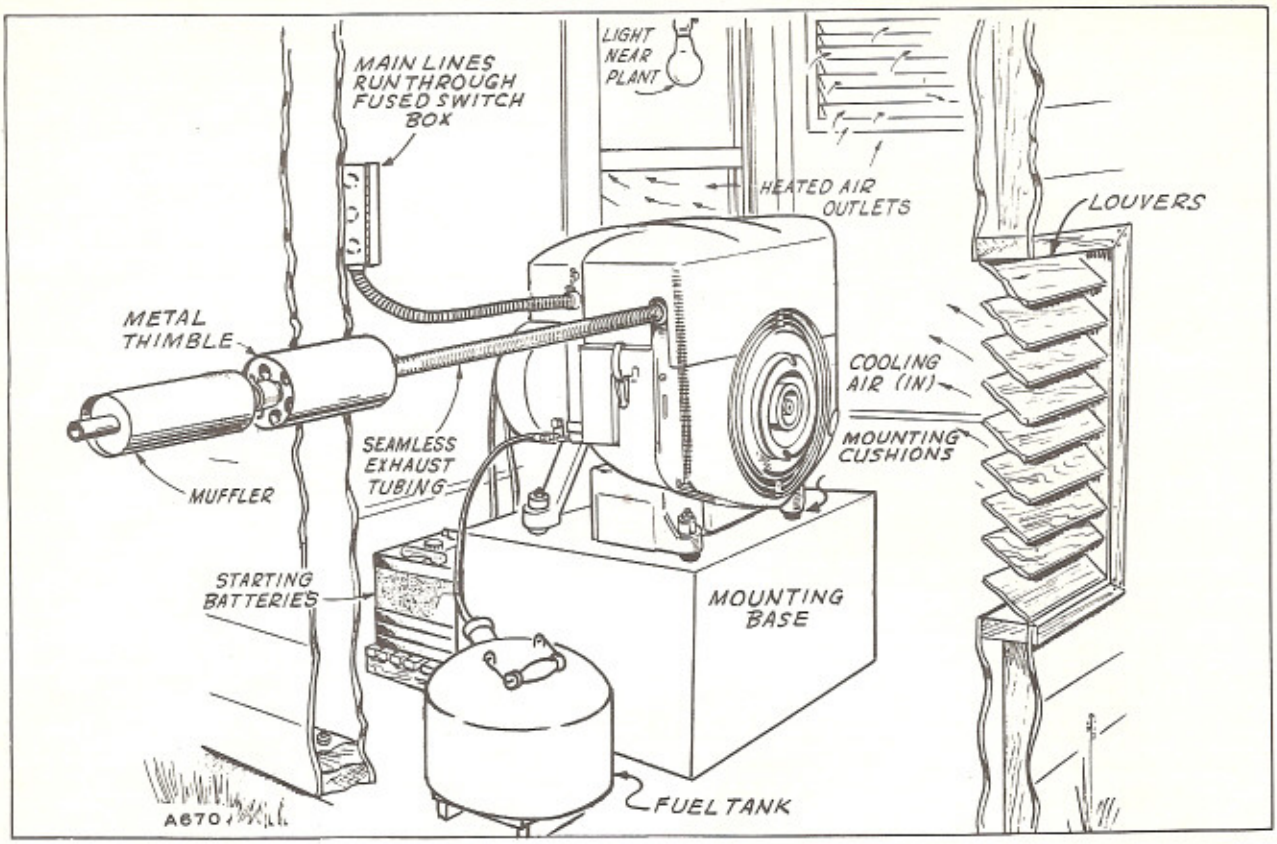

Figure 7. Typical Installation

TABLE 3. PRESSURE COOLING AIRFLOW AND VENTING

PLANT MODEL	RPM	AIR (cfm)	PRESSURE INLET VENT (sq ft)	OUTLET VENT * (sq ft)
AJ-AK	1800	115	1	2
AJ-AK	2400	138	1	2
AJ-AK	3600	224	1-1/2	2-1/2
LK	1800	300	1	2
LKB	3600	-	-	-
CCK	1800	500	2-1/2	5
CCKB	3600	-	-	-
705JB	1800	600	3-1/2	7
12, 15JC	1800	900	5	10
3DJA	1800	400	2-1/2	5
6DJB	1800	600	3-1/2	7
12DJC	1800	800	5	10

* If duct is used and length is more than 8 feet or if there are more than two 90° bends, use Vacu-Flo cooling.

TABLE 4. VACU-FLO AIRFLOW AND VENTING

PLANT MODEL	RPM	AIR (cfm)	INLET VENT (sq. ft)	OUTLET VENT * (sq ft)
AJ-AK	1800	180	1/4	1/8
AJ-AK	2400	240	1/2	
AJ-AK	3600	370	1/2	
LK	1800	450	1	1/6
LKB	3600	-	-	
CCK	1800	750	1	1/6
705JB	1800	600	1-1/3	*1/2
12,15JC	1800	1600	1-3/4	*1
3DJA	1800			*1/2
6DJB	1800			*1/2

* Area of outlet duct. When a long duct (over 8 feet) is used, or if there are more than two 90° bends, increase the duct size 50%. Static pressure in duct should not exceed .2" water column.

The centrifugal fan, if given an adequate source, is capable of easily moving the required volume of air. When a duct is used between the scroll discharge and the outlet vent, its free area must be at least as large as the scroll discharge. The radial cross sectional area of the duct must be increased if air flow is restricted by bends, long runs, screens, or the exhaust pipe. Exhaust pipes running inside Vacu-Flo ducts should be covered with asbestos tape to confine exhaust heat to the exhaust pipe. Ducts may not be needed if natural circulation is adequate, unless air conditioning is involved. The screen used to cover vents must be 1/4" mesh or larger.

Pressure Cooling

Instead of being pulled over the generator and engine, as with Vacu-Flo, cooling air is forced or pushed around the engine and cooling fins, (Fig.9). There is a blower for the engine inside a blower housing, and a separate blower for the generator. Vent sizes and air flow requirements are shown in Tables 3 and 4. The relative location of the inlet and outlet vents, as well as vent sizes, should be well planned, taking into account all factors which might influence air flow. Figure 9 shows a typical pressure cooling system . Figure 21 shows a pressure cooling installation.

The J-Series of engines with pressure cooling have provisions for attaching a duct to the air outlet side of the engine. If such a duct is used, the outlet vent should be at least as large as the cross section of the duct. If a long duct (over 8') is used, or if there are more than two 90° bends, use Vacu-Flo cooling.

Try to avoid 90° bends, if possible. Sweeping turns allow easier air flow.

Suggestions for Quiet Operation

Two types of noise are generally encountered with a generating plant installation; airborne noise and structural noise.

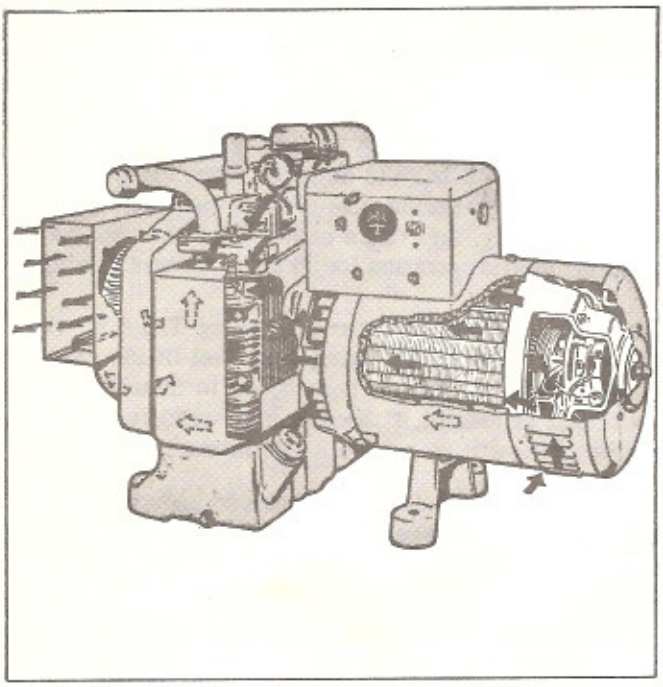

Figure 8. Vacu-Flo Cooling System

The most obvious airborne noise is usually exhaust noise.

If objectionable, this can be reduced by:

1. Using a more efficient muffler. Check with your Onan dealer.
2. Using a flexible exhaust line or adding a flexible section of line near the plant. This flexible line should be used in all installations.
3. Installing an exhaust deflector on the exhaust outlet to deflect exhaust toward the ground.

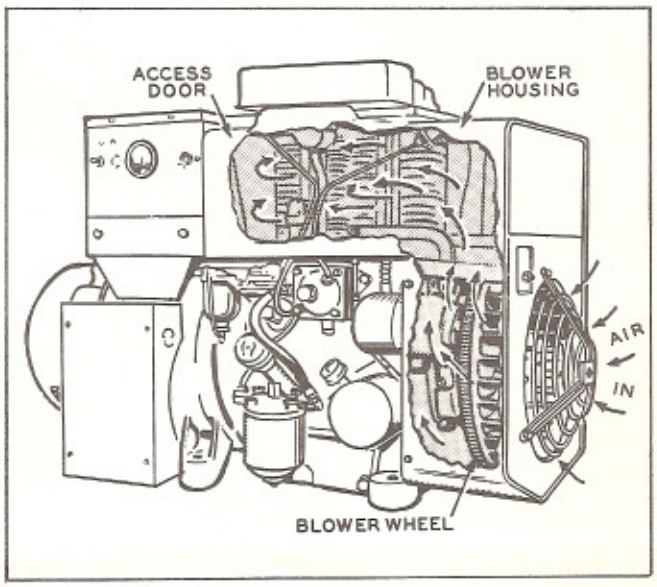

Figure 9. Pressure Cooling System

The plant may be silenced considerably by housing it in a suitable enclosure. If an enclosure is used, vents must be large enough to allow sufficient air flow. If they are too small, overheating could result, with possible plant damage.

Typical enclosures are shown in Figures 10, 11 and 12. Information regarding vent sizes can be obtained from Table 4. It is recommended that only Vacu-Flo plants be placed in enclosure of the types shown.

Adequate clearance must be allowed within the enclosure for plant movement during operation and for servicing the plant when needed.

The enclosure should allow at least 24" of space on each side of the plant for service access, or the enclosure may be hinged. In either case, keep service requirements in mind.

If additional soundproofing is desired, add sound-insulating material to the inside of the enclosure. Line the compartment with material such as fiberglass insulation. Onan supplies a 2" thick material, No. 128P90, and a 1" thick material, No. 128P91. The ceiling of the enclosure must be covered. Seal all openings, cracks and joints. Wiring and pipes must be securely mounted and not vibrate against the structure.

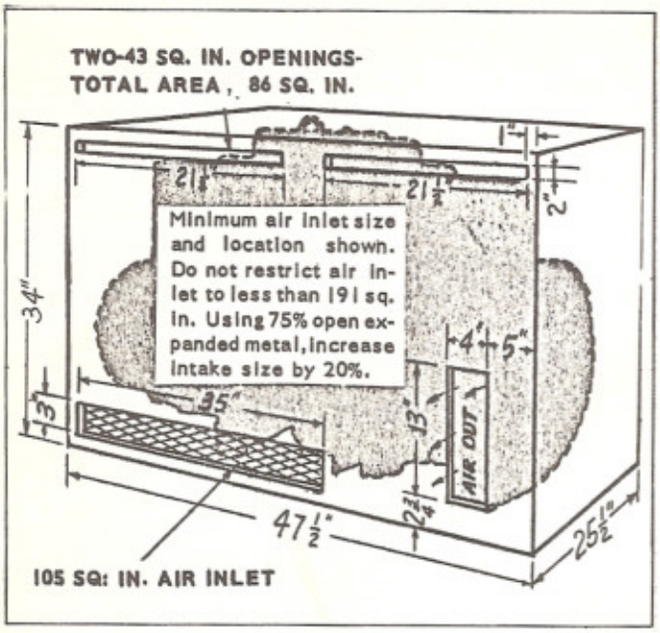

Figure 10. JB Vacu-Flo Enclosure

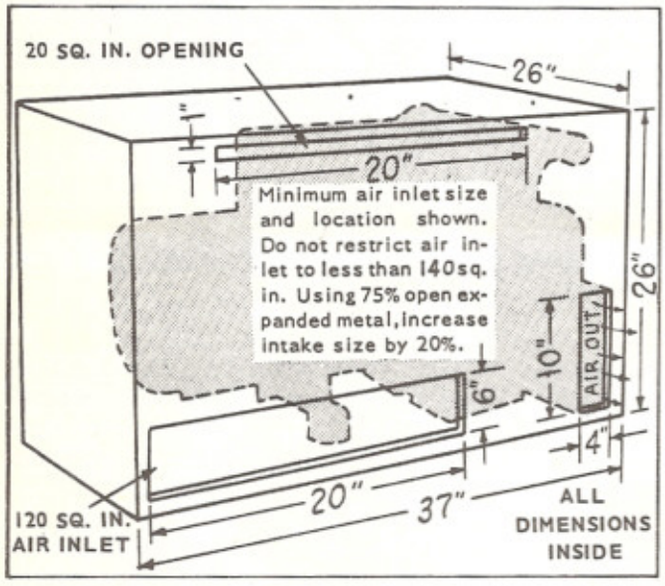

Figure 11. CCK Vacu-Flo Enclosure

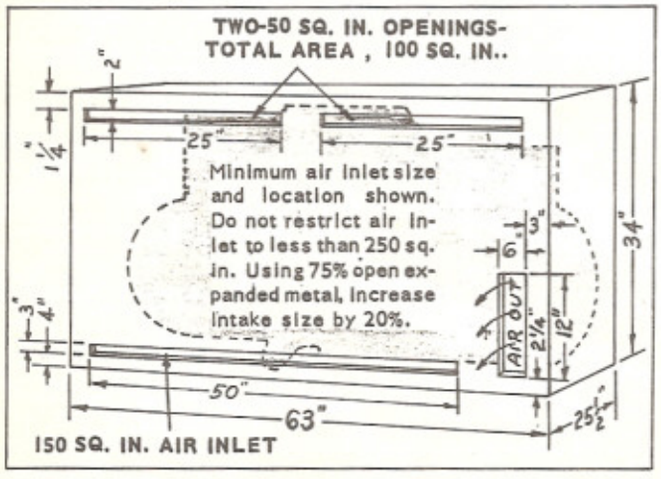

Figure 12. Model JC Vacu-Flo Enclosure

Rubber damper mounts supplied with Onan plants reduce structural vibrations to a minimum. Flexible exhaust fuel and electrical connections will also help reduce them. As a check of connection flexibility, shake the generating plant from side-to-side and end-to-end.

It should rock freely, without hitting anything, including the insulation.

Additional silencing may be obtained by the use of Z-ducting on the air inlet and outlet ducts. Ducts must be larger if this application is used, as more air restriction is encountered.

Factory Housings

Onan-built protective housings are available. Of all-metal construction, those for the Vacu-Flo-cooled AK, AJ, LK and CCK generating plants come complete with fuel tank, carrying handles battery rack and a 3-sided hinged cover hinged to the mounting skid. A control panel is standard equipment.

Models DJA, DJB, DJC, JB and JC are housed in special housings designed for pressure-cooled units. They include a battery rack and a top-mounted muffler as standard equipment. A side panel releases, giving easy access to the plant. The standard control panel is enclosed. Fuel tanks are optional, and may be built into the enclosure, which is skid-mounted.

FUEL SYSTEM

Install the fuel system carefully. The system may be a simple one, as in the case of a plant-mounted fuel tank, or it may have a separate tank with fuel lines running to the plant.

Several factors should be considered when setting up the plant. Consider the plant location, the fuel type, and the hours of continuous operation needed. If the plant must run for long periods of time without an operator, the fuel tank will have to be large enough to supply the engine for the expected time plus an extra safety factor time. Generally, fuel tanks should have the capacity to sustain full load operation for 36 hours without refueling.

The tank size can be figured by using Table 5, which gives fuel consumption figures and fuel-lifting capabilities of different plants. It is better to install a larger tank than is needed, if there is a possibility that more running time will be needed in the future.

Onan can supply Underwriter-approved underground fuel tanks with 55- to 560-gallon capacities. These tanks can accommodate a fill pipe, a vent pipe, a drop tube and two return lines.

Do not use galvanized lines, fittings or fuel tanks in the fuel system. Carefully clean all fuel system components before putting the plant into operation. Any dirt or contamination may cause major damage to the fuel injection system.

FUEL TANK LOCATION

Individual requirements and applicable codes must be considered. Fuel pump lift influences fuel tank location. Consult Table 5 for fuel lift figures and fuel line sizes.

TABLE 5. FUEL LINES, LIFT AND CONSUMPTION

MODEL	GAL. PER HR.	LIFT (FEET)	FUEL LINE SIZE (INCHES) SUPPLY LINE	SUPPLY LINES DAY TANK	SUPPLY LINES FUEL
1AJ	.29	4	5/16	3/8	-
105AK	.53	4	5/16	3/8	-
205AJ	.54	4	5/16	3/8	-
205LK	.42	4	5/16	3/8	-
3CCK	.57	4	5/16	3/8	-
4CCK	.70	4	5/16	3/8	-
4LKB	-	-	5/16	3/8	-
5CCK	.88	4	5/16	3/8	-
5JB	.74	8	5/16	5/16	-
705JB	1.05	8	5/16	5/16	-
10CCKB	-	-	5/16	3/8	-
12JC	1.5	8	5/16	5/16	-
15JC	2.25	8	5/16	5/16	-
3DJA	.36	6	5/16	-	5/16
6DJB	.66	6	5/16	-	5/16
12DJC	1.33	6	5/16	-	5/16

Lifting capabilities are reduced by elbows and bends in the fuel line. Great lateral distances also have a limiting effect. Fuel tanks should not be installed near exhaust pipes. Tanks may be installed above or below the ground. Gravity feed is permitted only from integral tanks of 25 gallons or less. If the tank must be positioned higher than the plant, or contains more than 25 gallons, use an anti-siphon system (Fig.17) for proper operation and safety. If the fuel tank is located below the fuel-lifting capability of the plant, use an electric fuel pump to aid fuel delivery. This system also uses a day tank, shown in Figures 14 and 15. If the anti-siphon system is not used, the top of the fuel tank must be below fuel tank level to prevent siphoning. Install a shut-off valve at the tank. If the fuel tank is shared with another engine, use a separate fuel line for each engine to avoid fuel starvation.

Important: Always use flexible tubing between the engine and the fuel supply or main supply line.

A filter in the line may be necessary. Electric solenoid shut-off valves in the supply line are usually required for indoor automatic or remote starting installations. Connect solenoid wires to battery ignition circuit to open valve during running. Install a demand-type gas regulator according to instructions, and position it near the plant to aid starting.

Diesel engines require a fuel supply line and a separate fuel return line.

For gaseous-fueled plants, check with the local fuel supplier for gas regulations and line pressure. Provide a manual gas valve. Most local codes require a solenoid shut-off valve.

Important: Always use flexible tubing bet ween the engine and the gas-demand regulator.

Figures 22 and 23 show fuel system details and installation of diesel plants.

Float Tank, Diesel

Gravity feed of fuel to some diesel engines is not recommended. Where fuel tanks must be situated above the fuel injector return, a float tank can be used as an intermediary between the main fuel supply and engine. A float valve in the intermediate tank controls fuel flow from the main tank. The maximum allowable fuel head is 25 feet.

Transfer Tank, Diesel

The ability of fuel transfer pumps to move fuel is limited by lateral and vertical distances. A fuel transfer tank and auxiliary fuel pump can be used to overcome certain limitations. A fuel transfer tank is installed with range of the engine driven fuel pump. An electric booster pump, installed close to the supply tank, pumps fuel to the transfer tank. The booster pump is usually controlled by a float switch in the transfer tank. The transfer tank must not be mounted on the engine. Refer to Figure 13.

Day Tank

Installations which demand quick, dependable starting through automatic controls must have a means of keeping the fuel system primed. A day tank mounted on or near the unit provides a small supply of fuel for immediate use by the engine. Refer to Figures 14 and 15.

Day tanks for gasoline systems have a one- or two-quart capacity. Tanks for larger units are pressurized by using a restricted bushing in the return line. The return line also serves as a vent. A solenoid valve is used at the outlet to the carburetor.

Diesel installation have day tanks of from eight- to sixty-gallon capacity.

This illustration only used on 30 KW and up - Water cooled units (has solenoid) Use one like Fig. 21.

Levelometer

The Levelometer is an easy-to-read level-indicating gauge designed for installations in underground fuel tanks up to 12' deep. The gauge operates on the hydrostatic principle, and can therefore be installed at any reasonable distance from the fuel tank. See Figure 16.

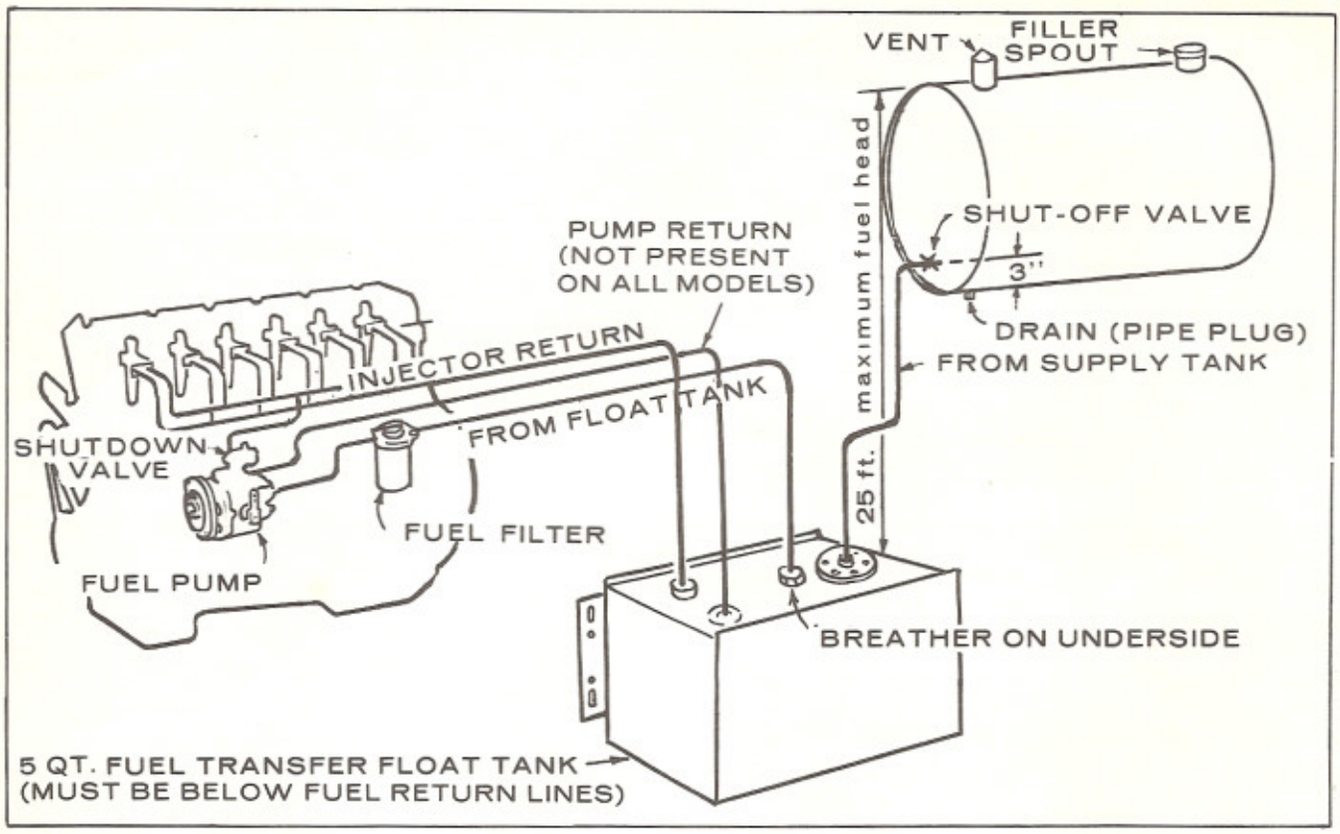

Figure 13. Diesel Transfer Tank

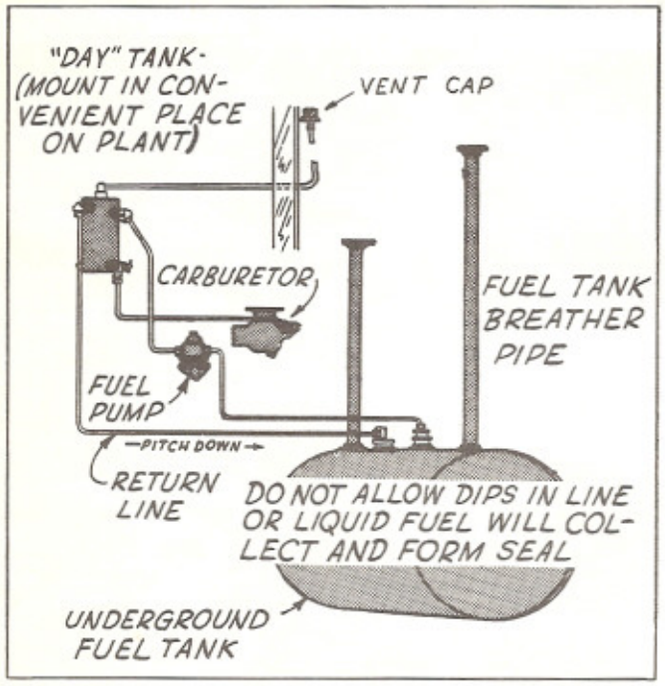

Figure 14. Day Tank

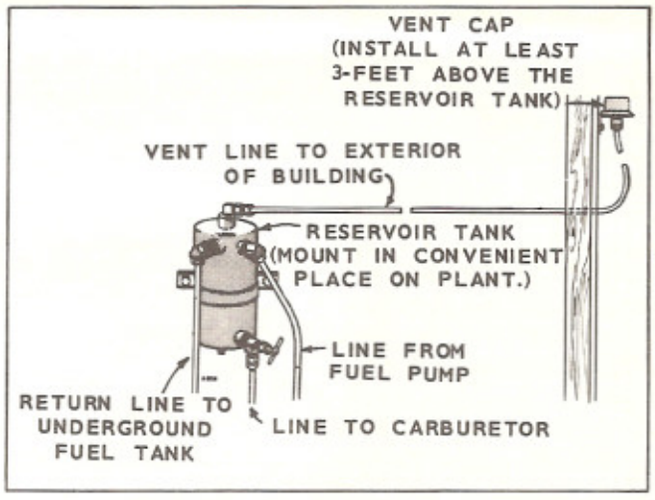

Figure 15. Day Tank Mounting

Anti-Siphon

Fuel from the supply tank fills a void created in the vacuum pipe by the engine fuel pump. The vacuum pipe should be about four times greater in diameter than the line leading from the fuel tank to the vacuum pipe. The vacuum pipe would then be 1-1/4". Refer to Figure 17 for details.

Figure 18 shows the fuel tank fittings recommended by Onan. All fittings must be properly located, and air tight to keep air from getting into the fuel lines.

The general layout of a diesel fuel system is shown in Figure 19. Notice that a diesel system requires both a fuel suction line and a fuel return line.

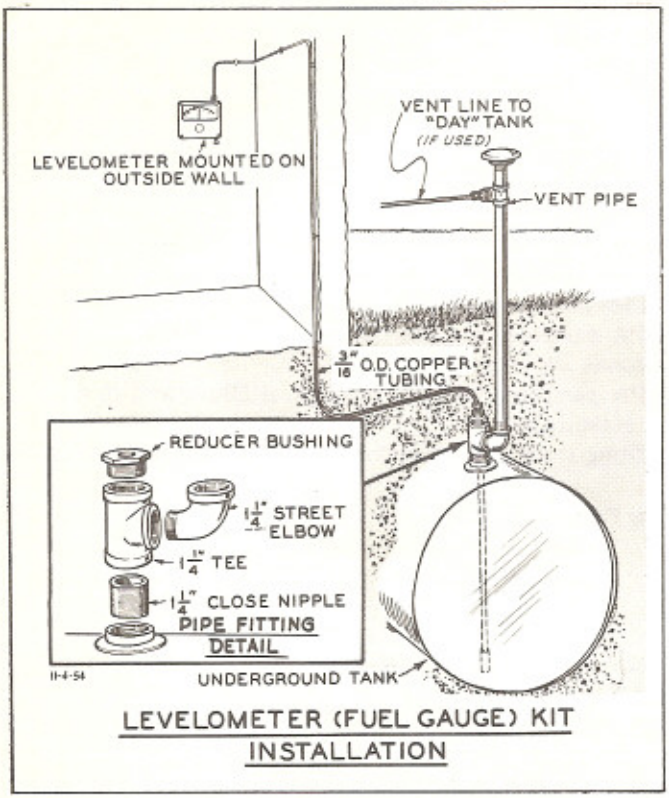

Figure 16. Levelometer Installation

BATTERY

Follow battery recommendations. If plant is to have two 6-volt batteries, use them. A 12-volt battery will not do as well, as it cannot deliver as much current as two good 6-volt batteries.

Mount battery (or batteries) on a wood or metal platform near the unit, but not beneath the generator. Use proper size battery cables and keep cable length as short as practicable. Coat battery terminal connections with grease to prevent corrosion. Check the electrolyte level periodically. Run the engine immediately after adding water to the battery during cold weather.

Trickle chargers are recommended for units which are run too seldom to maintain batteries in a fully-charged condition. Trickle chargers reduce utility voltage to 20 volts. Full wave rectification converts the power to dc. The dc is fed through a resistor, a charge-rated rheostat and a milliammeter into the battery at the rate of 50 to 200 milliamperes.

WIRING

All wiring must be in accordance with applicable electrical codes. Wires must be of adequate size, properly

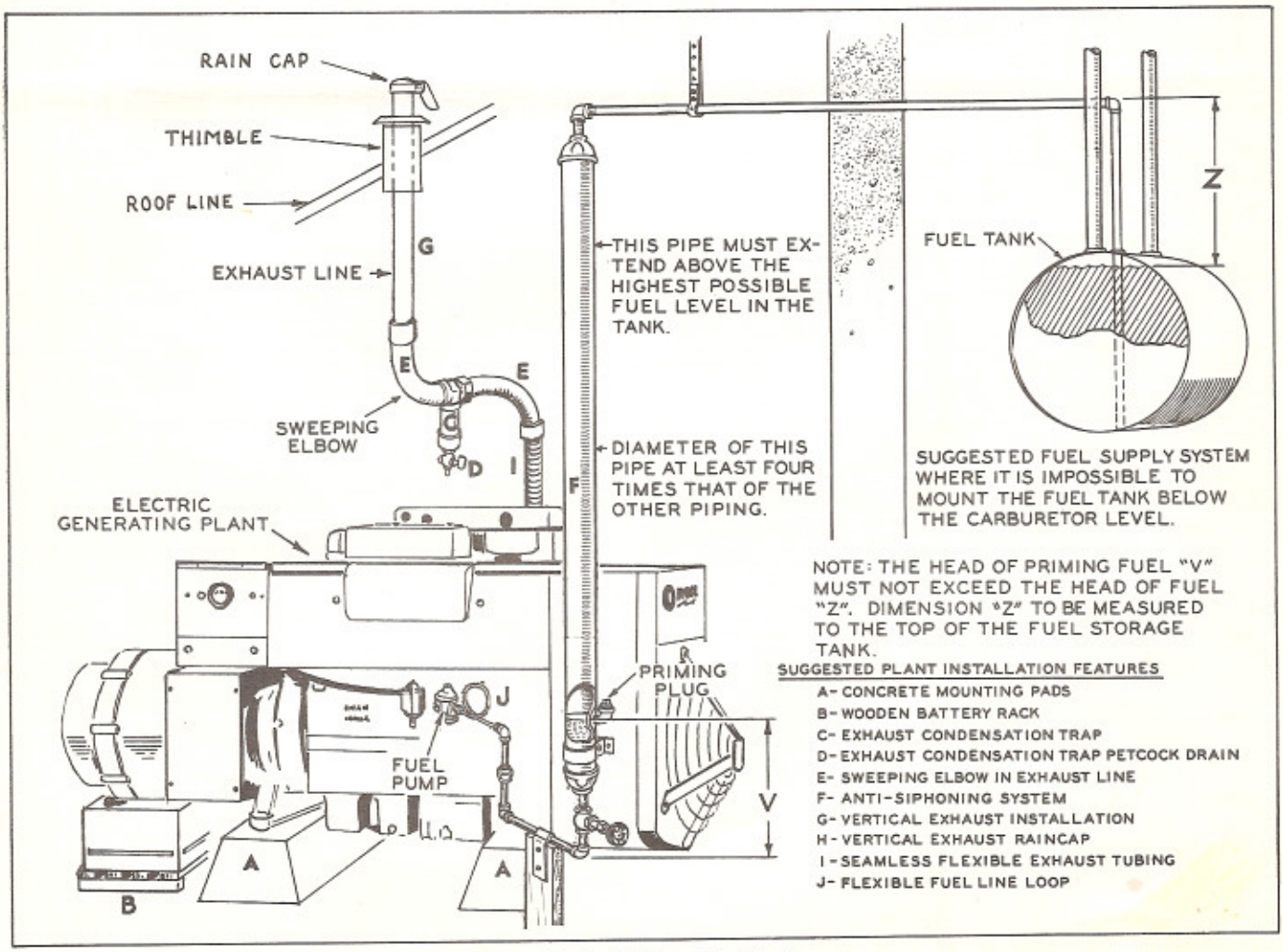

Figure 17. Anti-Siphon Installation

insulated and supported in an approved manner. Wires are easily run in any direction, and should not be placed where they can interfere with plant operation.

LOAD TRANSFER CONTROL

Onan Load Transfer Controls range from 30 to 2000 amperes in capacity. The transfer switch within the control is mechanically and electrically interlocked. Both lines and standby cannot be connected to the load simultaneously.

Transfer switches in the smaller controls are electrically held to the load side. Transfer switches in the larger controls are mechanically held to the load side.

Mount the control on an outside wall near the electrical load. Refer to Onan Technical Bulletin T-011 for detailed information.

BIBLIOGRAPHY

NFPA pamphlet no. 30, "Storage, Handling, and Use of Flammable Liquids"
NFPA pamphlet no. 37, "Installation and Use of Internal Combustion Engines"
NFPA pamphlet no. 54, "Installation of Gas Piping and Gas Appliances in Buildings"
NFPA pamphlet no. 58, "Storage and Handling of Liquefied Petroleum Gases"
NFPA pamphlet no. 70, "Nations Electrical Code" National Building Code.
NFPA pamphlet no. 76, "Essential Electrical Systems For Hospitals"
Building Code Standards for Heat Producing Appliances etc.
Fire Prevention Code.

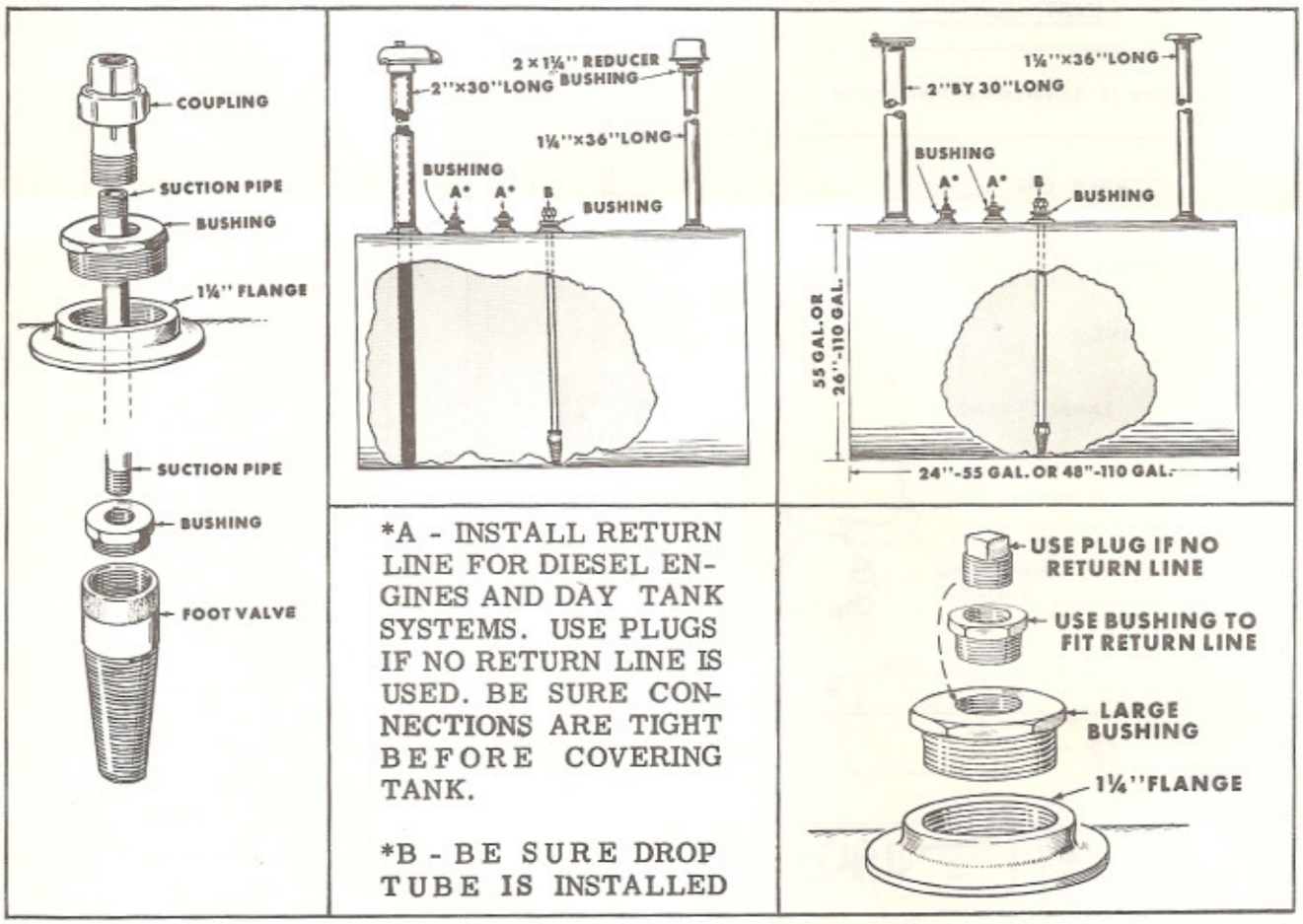

Figure 18. Fuel Tank Fittings

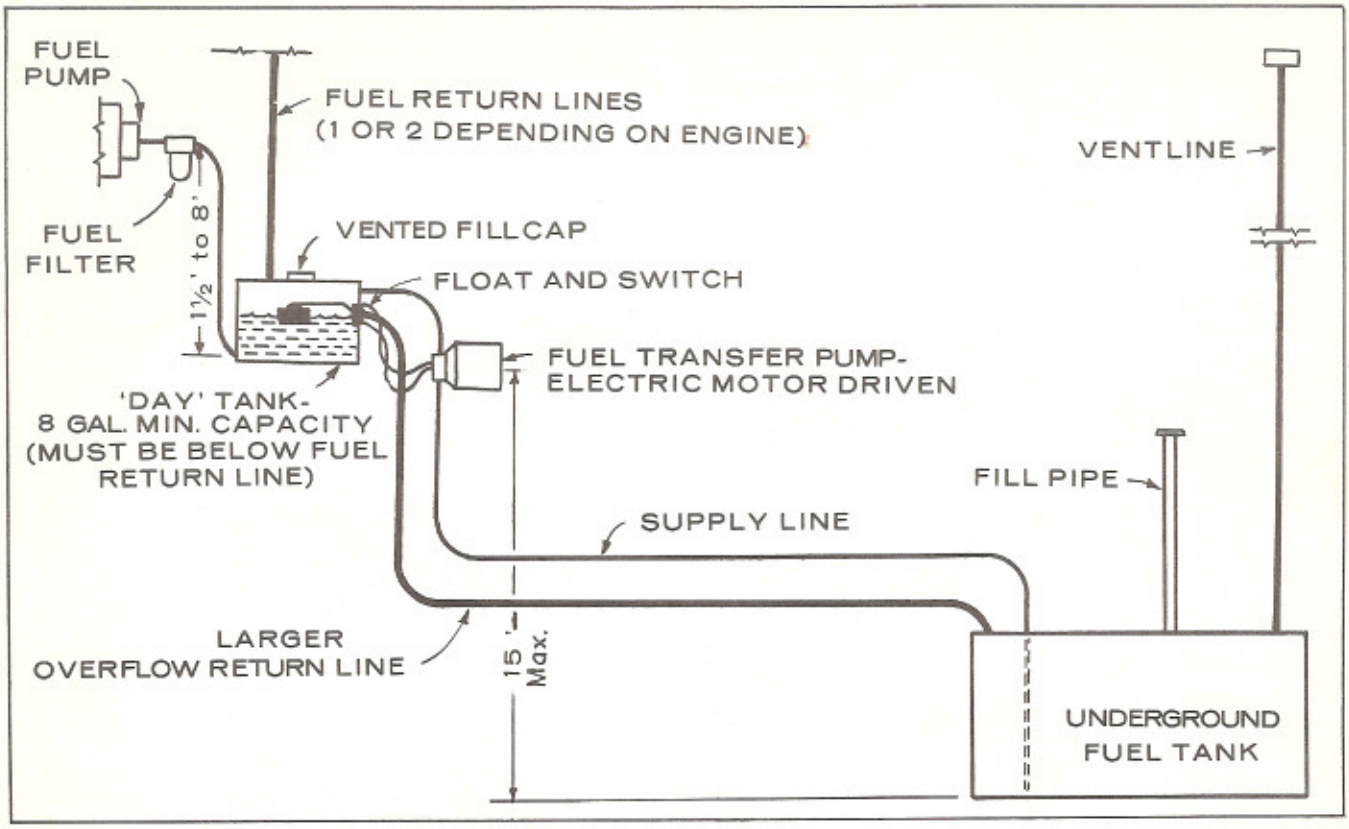

Figure 19. Diesel Fuel System

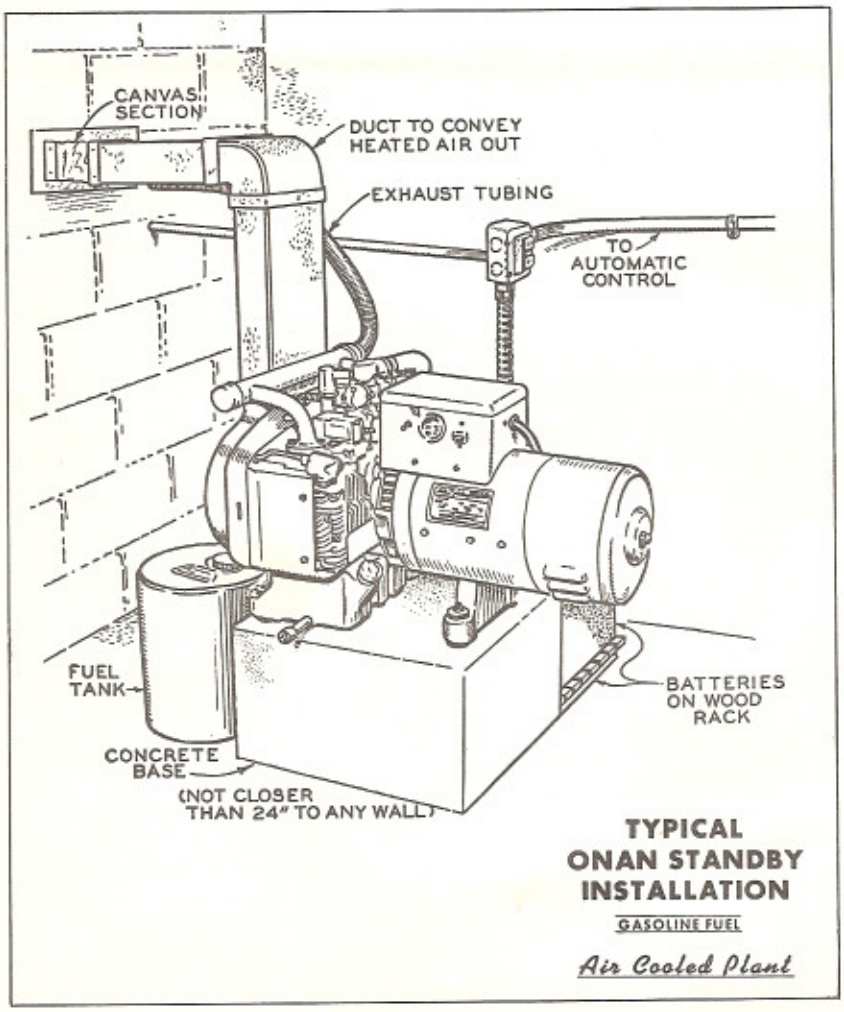

Figure 20. Typical Installation (Vacu-Flo)

NOTE: IF REVOLVING-FIELD-TYPE PLANT IS INSTALLED IN SMALLER THAN APPROXIMATELY 384 CU. FT. COMPARTMENT, DUCT GENERATOR HEATED AIR TO OUTSIDE.

DO NOT JOIN WITH DUCT FOR ENGINE HEATED AIR.

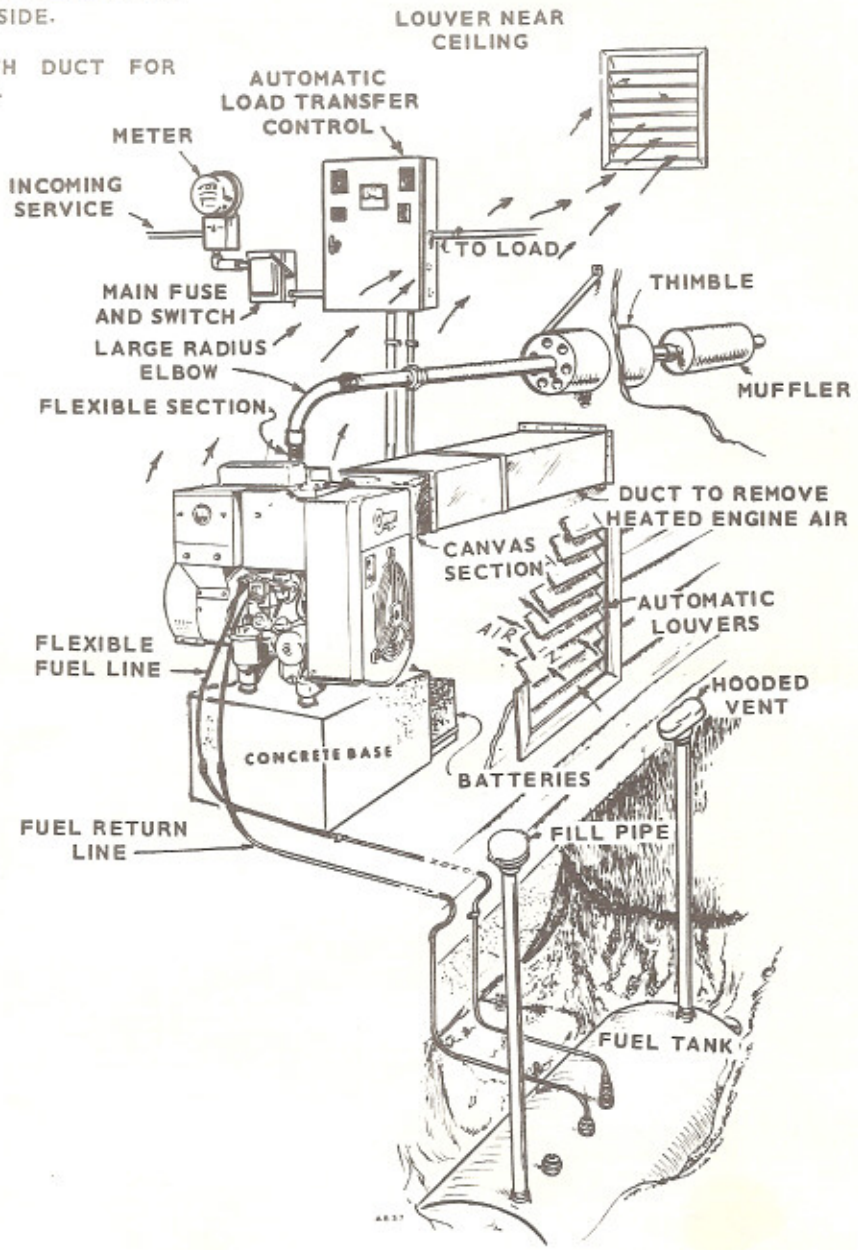

Figure 2 I. Typical Installation (Pressure)

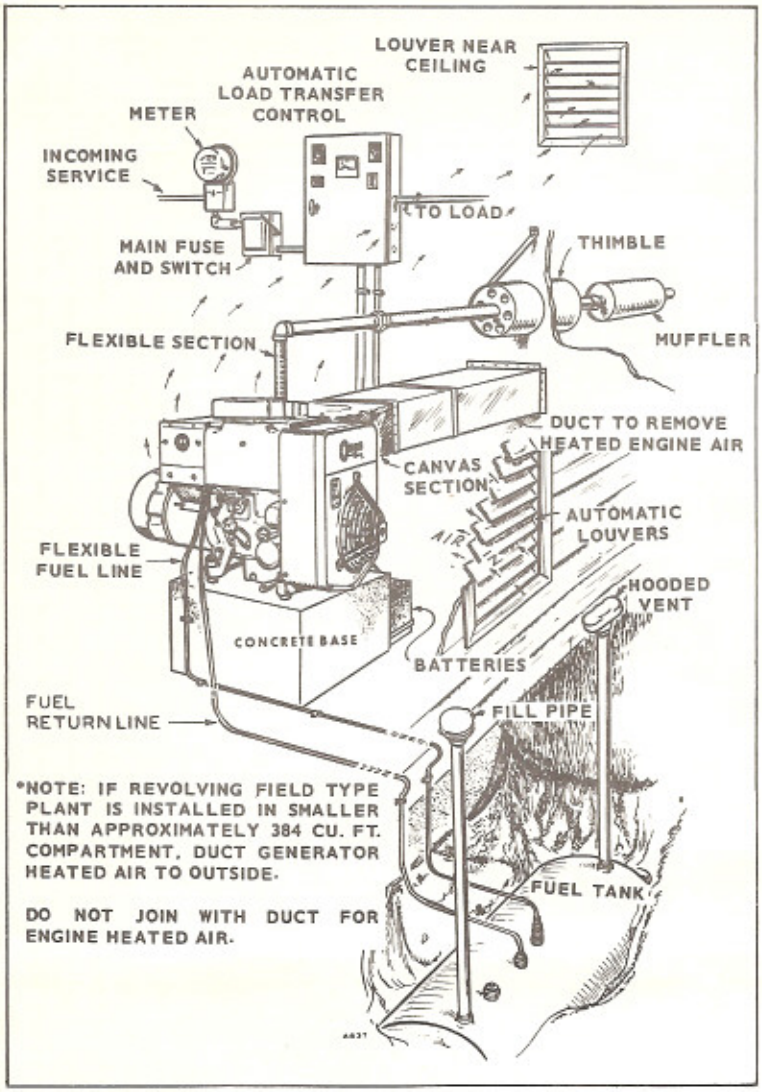

Figure 22. Fuel Tank Installation

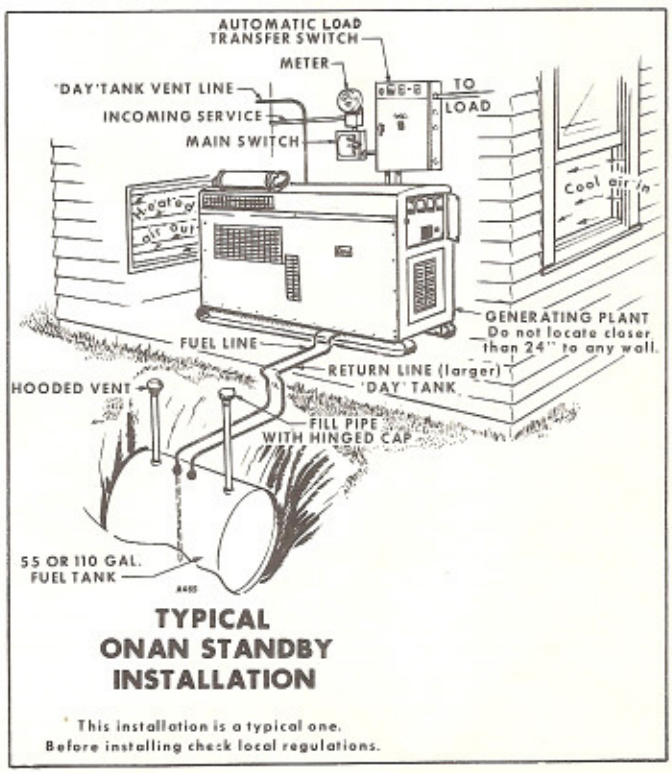

Figure 23. Fuel System and Enclosure Details