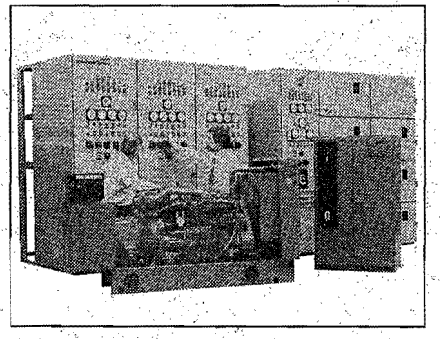
Onan

Technical Bulletin



Installation Information

for
Air Cooled
GenSets

3/88 T-029

Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and your equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE. Fire and explosion can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR ALLOW AN OPEN FLAME near the generator set or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands away from moving parts.
- Before starting work on the generator set, disconnect starting battery ground (-) lead first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing near moving parts, or jewelry while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages cause injury or death. DO NOT tamper with interlocks.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.

GENERAL SAFETY PRECAUTIONS

- Provide appropriate fire extinguishers and install them in convenient locations. Consult your local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguisher rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which present a potential fire hazard.
- Keep your generator set and the surrounding area clean and free from obstructions. Remove any debris from set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

SCOPE

This bulletin presents installation information for air-cooled GenSets. The bulletin consists of detailed safety precautions, mounting methods, ventilation and cooling systems, fuel systems, exhaust systems, and electrical systems. Also included are a glossary of terms, a standards index, an installation checklist and cranking and running checks.

Onan products appear on the world market. The following terms, both English and SI Metric units, are used.

Term	English	Multiplier	SI Metric
Dimensions	inch (in.)	25.4	millimeter (mm)
	inch (in.)	0.0254	metre (m)
	square inch ($in.^2$)	6.451	square metre (m^2)
Pressure	pounds per square inch (psi)	6.894	kilopascals (kPa)
	foot pounds (ft-lb)	1.356	Newton metre (N•m)
Density	pounds per cubic foot (lb^3)	1.602	kilograms/metre cubed (Kg/m^3)
Flow Rate	cubic feet per minute (cfm)	35.31	metre cubed per minute (m^3/min)
Mass (Weight)	pounds (lb)	0.4536	kilogram (kg)
Volume (Liquid)	gallon (gal)	3.7852	litre (L)
	Gal/Min.	3.7852	litre/Min.
Power	horsepower (HP)	0.746	kilowatt (kw)
Energy	British Thermal Unit (BTU)	1055.	Joules (J)
Temperature	Fahrenheit (F)	(°F-32) x 5/9	Celsius (C)
Frequency	cycles per second (cps)	None	hertz (Hz)

The customary unit of horsepower (HP) becomes kilowatts (kW) when converted to SI metric units. Do not confuse this kW rating with the kW rating of generators or motors which is always lower due to losses inherent with any electrical induction device.

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LIST OF FIGURES

Mounting

LOCATION

Generator set (GenSet) location is decided chiefly by related systems such as ventilation, wiring, fuel, and exhaust. Provide a location away from extreme ambient temperatures, protecting the GenSet from adverse weather conditions, yet as near as possible to the main power fuse box.

Plan for adequate access to the GenSet for service and repair with lighting facilities around the unit. Wood floors should be covered with sheet metal extending 12 inches (305 mm) beyond the extremeties of the GenSet.

GROUNDING LOADING

A proper mounting foundation must be calculated based on the total weight of the GenSet (includes fuel and oil), together with the structure of the ground or subfloor loading.

WEIGHTS

Liquid	Lb/U.S. gal (kg)	Specific Gravity
Lube Oil	**7.6 (3.45)**	**0.916**
Diesel Fuel	**7.1 (3.22)**	**0.855**
Gasoline	**5.9 (2.66)**	**0.702**

The ground or subfloor supporting the foundation must carry the total weight. Ground or subfloor loading is determined by the type of surface material. Bearing load capabilities of specific materials are defined in engineering manuals relative to foundation design.

MOUNTING

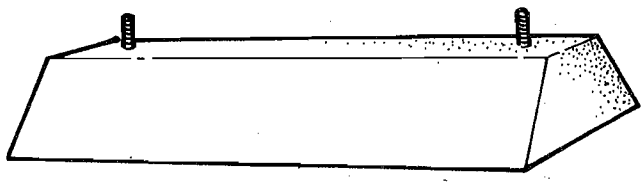
Mount the GenSet on a substantial and level base such as a concrete pad. Secure units not mounted on skids. Mount skid-mounted units on raised foundations. Foundations facilitate service and repair and protect the unit from seepage. Figure 1 shows typical foundations.

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

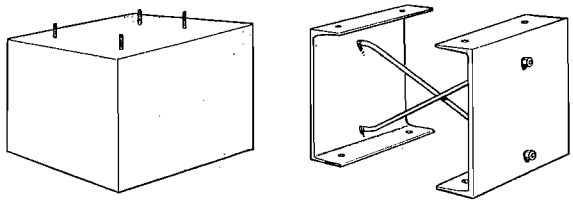
A typical foundation concrete mixture by volume is 1:2:3 of cement, sand, aggregate, with a maximum four (4) inch (101.6 mm) slump and 28-day compressive strength of 2500 psi (173 kPa).

Those installations requiring foundation reinforcement should use steel wire mesh (No. 8 gauge) or equivalent horizontally placed on six (6) inch (152.4 mm) centers. Alternately, use steel reinforcing bars (No. 6 gauge) or equivalent, horizontally placed on 12 inch (305 mm) centers. Steel wire mesh or steel bars should be below the foundation surface a minimum of three (3) inches (76 mm).

Mounting large units on foundations is optional but strongly 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 unit.



TAPERED CONCRETE BLOCK



POURED CONCRETE STEEL BEAM SECTIONS

FIGURE 1. TYPICAL MOUNTING FOUNDATIONS

VIBRATION CONTROL

Provisions for isolating vibration are available on all Onan units. Figure 2 shows a cone-mount vibration isolator used with most Onan air-cooled units. A tubular-mount vibration isolator is also used on some sets (see Figure 3). The mounting floor or base should be flat and give direct support under the GenSet's mounting feet.

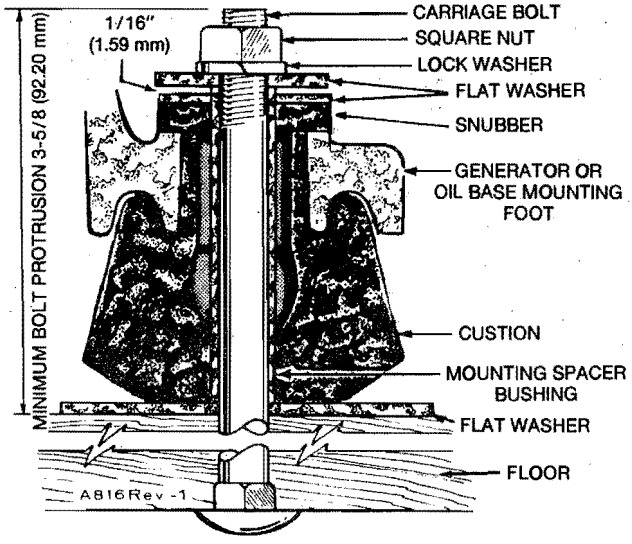


FIGURE 2. CONE-MOUNT VIBRATION ISOLATOR

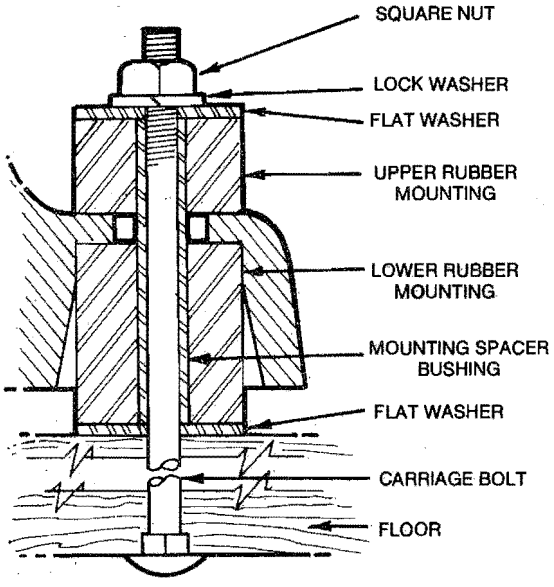


FIGURE 3. TUBULAR VIBRATION ISOLATOR

NOISE CONTROL

You can attenuate exhaust noise by using proper mufflers. To attenuate other noises, use line-of-sight barriers, total acoustical enclosures, sound attenuating duct treatment, or install the GenSets away from critical areas. Onan does not supply acoustical enclosures, but there are companies which supply such equipment.

Equipment	Sound Level Reduction dB (A) (Approximate)
Vibration Isolators	2
Baffle (Single Wall Barrier)	5
Absorption Material (Walls and Ceiling)	5
Rigid Sealed Enclosure (Walls and Ceiling)	15-20
Rigid Sealed Enclosure (Walls and Ceiling) and Vibration Isolators	25-30
Rigid Sealed Enclosure (Walls and Ceiling), Vibration Isolators and Absorption Material (Walls and Ceiling)	35-40
Double Walled Rigid Sealed Enclosure (Walls and Ceiling), Vibration Isolators and Absoprtion Material (Walls and Ceiling)	60-80

Ventilation and Cooling

VENTILATION

Ventilating systems must function to provide enough fresh air at the GenSet for efficient cooling and combustion. In addition to removing engine heat and replacing combustion air, the ventilating system has to remove heat produced by the GenSet and other equipment in the same general areas. When designing the system, consider prevailing wind direction, ambient temperature, sound principles of duct design and all other factors that might influence airflow and circulation.

Generally, there has to be an inlet and an outlet in the room for circulation. Arrange these vents so air cannot escape without first passing through the immediate area of the installation. Locating the outlet slightly higher than the inlet allows for convection air-current flow.

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

If free airflow is in any way inhibited by louvers or screens, increase the vent areas 1/4 to 1/2 times. Wind can also restrict free airflow if it blows directly into the outlet vent. Unless the wind blows regularly, this factor is of only marginal importance.

Thermostatic shutters can control airflow to maintain a desirable temperature range. They regulate airflow during operation and close at shutdown. Closing at shutdown 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.

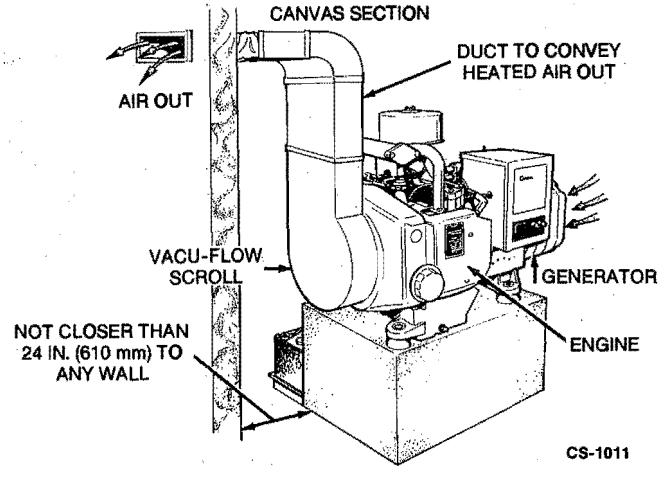


FIGURE 4. TYPICAL INSTALLATION (VACU-FLO COOLING)

Of vital importance is avoiding a situation that leads to recirculation of cooling air. If the inlet air temperature is 10°F/6°C above the ambient temperature, there is a good possibility of cooling air being recirculated. Take steps during installation planning to avoid this problem.

AIR COOLING SYSTEMS

All engines require air for combustion and for cooling purposes (this bulletin covers air-cooled engines only). Onan manufactures air-cooled GenSets with AC output capacities from 1,000 to 15,000 watts. Two methods of air cooling are used in these units depending on their use: (1) pressure cooling, and (2) Vacu-Flo cooling.

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 is called pressure cooling.

Vacu-Flo® Cooling

A fan in the generator end bell pulls in cooling air. As cooling air passes through the generator, it picks up heat produced by the generator and directs the air out of the engine end of the generator. A centrifugal fan in the Vacu-Flo scroll housing on the engine (Figure 5) pulls in cooling air at the generator end of the engine. The cooling air picks up heat from the engine and passes the heated air into the Vacu-Flo scroll where it is forced away from the installation area.

⚠WARNING ***Do not use discharged Vacu-Flo air for heating because it may contain carbon monoxide and other poisonous gases which may result in serious personal injury or death.***

The centrifugal fan, if given an adequate air source is capable of easily moving the required volume of air. When a duct is used between the scroll discharge and outlet vent (must be flexible enough to provide unit movement), its free area must be at least as large as the scroll discharge. Increase the radial cross sectional area of the duct if airflow is restricted by bends, long runs, screens, or the exhaust pipe (pressure buildup results in power loss and overheating).

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-inch (6.4-mm) mesh or larger.

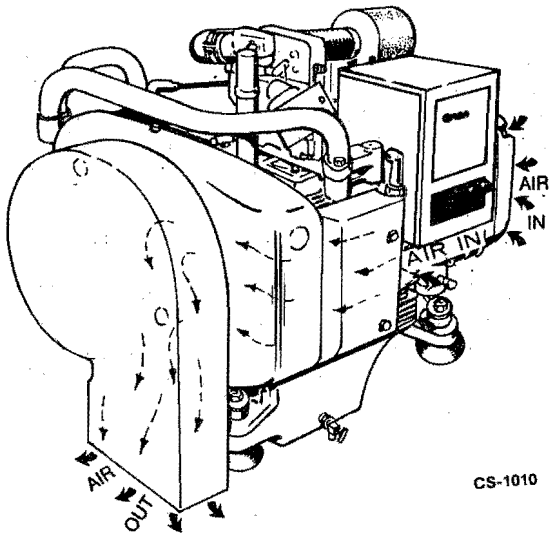


FIGURE 5. VACU-FLO COOLING SYSTEM

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 (Figure 6). There is a blower for the engine inside a blower housing and a separate blower for the generator. 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 airflow. Figures 6 and 7 show a pressure cooling installation.

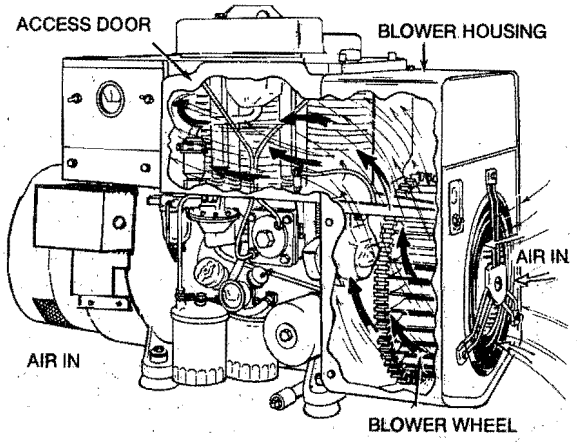


FIGURE 6. PRESSURE COOLING SYSTEM

Onan J-series engines with pressure cooling have provisions for attaching a duct to the air outlet side of the engine. With such a duct, the outlet vent should be at least as large as the cross section of the duct. If a duct over 8 feet (2.4 m) is used or if there are more than two 90 degree bends, use Vacu-Flo cooling.

Avoid 90 degree bends whenever possible. Large sweeping turns allow easier airflow.

DAMPERS

Damper or louvers protect the GenSet and equipment room from the outside environment. Their operation of opening and closing should be controlled by the operation of the GenSet(s). There are four main categories of dampers:

1. Automatic - The dampers open any time the GenSet runs.
2. Manual - This damper is opened and closed manually.
3. Thermostatically controlled - This damper is controlled by thermostats which sense air outlet temperatures.
4. Fixed - This damper is permanently open and cannot be closed.

In cooler climates, movable or discharge dampers are used. These dampers allow the heated air to be recirculated back to the equipment room. This enables the equipment room to be heated while the GenSet engine is still cold, increasing the engine efficiency.

SUGGESTIONS FOR QUIET OPERATION

Two types of noise are generally encountered with a GenSet installation, airborne noise and structural noise. 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 GenSet. This flexible line should be used in all installations.
3. Installing an exhaust deflector on the exhaust outlet to deflect exhaust toward the ground.

Housing a GenSet in a suitable enclosure can silence it considerably. If an enclosure is used, vents must be large enough to allow sufficient airflow. If they are too small, overheating could result with possible unit damage.

Typical enclosures are shown in Figures 8,9, and 10. It is recommended that only Vacu-Flo units be placed in enclosures of the types shown.

Adequate clearance must be allowed within the enclosure for unit movement during operation and for servicing when needed. The enclosure should allow at least 24 inches (610 mm) of space on each side of the GenSet for service access, or the enclosure may be hinged. In either case, keep service requirements in mind.

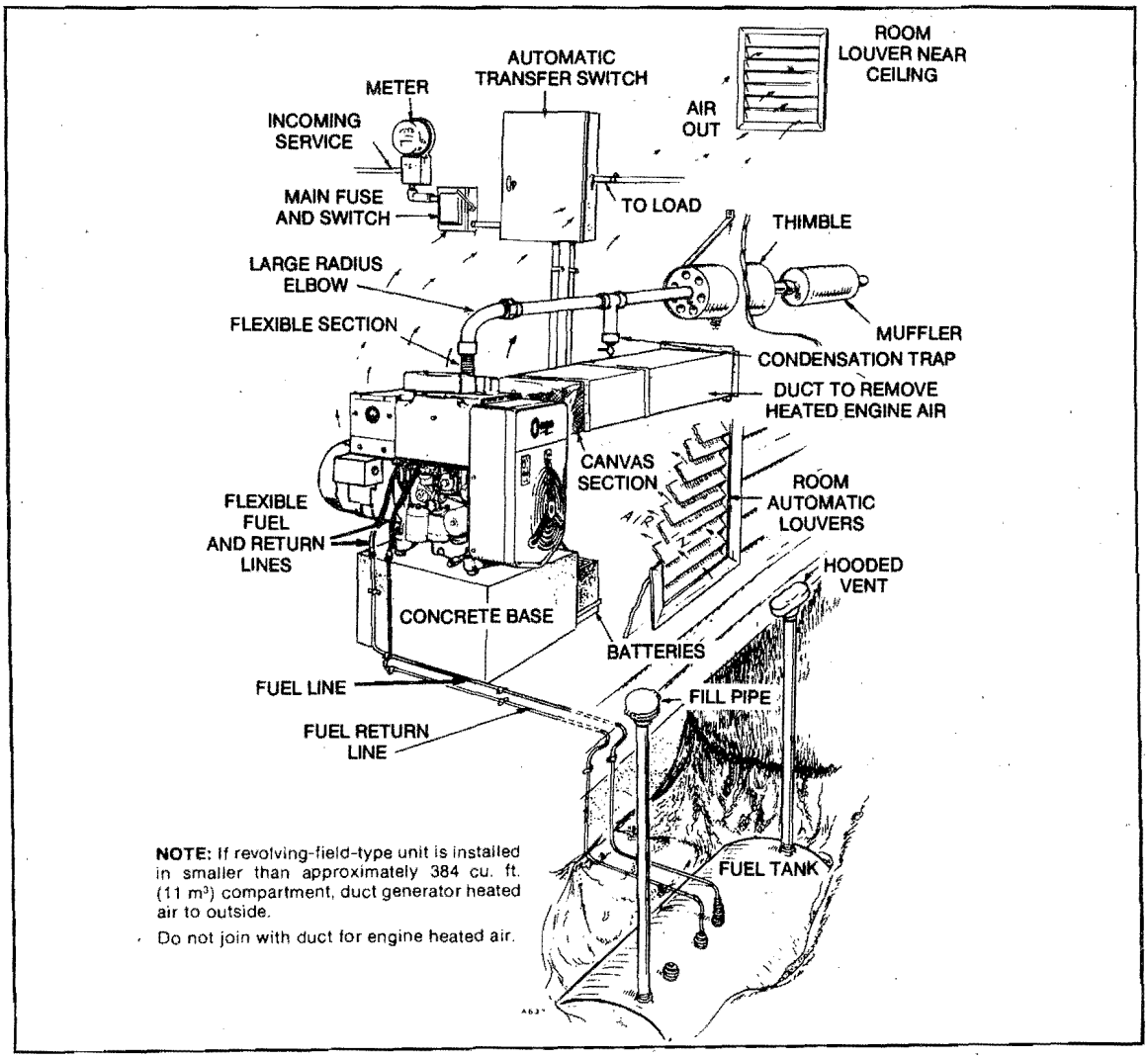
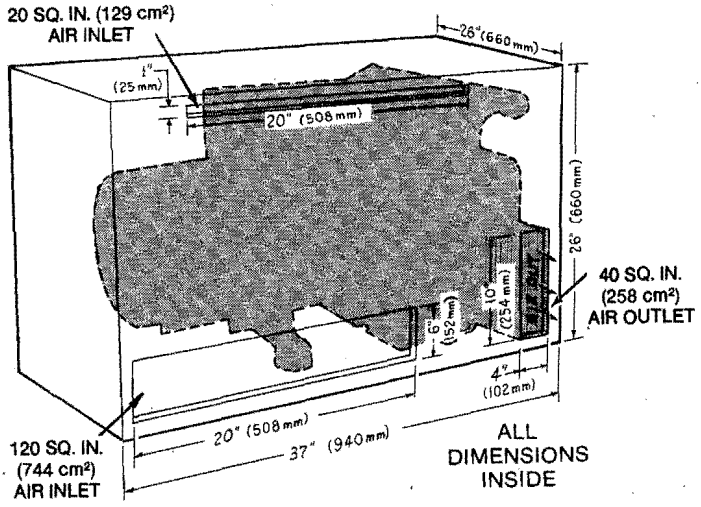
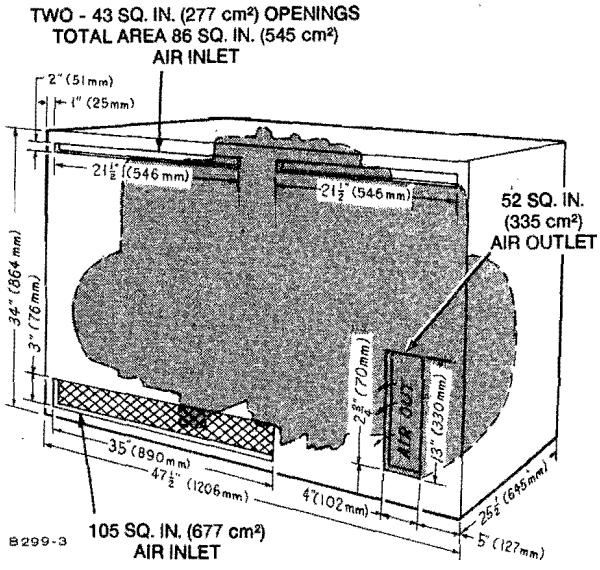


FIGURE 7. TYPICAL INSTALLATION (PRESSURE COOLING)



Minimum air inlet size and location shown. Do not restrict air inlet to less than 140 sq in. (903 cm²). Using 75% open expanded metal, increase intake size by 20%.

FIGURE 8. SMALL VACU-FLO ENCLOSURE



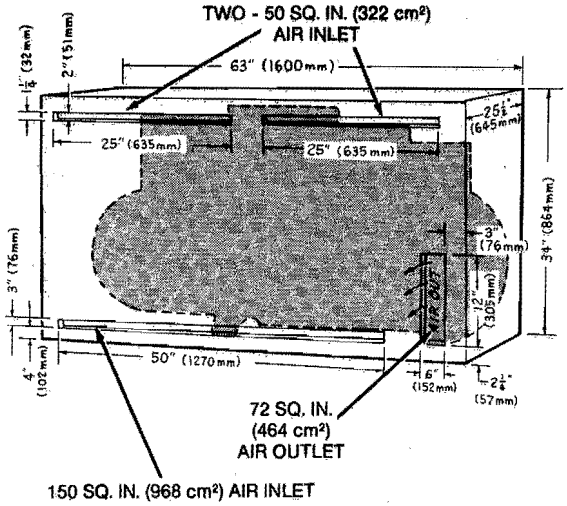
Minimum air inlet size and location shown. Do not restrict air inlet to less than 191 sq in. (1232 cm²). Using 75% open expanded metal, increase intake size by 20%.

FIGURE 9. MEDIUM VACU-FLO ENCLOSURE

If additional soundproofing is desired, add sound-insulating material to the inside of the enclosure. Line the compartment with fire resistant material such as fiberglass insulation. Onan supplies a 2 inch (51 mm) thick material and a 1 inch (25 mm) thick material. 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.

Rubber vibration isolators supplied with Onan units reduce structural vibrations to a minimum. Flexible exhaust, fuel and electrical connections also help reduce vibrations. As a check of connection flexibility, shake the GenSet from side-to-side and end-to-end. It should rock freely without hitting the surrounding material.

Additional silencing may be obtained by the use of Z-ducting on the air inlet and outlet ducts. This application requires larger ducts due to greater air restrictions.



Minimum air inlet size and location shown. Do not restrict air inlet to less than 250 sq in. (1612 cm²). Using 75% open expanded metal, increase intake size by 20%.

FIGURE 10. LARGE VACU-FLO ENCLOSURE

FACTORY HOUSINGS

Onan-built protective housings are available. Those for the Vacu-Flo-cooled GenSets come complete with carrying handles, battery rack and a three-sided cover hinged to the mounting skid. A control panel is standard equipment.

Some models 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 gives easy access to the unit. The standard control panel is enclosed. Fuel tanks are optional and may be built into the enclosure.

Fuel System

For gaseous fuel systems such as natural, manufactured, or LP gas, see technical bulletin T-015, *"USE OF GASEOUS FUEL WITH ONAN ELECTRIC GENSETS"* for installation information.

⚠WARNING ***Fuel leaks create fire and explosion hazards which can result in severe personal injury or death. Carefully design and install the fuel system observing applicable codes.***

STORAGE TANKS

Tank Size

If the GenSet must run unmonitored for long periods of time, the fuel tank should 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 of the GenSet for 36 hours without refueling.

Determine tank size by referring to the specification which gives fuel consumption for GenSet operation at full load. Fuel lifting capabilities are also stated. Onan can supply above ground fuel tanks with 55- to 560-gallon (208 to 2120-litre) capacities. These tanks can accommodate a fill pipe, vent pipe, drop tube and two return lines.

Tank Location

The fuel tank can be installed above or below the ground but locate it near as possible to the GenSet in accordance with code restrictions. Because the fuel pump influences fuel tank location check (refer to specification) fuel pump lift. If the sum of fuel pressure drop and vertical lift exceeds the lift capabilities of the standard fuel pump use an auxiliary fuel pump and day tank.

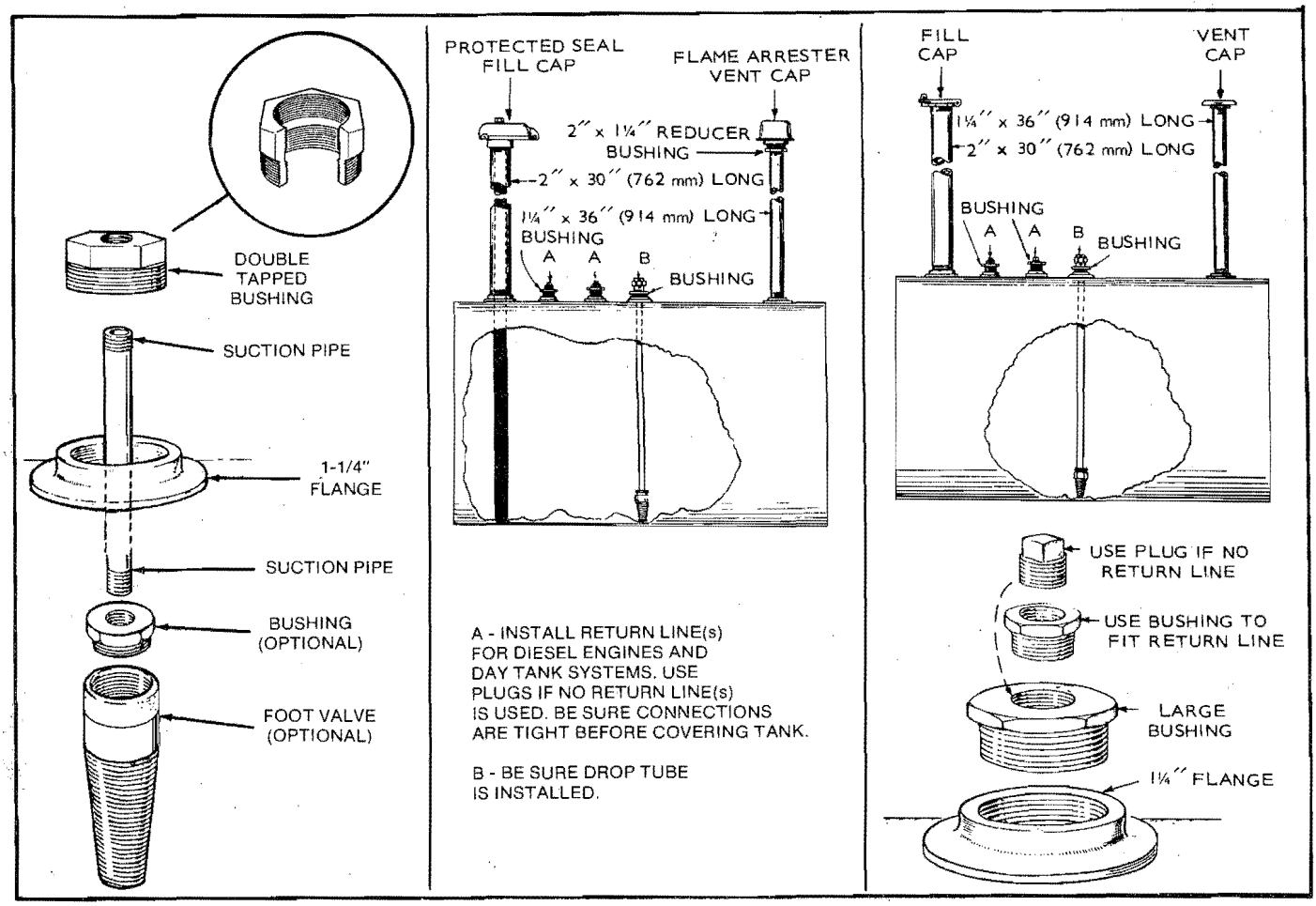


FIGURE 11. FUEL TANK FITTINGS

Day Tank

⚠WARNING ***Because of fire hazard which can result in severe personal injury or death, never install a fuel tank or fuel line near exhaust pipes.***

Day tanks are fuel transfer tanks used when the standard engine fuel pump hasn't the necessary lift to draw fuel from the supply tank (auxiliary pump is also required). For overhead fuel tanks, day tanks are used to remove fuel head pressures which otherwise would be placed on the engine fuel system components. See *"Diesel Day Tanks" or "Gasoline Day Tanks,"* whichever applies.

National Fire Prevention Bulletin No. 37 specifies that gravity feed of fuel is permitted only from integral tanks of 25 gallons (94.6 litres) or less. If the fuel tank is located higher than the GenSet and gravity feeds directly to the unit fuel pump, use an anti-siphon system for proper operation and safety with gasoline systems (See *"Gasoline Anti-Siphon System"*).

Primer Tank

A gasoline primer tank replenishes fuel evaporated from the carburetor of gasoline GenSets which require quick, dependable starts. See *"Gasoline Primer Tanks"* for more information.

Tank Fill and Vent Pipe

Figure 11 shows typical fuel tank fittings for the fill and vent pipes. If the fuel tank is underground, height of the pipes may vary. Make sure the fittings are air and moisture tight. Use a removable wire screen in the fill pipe neck, about 1/16-inch (1.6 mm) mesh, to trap contaminants whenever the tank is filled. The vent pipe must be high enough to meet fume abatement requirements.

Levelometer

The levelometer, available from Onan, is an easy-to-read fuel level indicating gauge. It functions with underground fuel tank installations up to 12 feet (3.7 m) deep. The gauge senses the fuel level hydrostatically, by pressure changes. See Figure 12.

Low Level Alarm Switch

The low level alarm switch S.P.D.T. (single pole double throw), available from Onan, accurately senses the fuel level hydrostatically, by pressure changes. See Figure 13. An alarm circuit (customer supplied) can be activated by the normally open or normally closed contacts of the switch.

For depths up to 10 feet (3 m) the riser extension pipe must be installed so the bottom inlet is 1 inch (25.4 mm) below the desired minimum fuel tank level. For each additional 10 feet (3 m) of depth the riser extension pipe should extend an additional 1 inch (25.4 mm) below the desired minimum fuel tank level. As an example, for a tank depth of 15 feet (4.6 m), switch actuation should occur when the fuel level drops within 1.5 inches (38 mm) of the riser extension pipe's bottom inlet.

All the switch and riser connections must be airtight to ensure proper operation. After the pipe connections are made from the tank, install the wiring and conduit between the switch and the alarm circuit.

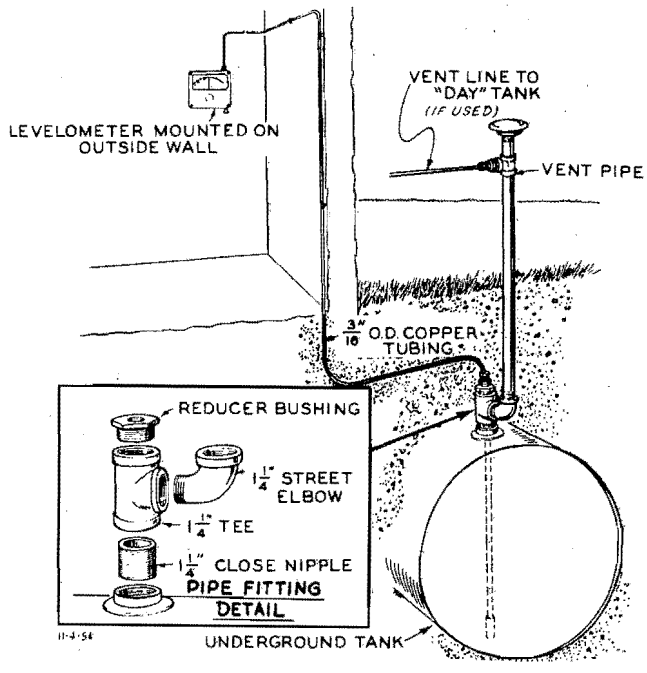


FIGURE 12. LEVELOMETER INSTALLATION

GENERAL FUEL PLUMBING

When buried fuel lines are used, use compatible metal fuel lines to avoid electrolysis. Onan has available copper fuel lines (Table 4) with brass fittings used for underground fuel tanks.

⚠CAUTION ***Never use galvanized fuel lines, fittings or fuel tanks with diesel fuel systems. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The zinc coating on galvanized lines or tanks reacts with the acid and flakes off to contaminate the fuel.***

Use a flexible section of tubing (code approved) between the engine and fuel supply line to withstand GenSet vibration (note diesel GenSets also require a separate fuel return line). All fuel line and tank fittings must be properly located and airtight to keep air from getting into the fuel lines.

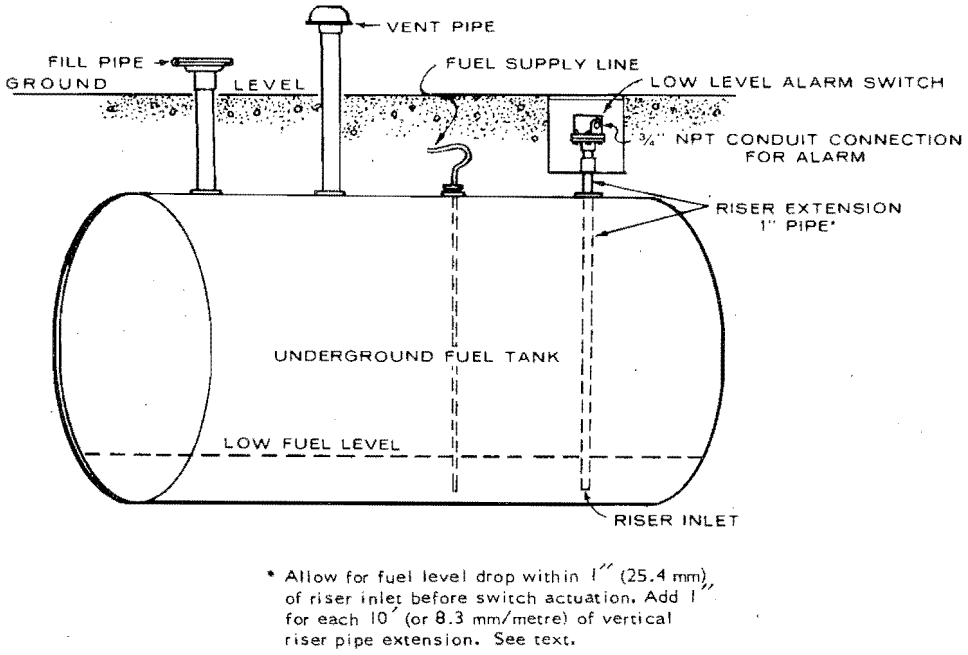


FIGURE 13. LOW LEVEL ALARM SWITCH INSTALLATION

Lifting capabilities are reduced by elbows, bends, and long lateral distances in the fuel line. Note during the descriptions of the various fuel systems using auxiliary fuel transfer pumps, the vertical lift is limited by the pump capability of the Onan transfer pump. With a larger capacity fuel pump, the vertical distance must not exceed 40 feet (12.4 m) lift. Fuel lifted long heights causes a pressure drop to the point where eventually the fuel boils, produces a vapor, and causes vapor lock.

Carefully clean all fuel system components before putting the GenSet in operation.

An electric solenoid shutoff valve in the supply line is always desirable and required for indoor automatic or remote starting installations. Connect the solenoid wires to the battery ignition circuit to open the valve during GenSet operation.

DIESEL DAY TANKS

Day tanks are fuel transfer tanks which are used when the standard engine fuel pump hasn't the capacity to draw the fuel from the supply tank; or, the supply tank is overhead and presents problems of high fuel head pressure for the fuel return. *Refer to Chart of Figure 14 for Maximum Allowable Static Head Pressure.*

Onan has day tanks with float switches available from 8 to 60 gallons (30.3 to 227 litres) in capacity. Day tanks with a float valve are also available (usually used with overhead fuel supply tanks).

Supply Tank Lower than Engine

With the installation (Figure 14), the day tank is installed near the GenSet and within the engine fuel pump lift capability, but below the fuel injection system (lift capabilities based on *no* horizontal run). An auxiliary fuel pump is installed close as possible to the supply tank and pumps fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.

The supply tank top must be below the day tank top to prevent siphoning from the fuel supply tank to the day tank.

A return line must be provided from the engine injection system return connection to the day tank (near the top) and extend down below the minimum fuel level of the day tank. Otherwise, drain-back from the engine fuel pump and filters may occur.

A day tank overflow (a size larger than supply line) must be provided to the supply tank in case the float switch fails to shut off the fuel transfer pump (Figure 14).

FUEL RETURN LINE - MAXIMUM STATIC HEAD PRESSURE

Engine	Maximum Head
Onan Diesel	6 feet (1.8 m)

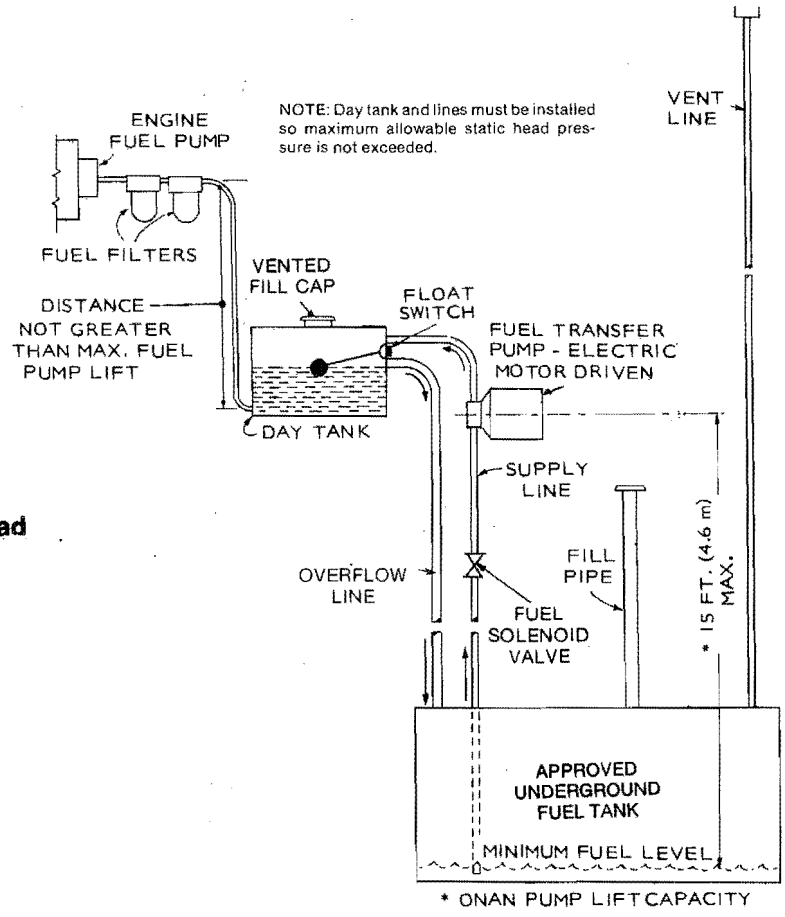


FIGURE 14. TYPICAL DIESEL FUEL SYSTEM WITH SUPPLY TANK BELOW GENSET

Supply Tank Above Engine

Due to the danger of hydraulic lock (fuel trapped on top of pistons) which causes serious engine damage, do not use a gravity feed fuel system directly to the engine fuel pump. The problem of such a system is the head on the engine fuel return line due to the overhead tank.

Figure 15 shows a typical installation when a day tank is used with overhead fuel supply tanks for diesel engines. The day tank is installed near the GenSet and within the engine fuel pump lift capability, but below the fuel injection system. Use fuel line at least as large as the fuel pump inlet. The engine fuel return line must enter the day tank and extend down below the minimum fuel level of the day tank. Otherwise, drain back of fuel from the engine fuel pump and filters may occur when the GenSet is not operating.

Observe in Figure 15 that a shutoff solenoid is included in the fuel line between the fuel supply tank and the day tank. It stops fuel flow when the circuit is de-energized.

GASOLINE DAY TANKS

Installations with gasoline day tank systems have many of the same requirements as the diesel day tank systems discussed earlier. The day tank must be located below the carburetor, but within lift capability of the engine fuel pump. Day tanks for gasoline fuel systems do not use a fuel return line from the engine. Follow building codes for gasoline system details.

⚠WARNING ***Do not use a vented fill cap on the day tank with a gasoline fuel system as escaping gasoline fumes can ignite resulting in severe personal injury or death.***

GASOLINE PRIMER TANKS

Gasoline evaporates from the carburetor bowl during long shutdown periods. Onan offers gasoline primer tanks on some models of gasoline fueled GenSets, which gravity feed fuel to the carburetor. This provides an immediate supply of fuel upon engine cranking. See Figure 16. A solenoid operated shutoff valve, open when the GenSet is running, is used between the primer tank and the carburetor. When the GenSet shuts down, the solenoid operated valve closes to prevent fuel from draining into the carburetor.

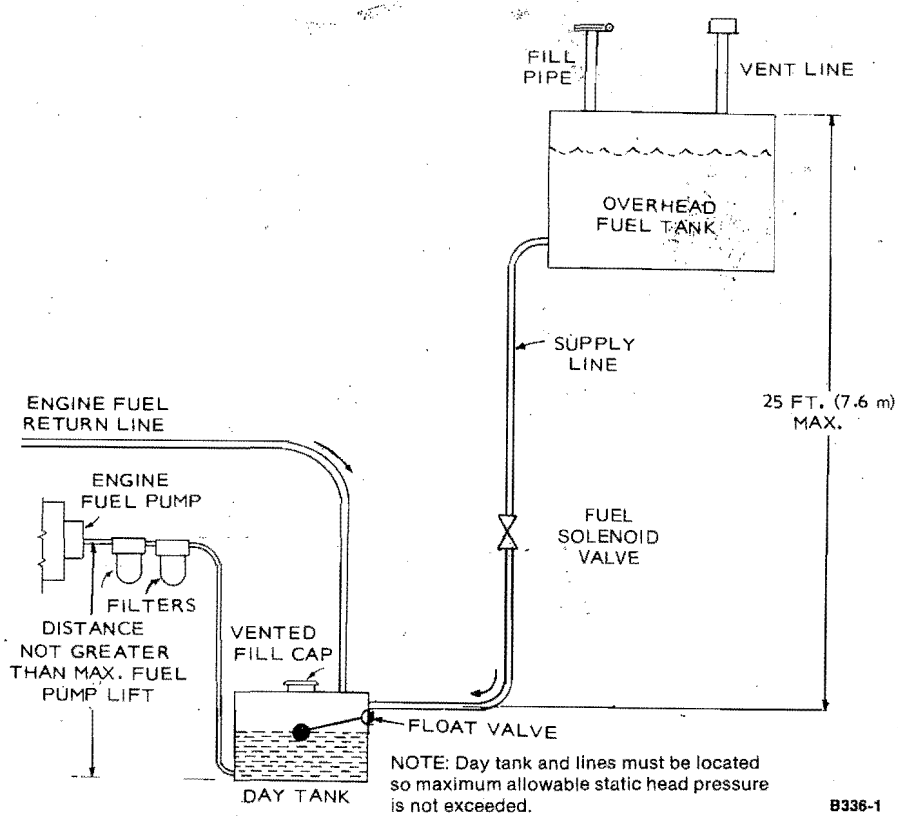


FIGURE 15. TYPICAL DIESEL FUEL SYSTEM WITH OVERHEAD FUEL TANK

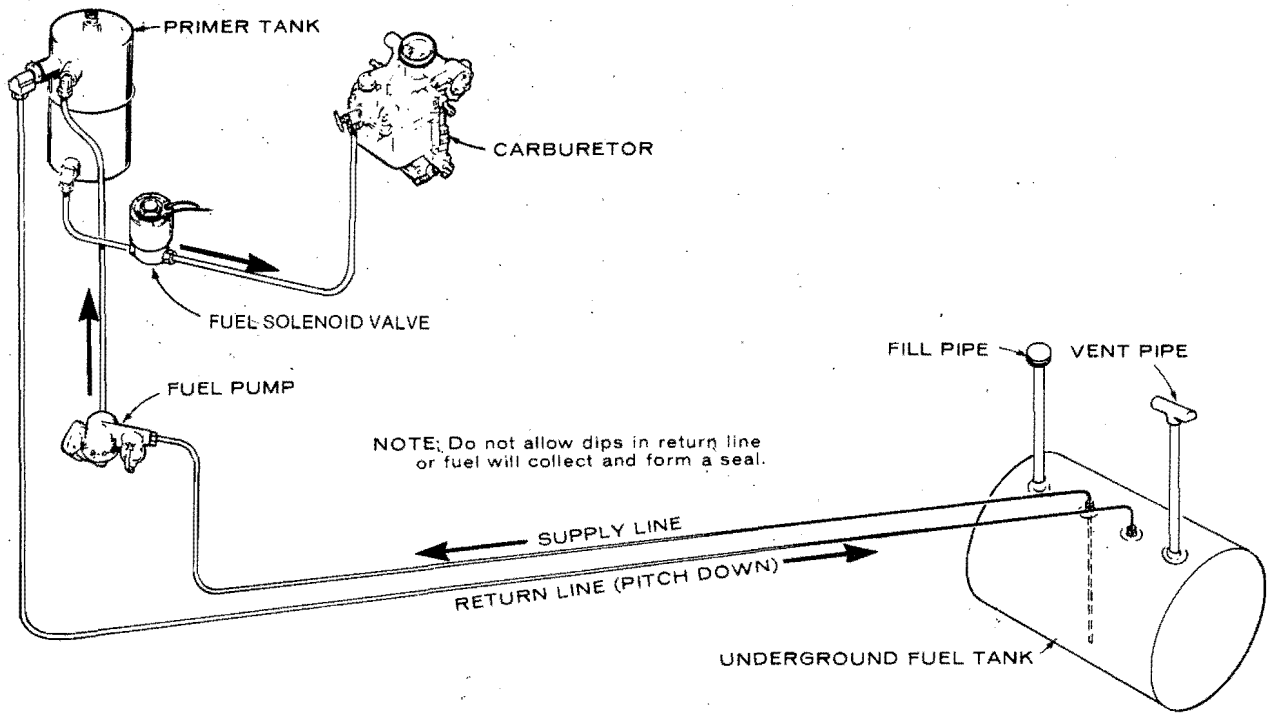


FIGURE 16. GASOLINE PRIMER TANK SYSTEM

The primer tank is pressurized by using a restrictive bushing in the return line. The return line to the supply tank, serving as a vent, will not gravity feed if the line includes any dips which trap fuel and block free air movement through the line.

GASOLINE ANTI-SIPHON SYSTEM

An anti-siphon system is often used when the fuel tank is located above the GenSet. It prevents siphoning of fuel directly to the engine fuel pump through use of special design plumbing. See Figure 17.

Fuel from the supply tank fills a void created in a vacuum pipe by the engine fuel pump. The vacuum pipe is about (4) four times greater in diameter than the line leading from the fuel tank to the vacuum pipe. For example, if the fuel line between the fuel tank and vacuum pipe is 5/16 inch, then the vacuum pipe is 1-1/4 inches.

Vacuum Pipe Assembly

The vacuum pipe assembly creates a head of priming fuel and consists of a vacuum pipe, manual shutoff valve, and priming plug. The vacuum pipe must be at least 4-times the diameter of the fuel line and long enough to extend above the fuel level in the fuel storage tank and below the engine fuel pump. The manual shut-off valve must be located between the vacuum pipe and the engine fuel pump. The priming plug must be located near the bottom end of the vacuum pipe.

To prevent exceeding the vacuum capabilities of the fuel pump but generate enough vacuum to lift fuel from the storage tank, the vacuum generated by "A" (head of priming fuel) must be equal or greater than the lift needed to overcome "B" (head of fuel).

The fuel storage tank head of fuel line must be high enough to allow an adequate level of head priming fuel.

The distance from the bottom of the fuel line to the priming plug "A" (head of priming fuel) must not exceed the height of the fuel line "B" (head of fuel) extending above the fuel storage tank.

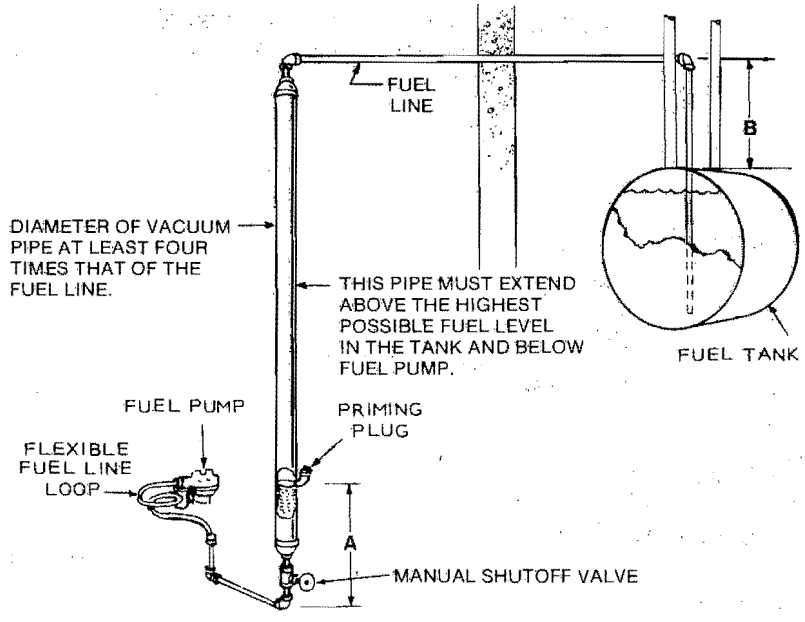


FIGURE 17. GASOLINE ANTI-SIPHON FUEL SYSTEM

Exhaust System

The purpose of the exhaust system is to direct engine exhaust from the engine and allow the exhaust to discharge into the atmosphere. A muffler should be connected into the exhaust system, either inside or outside the GenSet enclosure. For maximum efficiency, operation economy, and prevention of engine damage, design the exhaust system so it does not create excessive back pressure on the engine. Choice of proper pipe size, connections and muffler, if properly installed, will provide satisfactory operation.

⚠WARNING ***Plan the exhaust system carefully. Exhaust gases are deadly! Pipe exhaust gases outside away from windows, doors or other inlets to building. 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. Check exhaust systems visually and audibly at frequent intervals for leaks and repair as necessary.***

When exhaust gases must pass through a floor, ceiling, attic or concealed space, the exhaust pipes should be routed to or pass inside of a metal, masonry or other approved chimney. If other fuel burning appliances are vented into the same chimney, the engine exhaust pipe must extend up into the chimney beyond any other flue connection.

EXHAUST MANIFOLD

GenSet engine exhaust manifolds provide the channeling for exhaust gases from each cylinder to an exhaust outlet. The manifold affords a minimum of back pressure and turbulence to the engine cylinders and valves. GenSets are equipped with various types of manifold.

Two types of manifolds used are the standard dry air-cooled manifold and the water jacket watercooled manifold. The water jacket watercooled manifold applies water directly on the manifold.

EXHAUST PIPING

Every possible precaution must be taken to prevent back pressure on the engine cylinders and valves. Excessive back pressure can be caused by the following:

Piping too long
Piping diameter too small
Obstructions in exhaust system
Too many sharp bends in piping
Too much carbon buildup in exhaust system

Exhaust pipes must comply with applicable Local, State or National codes and for safety, comply with the following:

Exhaust pipes should be wrought iron or steel and strong enough to withstand the service.

Exhaust pipes must be free standing, not supported by engine or muffler.

Exhaust pipes must use vibration proof flexible connector.

Exhaust pipes must have a clearance of at least 9 inches (229 mm) from combustible materials and terminate outside of building.

Exhaust pipes must be guarded to prevent burning of personnel.

Exhaust pipes must avoid fire detection devices and automatic sprinkler alarm heads.

Exhaust pipes must be vented to the atmosphere away from building doors, windows and ventilation intake vents.

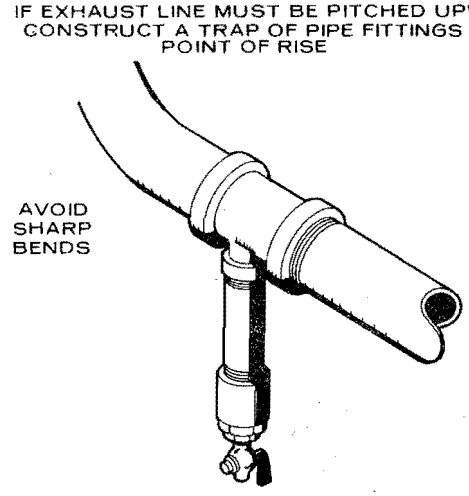


FIGURE 18. CONDENSATION TRAP

⚠CAUTION ***Total back pressure of all system components must not exceed maximum back pressure limits. Otherwise, engine damage can result.***

Pitch exhaust pipes downward away from the GenSet in a horizontal run or install a condensation trap with a means of drain where a rise in the exhaust system begins. Figure 18 shows a typical condensation trap. Be sure a flexible pipe section is included at the engine and the system is properly supported.

Flexible Pipe Section

A piece of flexible, bellows type exhaust pipe must be used between the engine exhaust connection and the exhaust piping system to permit GenSet movement and thermal expansion of piping without placing stress on the exhaust system. When selecting flexible pipe and length, consider:

1. Vibration isolators used—allow for 1 inch (25 mm) movement of engine exhaust outlet in all directions.
2. Expansion of pipe—depending on exhaust pipe support, note which direction expansion occurs.

Thimble and Rain Caps

An approved thimble must be used (Figure 19) where exhaust pipes pass through walls, partitions or roofs. Build the thimble according to codes (see National Fire Protection Association bulletin, Volume 4, section 211 on "Standards for Chimneys, Fireplaces and Vents"). Install a drip cap on the thimble when installed vertically as shown in Figure 19.

Onan has rain caps available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the GenSet. When the GenSet is stopped, the rain cap automatically closes, protecting the exhaust system from the environment.

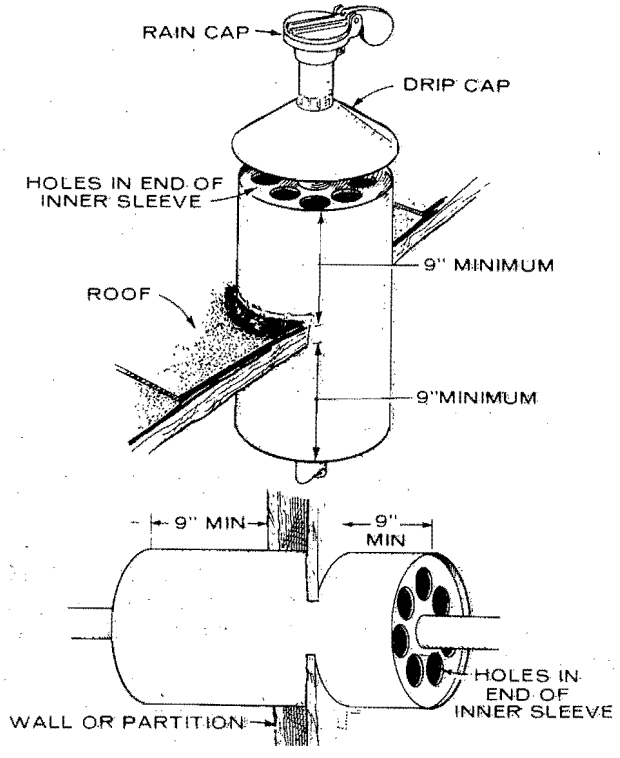


FIGURE 19. EXHAUST PIPE THIMBLE, THROUGH ROOF, WALL OR PARTITION

Exhaust System Support

The exhaust system components attached to the GenSet support reasonable piping loads.

Some GenSet models use turbochargers. Turbochargers operate at high speeds and employ closely fitted bearings and impeller. The turbo is built to pump large quantities of air. It is not capable of supporting the weight of long runs of pipe or mufflers.

With the typical pipe diameter and weight used in todays GenSet installations, a support will probably be required within 6 or 7 feet (1.83 or 2.13 m) of a naturally aspirated manifold. This distance may have to be shortened due to high shock loads. A support will be required within 4 feet (1.22 m) of a turbocharger. An 18 inch (457.2 mm) length of flexible exhaust tubing properly mounted will prevent an exhaust system from overstressing the GenSet turbocharger or manifold.

Exhaust Back Pressure

The exhaust back pressure of the GenSet when measured at full load and governed engine speed must not exceed the value indicated on the Product Data Sheet.

The size of exhaust pipe, number and types of bends and fittings together with the selection and location of the muffler determine exhaust back pressure. Pipe size for a typical installation presumes a minimum of short radius bends and reducers. Tight bends are usually the highest contributor of back pressure. Since restriction is inversely proportional to the fifth power of the pipe diameter, a small increase in pipe diameter will drastically reduce the pressure restriction due to the pipe.

Muffler back pressure can be obtained from Addendum-I Table 4, or the manufacturer of the muffler.

Checking Exhaust System

Use a manometer scaled to read in excess of 40 in. H_2O. Connect the manometer to the exhaust system close to the exhaust manifold outlet in a straight line section of pipe.

Operate the GenSet at rated speed and load and record the manometer reading. Check the allowable exhaust back pressure on the GenSet Product Data Sheet.

⚠CAUTION ***Weight applied to the engine manifold or turbocharger can result in manifold or turbocharger damage.***

MUFFLERS

Select a muffler to reduce noise of the exhaust system to levels required at the installation site. Onan mufflers are listed in Accessory Specifications. Three muffler types are available.

1. Industrial Muffler—Suitable for industrial areas or remote installation where attenuation is not critical.
2. Residential Muffler—Suitable where some low background noise is always present.
3. Critical Muffler—Suitable for the areas of hospitals, residential dwellings, etc. where background noise is minimal.

Attenuation is sound reduction given in decibels. Typical attenuation curves for industrial, residential and critical mufflers are shown in Figure 20.

For determining approximate sound level reduction for different distances from the sound source, subtract six decibels every time the distance is doubled. As an example, a sound level of 92 decibels at 100 feet (30 m) will be approximately 80 decibels at 400 feet (120 m).

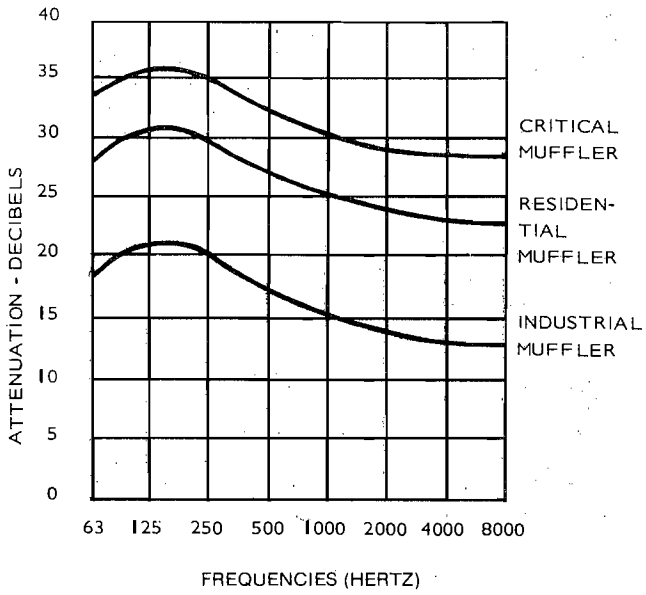


FIGURE 20. TYPICAL MUFFLER ATTENUATION CURVES

Location

Install the muffler as close as possible to the engine. Cool mufflers collect undesirable carbon residues and moisture.

Draining and servicing the muffler is more convenient if installed near the engine.

Installation

If the muffler is installed near the engine and is within reach of personnel standing on the installation floor level, protect it with a guard and insulation. If the muffler is installed outside the installation enclosure, it should have a guard or shield around it.

Electrical Systems

ELECTRICAL SYSTEMS

The electrical systems consist of AC power, DC control and DC starting. The AC power and DC control systems wiring must be enclosed in separate solid conduits.

⚠CAUTION ***Do Not install DC control wiring in the same conduit as the AC power. AC voltage induced currents can create operational problems with electronic solid-state devices.***

Most local regulations require that a licensed electrician perform wiring and wiring connections to a GenSet. A local inspector must approve the installation prior to equipment operation. All conduit, wire sizes, connections, etc. must conform to specifications, installation instructions, local codes and regulations.

AC ELECTRICAL POWER SYSTEM

⚠CAUTION ***Observe GenSet and load(s) phase wiring. GenSets typically rotate counterclockwise while utilities typically rotate clockwise, thus reversing phases. Reversed phases will prevent synchronizing GenSets and cause circuit breakers to trip.***

Install AC power cables in solid conduit with a flexible section at the GenSet generator. The flexible section of conduit prevents GenSet vibrations from generating damaging stresses on the solid conduit or GenSet generator connection terminals.

DC ELECTRICAL CONTROL SYSTEM

Install Start-Remote-Stop and Faults wiring in solid conduit with a flexible section at the GenSet control box. The flexible section of conduit prevents GenSet vibrations from generating damaging stresses on the solid conduit or GenSet control box.

If the installation is a standby system, use a double-throw transfer switch (manual or automatic) which protects against the possibility of commercial and generator power connecting to the load at the same time. Instructions for connecting transfer switches are included with the transfer switch equipment.

DC ELECTRICAL STARTING SYSTEM

A battery-powered starter motor performs the starting of most Onan air-cooled GenSets. Cranking speed depends on battery capacity, oil viscosity and ambient temperature around the GenSet. Follow the battery recommendations in the Onan specification sheets and operator's manuals for the GenSets.

For low temperatures, use lube oil heaters, etc. to ensure starting dependability (especially important with diesel sets).

Battery Location

Resistance in the starting circuit wiring has a significant effect on starting ability of the engine. Therefore, locate the batteries as close as possible to the GenSet (batteries must be accessible for servicing).

If the batteries are located relatively far from the starter motor, increase the battery cable size to avoid excessive voltage drop.

Most Onan sets have a "built-in" battery rack for the batteries. For the other models, mount the batteries on a wood or metal platform close to the GenSet.

Battery Charger

Most standby GenSets run too seldom to maintain full charge of the starting batteries. For such installations, a battery float charger is desirable because it can maintain battery potential. The battery charger is connected to the AC line source so it operates constantly when normal power is available.

A float charger is not designed to recharge batteries quickly.

Onan also has an SCR equalize battery charger with a charge timer which has a maximum charge rate up to 10 amperes for 12-volt systems and up to 6 amperes for 24-volt systems. For fast charging, the equalize charge timer can be manually set for any time period up to 12 hours (most battery manufacturers recommended 24 hours of equalize charging every month). Setting the timer raises the charger's output and maintains high charging voltage for the selected time. After this period, the timer automatically switches back to float voltage.

Nickel cadmium batteries do not require equalize battery charging.

Index of Tables

TABLE TITLE PAGE

TABLE 1. LINEAR EXPANSION OF STEEL PIPE LINES

(Metric equivalents in parentheses)

TEMPERATURE INCREASE	INCREASE IN LENGTH* Inches/100 Ft (Millimetres/30)
100°F (5.6°C)	0.76 (19.0)
150°F (83.3°C)	1.15 (28.7)
200°F (111.1°C)	1.57 (39.2)
250°F (138.9°C)	1.99 (49.7)
300°F (166.7°C)	2.47 (61.7)
350°F (194.4°C)	2.94 (73.5)
400°F (222.2°C)	3.46 (86.5)
450°F (250.0°C)	4.08 (102.0)
500°F (277.8°C)	4.67 (116.7)
550°F (305.6°C)	5.30 (132.5)
600°F (333.3°C)	5.98 (149.5)
650°F (361.1°C)	7.05 (176.2)
700°F (388.9°C)	7.86 (196.5)
750°F (416.7°C)	8.36 (209.0)
800°F (444.4°C)	9.31 (232.7)

* - If necessary, determine values for other lengths by direct proportion. For more information, see a mechanical engineering handbook.

TABLE 2. EXHAUST PIPE FITTINGS

(Metric equivalents, millimeter in parentheses)

TYPE OF FITTING	3/4-inch	1-inch	1-1/4-inch	1-1/2-inch	2-inch	2-1/2-inch	3-inch	4-inch
Standard Ell - Feet	2.2 (670)	2.8 (853)	3.6 (1097)	4.4 (1341)	5.3 (1615)	6.4 (1951)	8.1 (2469)	11.0 (3353)
Long Radius Ell - Feet	1.4 (427)	1.7 (518)	2.4 (732)	2.8 (853)	3.5 (1067)	4.2 (1280)	5.2 (1585)	7.0 (2134)
Medium Radius Ell - Feet	1.8 (549)	2.3 (701)	3.0 (914)	3.6 (1097)	4.6 (1402)	5.4 (1646)	6.8 (2073)	9.0 (2743)
Standard Tee - Feet	4.7 (1433)	5.6 (1707)	7.5 (2286)	9.3 (2835)	13.0 (3962)	14.0 (4267)	17.0 (5182)	22.0 (6706)

TABLE 3. HEAT LOSS FROM UNINSULATED EXHAUST PIPE AND MUFFLERS

PIPE SIZE	Uninsulated, Steel Pipe Heat Loss		Uninsulated, Critical Muffler Heat Loss	
Inch	BTU/Hr/Linear Foot	MJ/Hr/Linear Metre	BTU/Hr	MJ/Hr
1.5	2,800	0.9004	17,800	5.7238
2	3,400	1.1190	29,400	9.4540
2.5	4,180	1.3441	47,100	15.1454
3	5,040	1.6207	66,000	21.2232

TABLE 4.
COPPER FUEL LINES AVAILABLE FROM ONAN

Type of Line Use		
Supply	Return (No Tank)	Return (Tank)
5/16	5/16	5/16
3/8	3/8 - 5/16	1/2
5/8	1/2	5/8
1/2	3/8	1/2

Glossary of Terms

GLOSSARY OF TERMS

DAY TANK - a type of fuel transfer tank normally used when the engine fuel pump does not have the capacity to draw fuel from the main fuel tank. Also used together with overhead fuel tanks to remove fuel head pressures.

HYDROSTATIC PRESSURE - the pressure exerted by a liquid, relative to the function of a Levelometer, used to measure the amount of fuel (gasoline or diesel) in an underground tank.

LEVELOMETER - a fuel gauge that functions using the hydrostatic principle of operation.

PRIMER TANK - a gasoline tank that replenishes fuel evaporated from the GenSet carburetor. Sometimes used with GenSets requiring quick starts.

Standards Index

ITEM NO.	STANDARD OR BOOKLET NO.	TITLE	AVAILABLE FROM
1	NFPA No. 30	Storage, Handling and Use of Flammable Liquids	National Fire Protection Batterymarch Park Quincy, MA 02269
2	NFPA No. 37	Stationary Combustion Engines and Gas Turbines	National Fire Protection Batterymarch Park Quincy, MA 02269
3	NFPA No. 54	National Fuel Gas Code	National Fire Protection Batterymarch Park Quincy, MA 02269
4	NFPA No. 70	National Electrical Code	National Fire Protection Batterymarch Park Quincy, MA 02269
5	NFPA No. 76A	Essential Electrical Systems For Health Care Facilities	National Fire Protection Batterymarch Park Quincy, MA 02269
6	NFPA No. 58	American National Standard For the Storage and Handling of Liquefied Petroleum Gases	National Fire Protection Batterymarch Park Quincy, MA 02269
7	NFPA No. 110	American National Standard For Emergency Standby Power Systems	National Fire Protection Batterymarch Park Quincy, MA 02269
8	H38.7-1972 (ASTM B241-71b)	American National Standard For Aluminum Alloy Seamless Pipe and Seamless Extruded Tube	American National Standards Institute, Inc 1430 Broadway, New York, NY 10018
9	H23.1-1970 (ASTM B-88-69)	American National Standard For Seamless Copper Water Tube	American Society For Testing and Materials 1916 Race St., Philadelphia, PA 19103
10	H23.5-1976 (ASTM B280-66A)	American National Standard For Seamless Copper Tube For Air Conditioning and Refrigeration Field Service	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018
11	ASTM A539-73	Specification for Electric Resistance Welded Coiled Steel Tubing For Gas and Fuel Oil Lines	American Society For Testing and Materials 1916 Race St., Philadelphia, PA 19103
12	B36.35-1966 (ASTM A254-64)	American National Standard For Copper Brazed Steel Tubing	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018

STANDARDS INDEX (CONTINUED)

ITEM NO.	STANDARD OR BOOKLET NO.	TITLE	AVAILABLE FROM
13	H38.3-1972 (ASTM B210-71)	American National Standard For Aluminum Alloy Drawn Seamless Tubes	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018
14	ASTM D2513-73	Specification for Thermo Plastic Gas Pressure Pipe, Tubing and Fittings	American Society For Testing and Materials 1916 Race St., Philadelphia, PA 19103
15	ASTM D2517-73	Specification For Reinforced Thermosetting Plastic Gas Pressure Pipe and Fittings	Americal Society For Testing and Materials 1916 Race St., Philadelphia, PA 19103
16	B2.1-1968	American National Standard For Pipe Threads (Except DrySeal)	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018
17	Article X	National Building Code	American Insurance Association, 85 John St., New York, NY, 10038
18	A52.1-1971	American National Standard For Chimneys, Fireplaces and Venting Systems	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018
19	Z225.1-1972 (NFPA No. 59A)	American National Standard For Production, Storage and Handling of Liquefied Natural Gas	American National Standards Institute, Inc. 1430 Broadway, New York, NY 10018
20	MSS SP-58-1963	Hangers and Supports	Manufacturer's Standardization Society of the Valve and Fitting Industry, 1815 North Fort Myer Drive Arlington, VA 22209
21		Agricultural Wiring Handbook	Food and Energy Council, 909 University Ave., Columbia, MO 65201

Installation Checklist

BUYER	INSTALLER
Name _____	Name _____
Address _____	Address _____
_____	_____
Telephone _____	Telephone _____

Location of System _____

Type Installation ☐ Outdoor ☐ Indoor ☐ Roof

GenSet:	Transfer Switch:
Model No. _____	Model No. _____
Serial No. _____	Serial No. _____
OSPS:	**SPF:**
Model No. _____	Model No. _____
Serial No. _____	Serial No. _____

Line Service:	GenSet Service:
Current (Amperes) _____	Current (Amperes) _____
Phase(s)/Voltage _____	Phase(s)/Voltage _____

Alarms

Annunciators:	Telephone Dialers:
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____

Optional Equipment

Battery Warmer ☐ Battery Charger ☐

Other (List):

_____

General

- [ ] 1. GenSet wattage capacity is sufficient to handle maximum anticipated load.
- [ ] 2. At least 3 feet clearance minimum is provided around the entire genset for servicing and ventilation.
- [ ] 3. GenSet is located in an area not subject to flooding.
- [ ] 4. Operating instructions have been conspicuously posted.
- [ ] 5. Owner(s)/operator(s) have been thoroughly briefed on system exercise requirements.
- [ ] 6. Owner(s)/operator(s) have been thoroughly briefed on correct operating and preventive maintenance procedures.

GenSet Support

- [ ] 1. Floor, roof, earth, or other structure on which the genset rests is strong enough and will not allow shifting or movement.
- [ ] 2. GenSet is properly supported and retained to approved base which is separate and independent of the surface on which it sits.
- [ ] 3. Supporting base is large enough - extends 12-inches all around set.
- [ ] 4. Where genset or supporting base rests on combustible surface, the surface area beneath set and at least 12-inches beyond is covered in non-combustible insulation, with sheet metal installed between insulation and the set or supporting base.

Exhaust System

- [ ] 1. Owner(s)/operator(s) thoroughly briefed on the dangers of carbon monoxide gas, preventing the buildup of this gas in inhabited areas.
- [ ] 2. Areas around set well ventilated. No possibility of exhaust fumes entering building doors, windows, exhaust fans, or intake fans.
- [ ] 3. Exhaust gases piped safely outside and away from building.
  - [ ] a. The correct length of approved rigid pipe is connected to the genset exhaust pipe, using approved securing methods.
  - [ ] b. The correct length of flexible metal coupling properly connected to rigid pipe, using approved securing methods.
  - [ ] c. Exhaust piping, allowing expansion and contraction, correctly supported.
  - [ ] d. Condensation drain provided in lowest section of exhaust piping.
  - [ ] e. Exhaust piping material is sufficient to withstand service.
  - [ ] f. Exhaust piping terminates outside building where hot gases or sparks are discharged harmlessly. Not directed against combustibles.
  - [ ] g. Exhaust piping insulated to guard against burning personnel.
  - [ ] h. Exhaust piping passing through walls or ceilings have approved fire proof materials and are in compliance with codes.
  - [ ] i. Exhaust piping passing into chimney extends up into the chimney beyond any other flue connection. In compliance with codes.
  - [ ] j. Exhaust piping large enough in diameter to prevent back pressure on engine.

Cooling Air Flow

- [ ] 1. GenSet air inlet is faced into wind where strong prevailing winds are evident.
- [ ] 2. Air inlet openings are unrestricted and are equal to 1½ times the radiator air duct area.
  - [ ] a. Cooling air exhaust opening in building is unrestricted and free air inlet area is at least as large as the air inlet area.
  - [ ] b. Louvers have been properly compensated for in cooling air inlet and exhaust openings.

Gasoline Fuel System

- ☐ 1. Check that genset fuel tanks contain the proper fuel, non-lead, low-lead, or regular grade of gasoline per engine specifications.
- ☐ 2. Fuel tanks meet or exceed all Local, State or National codes.
- ☐ 3. Fuel lines are of copper and properly installed, supported and protected against damage.
- ☐ 4. Flexible fuel lines installed where required to protect against vibration, expansion, contraction, etc.
- ☐ 5. Fuel line shutoff valves provided to stop fuel in the event of leaks.
- ☐ 6. Fuel line fuel pumps connected and operated to be turned On when genset is started and turned Off when genset is shut down.
- ☐ 7. No fuel leaks are found in supply lines or engine fuel system.

Diesel Fuel System

- ☐ 1. Check that genset fuel tanks contain the proper fuel, #1, #2, or a mixture of #1 and #2 diesel fuel oil per engine specifications.
- ☐ 2. Fuel tanks meet or exceed all Local, State or National codes.
- ☐ 3. Fuel lines are of copper and properly installed, supported and protected against damage.
- ☐ 4. Flexible fuel lines installed where required to protect against vibration, expansion, contraction, etc.
- ☐ 5. Fuel line shutoff valves provided to stop fuel in the event of leaks.
- ☐ 6. Fuel line fuel pumps connected and operated to be turned On when genset is started and turned Off when genset is shut down.
- ☐ 7. No fuel leaks are found in supply lines or engine fuel system.

Gaseous Fuel System

- ☐ 1. LP Gas system connected to liquid or vapor withdrawal supply system.
- ☐ 2. Gaseous fuel system piping complies with all Local, State, or National codes.
- ☐ 3. Gaseous fuel piping has been leak tested, and properly purged prior to operation.
- ☐ 4. Gaseous fuel tanks, piping, and flexible piping are installed in strict compliance with Local, State, and National codes.
- ☐ 5. Approved gas shutoff valves are provided in gas supply lines to shut down gaseous supply in the event of a piping line break.
- ☐ 6. Pressure output from gaseous fuel tanks, gas service from natural gas line service regulator is correct. Checked per local codes.

AC Power Connections

- ☐ 1. Wire sizes (current carrying) of all AC wiring meets with applicable codes.
- ☐ 2. Type of wiring insulation, wiring conduits, connection methods, and devices wiring together with conduit support methods meet applicable codes.
- ☐ 3. All load, line and generator connections proper and correct.
- ☐ 4. All 120 Volts AC line connections to the engine accessories are NOT CONNECTED until after the cooling system is serviced and the batteries are installed.

DC Power Connections

- ☐ 1. All DC power or signal lines between genset and auxiliary equipment properly routed, supported, protected, and connected per code.
- ☐ 2. All contractor DC power or signal lines between genset and utility power source connected per code.

GenSet Initial Servicing

- [ ] 1. GenSet engine properly serviced.
- [ ] 2. Batteries properly installed, serviced and charged.
- [ ] 3. Battery cables installed per correct polarity (- or + grounded) per engine specification.
- [ ] 4. Engine carburetors (Gasoline, Gaseous) properly purged.

GenSet Pre-Start Checks

- [ ] 1. GenSet covers and shields properly installed.
- [ ] 2. V-belt pulleys tension and alignment are correct.
- [ ] 3. Pre-choke and vacuum shutoff mechanisms properly adjusted.
- [ ] 4. Engine crankcase serviced properly.
- [ ] 5. Batteries properly installed, serviced and charged.
- [ ] 6. All 120 volts AC power avaialble to operate battery heater, and battery charger.
- [ ] 7. Battery heater and battery charger are operational.
- [ ] 8. All fuel shutoff valves operational.

Cranking and Running Checks

Description of Check or Test	Test Results	
	Desired	Actual
☐ 1. Carburetor, Choke, Idle, etc. functions properly.		
☐ 2. Starter cranks engine normally.		
☐ 3. Engine starts normally.		
☐ 4. Engine oil pressure normal.		
☐ 5. No abnormal operating noises.		
☐ 6. No leaks in fuel, oil, vacuum lines or exhaust system.		
☐ 7. Engine governor properly set.		
☐ 8. Voltage at full load.		
☐ 9. Frequency at full load.		
☐ 10. Current at full load.		
☐ 11. Engine oil pressure at full load.		
☐ 12. Overspeed shutdown setting.		
☐ 13. Engine high temperature shutdown.		
☐ 14. Engine low oil pressure shutdown.		
☐ 15. GenSet or remote panel shutdown system normal, including transfer switches.		
☐ 16. Test position of transfer switches to start GenSet(s) and transfer loads (Utility-to-GenSet and GenSet-to-Utility).		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