

Memorandum on

MUNICIPAL SIGNALING SYSTEMS

INCLUDING SPECIFICATIONS FOR
EMERGENCY ELECTRICAL POWER EQUIPMENT

Prepared by
Defense Communications Board



Published September 1941, by
UNITED STATES OFFICE OF CIVILIAN DEFENSE
Washington, D. C.

*This is Publication No. 12 of the
OFFICE OF CIVILIAN DEFENSE*

*For sale by the Superintendent of Documents
at 10 cents per copy.*

Washington, D. C., September 1941

MUNICIPAL SIGNALING SYSTEMS

MUNICIPAL signaling systems constitute an important line of defense against accident, sabotage, or attack. Unfortunately, these services themselves are subject to sabotage. Damage to the communication system means that sabotage elsewhere becomes easier and is more likely to be effective.

Sabotage would probably be attempted first on the more obviously vulnerable spots in the signaling system, especially if by damaging those vulnerable areas the entire system could be paralyzed.

It is suggested, therefore, that municipalities undertake adequate surveys of their normal and emergency signaling systems, in order to ascertain where those services most need guarding or supplementing. Once the needs are determined, the proper guards and supplements should be supplied. A complete layout should be made of police and fire-alarm communications *with plans and maps*. A brief outline for making such a survey appears on page 3.

CENTRAL POLICE AND FIRE-ALARM HEADQUARTERS.

The central station is the brain and key to the whole fire and police signaling system. The reception of messages, the location of emergency calls, the proper dispatching of protection forces—all depend upon the proper functioning of the signaling system at the central station. Sabotage at such a point would be one of the most disruptive steps an enemy could take. Therefore, certain steps should be taken to protect the central station and to arrange for effective substitute service.

a. Guard windows with opaque wire-glass and outside heavy screens, and keep them locked. Keep doors closed and locked. Keep fences and their gates, if used, tight. Allow entrance to outer enclosure and to station itself, only to persons absolutely proven to be loyal by unmistakably good credentials. Make roofs of stations fire-resistant, and bar all openings.

b. Admit no visitors or workmen other than certified signal-service personnel to the central station signaling equipment or to the area adjacent thereto. Bar visitors and workmen from the signaling equipment by walls or screens with closed and locked doors and with no other openings.

c. *Equip the central station with a wholly self-contained source of electrical energy such as a Diesel or gasoline engine with generator.* (See specifications beginning on p. 4.) See that outside sources of energy and of communication are in duplicate or triplicate, if possible.

d. Provision should be made, in case of destructive sabotage or other attack upon the personnel or equipment of the central station, to receive elsewhere and to relay to the fire or police all signals sent in from locations needing and relying upon the protective forces. Any equipment needed for a quick change from centralized to decentralized signaling such as signals from signal boxes in any one district direct to the regularly manned protective fire or police stations in that district, should be put in place promptly, and the conditions under which such equipment shall be used, what signals for use shall be given, and who shall put in use, should be worked out and practiced.

e. Bring all wires into central station underground.

f. Spare parts for the more vulnerable pieces of equipment in central stations should be on hand in adequate and sufficient quantities.

ADEQUATE NUMBER AND PROPER LOCATION OF SIGNAL BOXES.

Heretofore, an insufficient number of boxes, and especially an insufficient number in certain key locations where many were needed, has meant only a somewhat increased insurance rate on properties inadequately protected. Today, a scarcity of signal boxes may enable an act of sabotage to attain a great measure of success before municipal aid can be secured.

Municipal Signaling Systems

a. Near every key location, as ascertained by proper survey, a close spacing of boxes, and preferably a duplication of alarm circuits should be provided, and special arrangements should be made for vigilant patrolling of these portions of the municipal facilities.

b. Key locations should have more than a normal or standard number of fire and police boxes. Some boxes should actually be within the more vulnerable parts of the key location, and they should be actuated manually or automatically, or both, from within those parts. These key locations should have not merely a standard but a superstandard supply of protective signaling devices. The time saved in serving the police and fire forces may result in a great saving of life or property.

c. An immediate survey should be made in each municipality to determine the means for coordinating municipal signaling equipment and protective facilities with those of industrial plants. Properly coordinated signaling equipment may make the difference between an operating and a destroyed national defense plant.

d. The extension and distribution of the fire and police signaling systems into the newly developed residential areas is essential.

OVERHEAD AND UNDERGROUND LINES.

a. Spare overhead conductors and cables, including cables capable of operating on the ground to bridge gaps in overhead lines caused by open lines, shorted lines, broken wires and broken poles, should be kept at various known locked locations, and provision made for adequate personnel to assure quick repair.

Duplicate routing of circuits in some cases is desirable.

b. Underground lines, though normally less subject to accident than overhead ones, are subject to intentional sabotage by entrance of saboteurs into manholes and by their dropping acid, bombs, or other destructive agency into manholes and upon the cables within. These acts of sabotage are less likely to be observed by police or pedestrians than would sabotage to overhead lines.

Means should be provided for securely and tightly closing and locking all manhole covers where fire and police alarm signaling wires are contained in cables within the manhole (sometimes in, or with telephone cables). Cables should be covered with acid-resisting shields, where possible.

Only authorized persons should ever be allowed to open a manhole, work in it, or be near it when it is open.

PEDESTALS.

Pedestals for signaling boxes should be protected, especially if the grounding feature or threefold operation is not used on the signaling system. Because of the possibility of damage, pedestals should not be used as terminal points for important cables.

Therefore, all important connections should be removed from pedestals at the earliest possible moment, and manholes installed equipped with effective locking devices.

EMERGENCY SUBSTITUTES FOR REGULAR SIGNALING FACILITIES.

Two-way radio equipment might be installed on all fire apparatus, mobile units, fire boats, etc., and is especially desirable where municipalities have two-way radio.

Alarm gongs or air horns should be placed on fire and police stations at locations where the best coverage could be secured. These should be connected to the existing central stations and all decentralized stations so that auxiliary police and firemen could be quickly called to duty should an emergency arise. These air horns could be used for calling off-duty firemen, auxiliary firemen and police or other personnel.

AUXILIARY POWER SUPPLY.

All police radio stations, police signaling systems and fire alarm systems should be equipped with auxiliary power units, either Diesel or gasoline operated. They should be automatically connected so that when the normal source of supply is interrupted these units will automatically start and continue to operate during the interruption and will again automatically shut down upon the resumption of the normal supply. (See specifications beginning on p. 4.)

Municipal Signaling Systems

ADEQUATE TOOL AND REPAIR FACILITIES.

Adequate tool and repair facilities should be made available at central stations and placed in locked and guarded houses at strategic and sufficiently numerous locations. Needed tools and repair facilities should be so arranged as to be moved readily from place to place.

A survey should be made by each municipality to determine the adequacy of their parts and tool supply and any deficiency corrected at once.

MUTUAL AID PROVISIONS.

A growing appreciation of the need for handling local disaster by neighborhood cooperation has brought about, in many neighborhoods, a fairly well worked out plan of mutual aid. Through the coordination of the signaling systems of the various municipalities, aid for one city can be quickly secured from other cities. In effect, the cities become one large scattered municipality for the period of the given emergency.

To supply adequate protection for large factories or other units important to defense,

municipalities should conclude mutual aid agreements and coordinate their signaling and protective services to that end.

IDENTIFICATION AND INVESTIGATION OF PERSONNEL.

The ability of States and municipalities to operate their communication systems under present methods is dependent to a considerable degree upon the stability of both power and communication wire circuits. One of the most effective ways to halt these communications would be to destroy either power or communication facilities at some outside point. It is, therefore, recommended that police officers should as a matter of practice investigate persons observed to be working on overhead power or communication installations, or in manholes and require that such persons establish their identity and authority.

Organizations responsible for the operation of wire facilities and maintenance of power or communication wire circuits should provide their personnel with adequate means of identification, preferably including photographs and fingerprints.

CHECK LIST FOR EXISTING SYSTEMS

I. FIRE ALARM

- A. Central fire-alarm headquarters.
 - 1. Location—size, etc.
 - 2. Equipment.
 - 3. Personnel—operators, linemen, etc.
 - 4. Engine-house equipment, type, etc.
- B. Fire alarm boxes.
 - 1. Number—adequacy.
 - a. High—medium—low-value areas.
 - b. Residential—commercial—industrial areas.
 - 2. Circuits—number—adequacy.
 - a. Overhead.
 - b. Underground.
- C. Other types of fire-alarm communications.
 - 1. Radio.
 - 2. Voice.
 - 3. Teletype.
 - 4. Others.
- D. Power.
 - 1. Normal—battery—rectifiers.
 - 2. Reserve—number of units—size.
- E. Direct auxiliary fire-alarm connections.
 - 1. Industry.
 - a. Municipal fire alarm.
 - b. Commercial central-station connections.
 - 2. Army cantonments and bases.
 - 3. Navy yards.
 - 4. Defense housing projects.
 - 5. Auxiliary systems that could be utilized.

II. POLICE ALARM

- A. Central police headquarters.
 - 1. Location—size, etc.
 - 2. Equipment—telephone—teletype—radio—other.
 - 3. Personnel—operators—linemen, etc.
 - 4. Precincts—number—location—type of equipment.
- B. Number of patrol boxes.
 - 1. Circuits—underground—aerial.
- C. Power.
 - 1. Normal—auxiliary.
- D. Number of mobile units equipped with one-way or two-way radio.

III. TELEPHONE SYSTEM.

- A. Lay-out of system.
- B. Power—normal—auxiliary.
- C. Personnel.
- D. Emergency units.

IV. TELEGRAPH SYSTEMS.

- A. Lay-out of system.
- B. Power—normal—auxiliary.
- C. Personnel.
- D. Emergency units.

V. RADIO SYSTEMS.

- A. Commercial (broadcasting, emergency).
 - 1. Stations—location—personnel.
 - 2. Power facilities.
 - 3. Emergency arrangements.
- B. Amateur.
 - 1. American Radio Relay League.
 - 2. Stations—power facilities.

EMERGENCY ELECTRICAL POWER EQUIPMENT

Continuity of communications requires the availability of an emergency power supply. Emergency power systems have been designed for many types of services and to supply power under many conditions. A recommended specification, to be used as a guide, may be of material assistance to states and municipalities in securing the proper type of equipment for the operation desired.

The specifications are divided into five units because of the different circumstances and conditions under which emergency power is required. For electrical power to drive a system involving telegraph printers, a strict control of power frequencies is generally required. There are two specifications to meet these conditions, one covering gasoline (Type 2) and the other Diesel power (Type 4). If telegraph printers are not involved, a less strict power frequency is required with consequent saving in initial cost. Two specifications are provided in this category, one for gasoline (Type 1) and one for Diesel (Type 3). Type 5 is a power system readily transportable, suitable for use in providing flood lights or driving electric pumps or other portable electrical apparatus.

GENERAL SCOPE

The following specifications are applicable to stand-by electric generating plants for the operation of fire-alarm systems, police radio systems, police telegraph systems, telephone systems, X-ray, emergency lighting, and the powering of electric motors.

Stand-by electric generating plants can be supplied commercially in the following sizes: 1.5, 3.0, 5.0, 7.5, 15.0 kilowatts. This range of sizes covers the maximum recommended for use with gasoline engines. For reasons of safety and economy of operation, Diesel engines are recommended for plants in excess of 15.0 kilowatt rating.

The purchaser should determine the type and size of unit required for the operation intended. The specification tables herein will assist in this determination. The following details should be considered when purchasing a generating unit for any of the above uses:

(1) The amount of current needed to operate equipment, lights, appliances, motors, etc., at

the time of *peak demand*. (Electric motors require from twice to eight times the normal rated current for starting, depending on type and size.)

(2) Method of starting.

(3) Voltage output. (Whether 110 or 220 volts, single phase, or whether 110/220 volts 3-wire, single phase, or whether 220 volts 3-phase is required.)

If other than that indicated in specification table, proper designation of required voltage must be made in the proposal.

The purchaser should specify one of the following methods of starting, depending upon his individual requirement.

1. *Manual start*.—The unit is started manually, by means of a hand crank or rope. Magneto ignition must be provided on the engine.

2. *Self-start*.—The unit is started and stopped by means of push-button control, buttons being located at the plant. Starting batteries are used with the plant, providing 12 volts, but magneto ignition is used to assure starting manually in case of battery failure.

3. *Semi-automatic*.—The unit will start automatically upon main power failure and will continue to run for not less than 5 minutes and if normal source of supply is resumed after the 5-minute period, it will automatically shut down; or, if the power has not been restored, the plant will operate indefinitely.

Gasoline engines are not recommended as practical beyond a size of 15.0 kilowatts because the larger volumes of fuel which are required, which constitute a storage hazard. Gasoline fuel, when used only in stand-by service, will deteriorate if allowed to stand in storage tanks for any prolonged period of time. Therefore, if possible a Diesel is recommended for larger sizes, since Diesel fuels have greater stability and will stand longer periods of storage without serious deterioration.

Installation of tanks.—Gasoline storage tanks should be installed in accordance with the local fire department regulations and the regulations of the National Board of Fire Underwriters.

Municipal Signaling Systems

SPECIFICATIONS, TYPE 1

A. APPLICABLE SPECIFICATIONS.

A-1. The specifications enumerated below of the issue in effect on the date of the Invitation for Bids are made a part of this specification.

American Standards for Rotating Electrical Machinery.

Electrical Safety Code for Electrical Installations and Wiring.

B. TYPE.

B-1. This specification covers a semiautomatic controlled, permanently mounted, gasoline engine driven, alternating current, electric generating set, mounted on a rigid base or chassis, for installation on a concrete foundation.

C. MATERIALS AND WORKMANSHIP.

C-1. *Materials.*—The materials for each part of the set shall be as specified herein. All parts subject to corrosion in a damp, salt, tropical climate shall be suitable to withstand corrosion or suitably protected from corrosion. When a definite material is not specified, the material used shall be of the best quality normally used for the purpose in good commercial practice.

C-2. *Workmanship.*—All parts of the generating set and controls shall be manufactured and finished in a thoroughly workmanlike manner. All dimensions shall be held as close as is consistent with good shop practice.

Gasoline driven electric generating set, 60 cycles alternating current, semiautomatic, nonfrequency regulation for use in case of power failure

D. GENERAL REQUIREMENTS.

D-1. There are no general requirements applicable to this specification.

E. DETAIL REQUIREMENTS.

E-1. *General.*—The set shall consist of a gasoline engine, direct connected to an alternating current generator; a built-in or direct-connected exciter; a switch gear for semiautomatic and manual operation, control and protection of the set; a rigid metal base; tools, accessories, spare parts, instruction books, etc., all as described herein. The complete set shall be permanently mounted on a common subbase provided with proper holes, bolts, bushings, etc., for installation on a concrete foundation. The general design shall be such as to produce a workmanlike, practical, and satisfactory machine without the use of unproven devices. The equipment is intended for emergency stand-by operation and the design shall be such that a nontechnical operator can, with a period of special training of not more than one week duration, operate the generating set without difficulty in the dark. The set is intended to provide electric power for lighting and power, including electric motors, where the power factor of such load will vary from unity to 0.8 (approximately).

E-2. *Capacity.*—The set shall be capable of delivering continuously, at an engine speed of not to exceed 1,800 revolutions per minute, an output not less than that specified in the table of sizes for type 1, in paragraph E-3, for the size required in the accompanying proposal.

E-3. Table of sizes for type 1.

Size	Kilowatt rating capacity	Rated voltage	Frequency control from 60 cycles, maximum variation	Intermittent overload (1 percent) 1 hour, minimum	Engine horsepower delivered to generator shaft, minimum	Number of cylinders, engine, minimum	Maximum piston speed
A	1.5	110	±2	30.0	4.0	1	<i>Ft./min.</i> 825
B	3.0	110	±2	20.0	7.0	2	825
C	5.0	110	±2	20.0	14.0	4	850
D	7.5	110	±2	25.0	18.0	4	900
E	10.0	110	±2	25.0	24.0	4	1,150
F	15.0	110	±2	25.0	38.0	6	1,150

E-4. *Engine.*—The gasoline engine shall be of a water-cooled, four-stroke cycle, vertical or V type, having the number of cylinders, horsepower delivered to the generator shaft, and piston speed, as specified in E-3, table of sizes for type 1. Operating speed shall not exceed 1,800 revolutions per minute. All power requirements as defined by this specification shall be obtained with ordinary standard, straight (unblended) gasoline, not exceeding 68 octane. The power requirements are based on standard conditions of sea level with atmospheric pressure of 14.7 pounds per square inch and ambient temperature of 60° F. The engine shall be of a standard commercial design that has proven satisfactory in extensive generating set use, and shall be one for which spare parts are readily obtainable

throughout the United States. Lubrication of engines having plain bearing crankshaft and camshaft shall be by means of either the force-feed and splash type, or force-feed type with gear-driven oil pump, and so arranged that lubrication can be maintained under all conditions of service. Lubrication of engines equipped with antifriction bearing camshaft and crankshaft may be by means of the constant level or splash type. Magneto ignition shall be provided and the entire ignition system must be shielded effectively to prevent radio interference. The engine shall be equipped with a suitable gasoline filter, a mechanical fuel pump with flexible fuel line lead, and a mechanical governor which shall control the speed to within 5 percent from no load to full load. The muffler shall be of the highest grade and shall effectively silence exhaust noise. Suit-

Municipal Signaling Systems

able fittings shall be provided to make proper connections from the exhaust manifold to the remote exhaust outlet and 15 feet of flexible exhaust tubing shall be supplied for connection thereto. The carburetor shall be equipped with suitable air filter and back-fire trap with provisions made to trap or drain all excess fuel which might drip from the carburetor bowl under conditions of over-choking. The carburetor, fuel pump, and all other similar parts shall be constructed of corrosion-resisting materials, suitable to withstand a damp, salt, tropical climate, or otherwise protected against corrosion by suitable means such as plating, enameling, etc. The complete engine unit, including radiator and accessories, shall be so arranged that all parts are readily accessible.

E-4a. Starting.—The unit shall be provided with controls, such that a semiautomatic start may be accomplished at any moment when normal supply is shut off. At the moment of power-line failure, an automatic transfer switch shall open its initial connection with the power line, connect the demand circuit with the alternating-current output of the electric generator and set into operation the cranking circuit of the starting system on the engine. A safety switch shall be provided in the cranking circuit such that electric cranking will cease after approximately 10 seconds if the engine fails to start. A manual reset shall be incorporated in the safety switch to permit further operation. Any proposed control system shall be of a proven type, and full description of same, together with proof of unailing reliability *must* be submitted with bid at the time of opening. Provision for manual starting of the unit shall be made in case the battery condition is too low to permit cranking electrically. Cranking may be accomplished by means of the generator exciter or automotive accessory type. Provision shall be made for recharging the starting battery. Starting voltage shall not be less than 12 volts, and batteries for starting shall consist of a pair of 6-volt units, connected in series. An automatic choke shall be provided. The path of the hand crank shall be unobstructed.

E-4b. Cooling system.—The engine shall be equipped with a suitable type of cooling system, including radiator of ample size, ventilating fan of the pusher type, and water pump—if required. Thermal-syphon systems are allowed. The system shall provide sufficient cooling capacity to keep the engine at a temperature which will insure economical and satisfactory operation when powering the generator under full rated load and with a maximum circulating water temperature of not more than 100° F. above an ambient temperature of 100° F. The engine block and radiator shall be provided with suitable water drains. A suitable protective grille shall be provided for the radiator.

E-4c. Fuel tank.—A fuel tank shall be provided, having a capacity of at least 55 gallons, and shall be suitable for underground installation. It shall be arranged for either gravity or pump feed to the engine, and shall be located not more than 15 feet away from the generating plant, horizontally, or more than 6 feet below the level of the fuel pump on the engine. All necessary fittings shall be provided and shall include suitable filler pipe and cap, vent pipe, supply outlet fittings, 25 feet of copper fuel line tubing, line water trap with fittings, etc. The fuel tank shall be treated inside with a protective coating of nonmetallic material suitable to reduce corrosion from the effects of water and from such corrosive elements as may occur in standard grades of gasoline. The tank shall be coated on the exterior in a commercially acceptable manner for protection against corrosion due to contact with the damp earth.

E-5. Generator.—A 60-cycle, single-phase, alternating current, continuous rating, semienclosed, self-ventilated generator as defined by the American Standards for Rotating Electrical Machinery shall be provided. The generator shall have a rated full load capacity as specified in E-2 and in E-3 (Table of sizes). The generator shall fulfill this capacity requirement under full service conditions including the heating effects obtained with the entire equipment assembled for operation. The exciter shall be either built-in or direct-connected to the generator shaft. All coil and winding insulation shall conform with class B insulation as defined by the American Standards for Rotating Electrical Machinery and all temperature measurements and tests shall be in accordance with American standards for the type of equipment supplied. The coils and windings shall be thoroughly treated with an oil and water resisting insulation compound. At intervals following successive applications of the compound or varnish, the coils shall be thoroughly baked. The whole machine shall be insulated and protected for continuous operation in a damp, salt, tropical atmosphere and provision shall be made to prevent failure of insulation due to condensation of moisture upon metallic parts. The terminal leads from the generator shall be brought through the frame, with suitable insulating bushings. The generator shaft shall be provided with antifriction bearing or bearings.

E-5a. Overload.—The generator shall operate satisfactorily in all particulars at loads up to and including full rated load plus overload as stated in table (E-3) at unity power factor without objectionable noise, vibration or heating. It shall be capable of delivering full rated load plus overload at unity power factor continuously for at least one hour and withstand a dead short circuit across the terminals for 5 seconds without injury.

E-5b. Voltage regulation.—The generator voltage at unity power factor shall not vary more than 11 percent of full load voltage at all points between no load and full load when the generating set is completely assembled and operating under normal conditions. The voltage regulation shall be inherent, that is, obtained without the use of separate voltage regulation devices.

E-6. Control.—The set shall be arranged for manual control, in addition to the semiautomatic control circuit. Provision shall be made through necessary switches so that by a simple change of switch positions, manual start by means of hand cranking or push-buttons may be made. Provision shall be made for manual stopping of the engine at any time by means of push-button or toggle switch control, without a tendency for battery cranking to set in. All necessary controls for semiautomatic operation must be supplied.

E-7. Switchboard.—A substantially constructed switchboard panel, of impregnated, homogeneous, ebony asbestos, compound or other similarly suitable material, with all instruments and other devices suitably mounted thereon, shall be supplied. The instruments shall consist of one voltmeter with scale of 0-150 volts alternating current; one ammeter with scale of sufficient spread to indicate at least 130 percent of rated amperage, and one zero center direct current ammeter to indicate charging rate to battery. One main circuit breaker with overload protection shall also be conveniently mounted upon the panel. A rheostat control for battery charge-rate adjustment shall be provided. The instruments shall be furnished complete with all fuses, shunts, etc., necessary for their proper operation. Each instrument and device on the panel shall be iden-

Municipal Signaling Systems

Electric spares

tified by stamped designation plates, stenciled with paint, or suitable identification on the particular piece of equipment. The complete switchboard panel shall be arranged for the most convenient installation near the generating unit for wall mounting or on pipe standards. A wiring diagram, showing all electrical circuits as well as identification of all terminals shall be provided, whether painted on the face of the panel, or mounted in a suitable unexposed part of the panel or control boxes, protected by suitable covering or clear shellac.

E-8. Wiring.—All wiring and other current carrying parts shall be proportioned so that no undue heating will occur when the set is operated under the most severe conditions. Connections shall be so secured as to prevent contact with the frame or moving parts and resist movement under stress of normal vibration. All wiring shall be in accordance with the latest edition of the Electrical Safety Code for Electrical Installations and Wiring.

E-9. Base.—The generating unit shall be mounted on a substantial subbase or chassis of cast iron or pressed steel, unless an oversized oil sump base is provided for this purpose. In case of the latter construction, all sections of such base shall be of generous size and proportion, designed particularly for the purpose, and not a conversion of base type oil pan for gasoline engine, as such. The base shall be extended a sufficient distance to the rear so as to provide ample footing for the balance of the complete assembly. Shock-resisting bushings, or other type of vibration dampening shall be provided with the unit so that ample cushioning may be established between the unit and concrete base.

E-10. Finish.—The machine shall be finished in accordance with the best commercial practice. All exposed parts and surfaces shall be properly primed and given two coats of best grade machinery enamel.

E-11. Nameplates.—The engine and generator shall be provided with manufacturer's nameplates bearing the serial numbers, dates, and names of the manufacturer, together with all other pertinent information usually furnished. Identification plates shall be attached to each of the boxes containing automatic control devices.

E-12. Tools, accessories, spare parts, etc.—

E-12a. All tools, accessories, and spare parts necessary for the operation and maintenance of the generating set shall be supplied. Tools and spare parts shall include the following:

Tools

Set of standard open-end wrenches for all removable nuts, caps, and plugs.

Set of special wrenches, extensions, spanners, and accessories required for removal and maintenance of all parts. One oil can.

Spare parts

Set spark plugs.

Set intake valves.

Set exhaust valves.

Set valve springs.

Set valve keys.

Set cork and copper gaskets.

Set ignition breaker points.

Set water hoses.

Set hose clamps.

One distributor cap.

Two fan belts.

One oil filter removal cartridge.

One flexible fuel line connection.

One set generator brushes.

One set generator brush springs.

Ten fuses of each kind and capacity used on the set.

A set is the amount required for one engine or one generator. All tools and accessories shall be of the best quality and shall be acceptable to the contracting agent. All spare parts shall be furnished by the manufacturer of the original equipment and shall be interchangeable therewith.

E-13. Container.—A container of wood or metal, provided with a 1½-inch padlock complying with Federal Specification No. FF-P-101, Type VI-A, with two duplicate keys, shall be provided for the tools, spare parts, accessories, and instruction books. The container shall be arranged with suitable compartments to secure and protect the parts in a manner so as to be readily accessible. A holder shall be provided for an oil can in an accessible position.

E-14. Instruction books.—The contractor shall furnish for each generating plant four (4) copies of a complete instruction book covering the assembly, description of operation, adjustment, maintenance, and replacement of parts. This manual shall include a wiring diagram and a detailed parts list having pictures or drawings with part numbers for each part of the generating set. The manual shall also include a complete description of the measures that must be taken in order to operate the set at temperatures as low as -10° F. The instructions and parts lists shall be distributed as follows:

Two copies packed with each generating plant.

Two copies mailed direct to the contracting agent.

E-15. Standard products.—The equipment supplied under this specification shall be new and unused and shall be essentially standard products of the manufacturers; shall be the manufacturers' latest approved designs, and shall be in regular production in order that prompt and continuing service and delivery of parts may be guaranteed.

E-16. Ruggedness.—The equipment to be furnished under this specification shall have demonstrated by extensive satisfactory commercial use the ruggedness essential not only for employment under the type of service for which it is herein intended, but also to withstand shock of the usual means of transportation. The contracting agent may require the bidder to show evidence of the extensive satisfactory commercial use of the equipment he proposes to furnish.

E-17. Guaranty.—All materials and workmanship shall be of the highest grade and shall be free from any defects or imperfections. Any defect clearly due to the faulty design or to faulty material or workmanship, which may develop within 1 year after completion of the contract, unless otherwise specified, shall be made good by and at the expense of the contractor. Corrections or replacements required because of the faulty design, etc., shall be made within the continental limits of the United States by the contractor, at his expense and at the convenience of the contracting agency, at the plant of the manufacturer.

F. METHOD OF INSPECTION AND TEST.

F-1. Inspection.—The contractor shall at all working hours permit the entrance of representatives or inspectors of the contracting agent, who shall have the right to follow the material through all the processes of manufacture, tests, packing, and shipping, to determine compliance with this specification. Each

Municipal Signaling Systems

generating set will be inspected to see that it is constructed, finished, and packed in accordance with the requirements set forth in this specification.

F-2. *Tests.*—The complete equipment shall be given such operating and other tests as may be necessary to assure compliance with these specifications, including the tests described herein. When tests are made at the factory, the contractor shall furnish all the necessary facilities and testing instruments therefor without expense to the contracting office. The contractor shall also furnish such information as may be necessary to determine whether or not the materials used are as specified. The manufacturer shall be held responsible for any defects in material or workmanship which are of such a nature that they could not be detected by careful inspection or tests.

F-2a. *Voltage regulation test.*—The set shall be operated at full load until the generator temperature becomes approximately constant. From full load, the load shall gradually reduce to no load, taking voltage readings at full load, three-fourths load, one-half load, one-fourth load, and no load.

F-2b. *Limited operating test.*—The set shall be operated at full load for one continuous period of not less than two hours after warm-up is complete. During this test the set shall operate without excessive heating or wear of any part. Each set shall be given the voltage regulation test and the limited operating test.

G. PACKING AND MARKING.

G-1. *Packing.*—

G-1a. All parts, liable to rust, shall be thoroughly slushed with a rust-preventing grease.

G-1b. For domestic shipment, the unit shall be packed in accordance with the best commercial practice in order to assure safe delivery. For export shipment, when required, it will be enclosed in wood containers, conforming to standard practice for export shipment.

G-2. *Marking.*—The marking for shipment shall be in accordance with the best commercial practice, and in accordance with instructions which accompany official order.

H. NOTES.

H-1. *Information, cuts, descriptions, etc.*—The bidder is required to submit full catalog cuts, descriptions, drawings, diagrams, and all details concerning the equipment he intends to furnish under the proposal. Lack of such information will constitute an insufficient bid and will be disregarded by the contracting officer in consideration for award. Telegraphic bids will not be considered.

H-2. *Questions, comments.*—All questions or comments arising from the contents of this specification or proposal shall be submitted at least 5 days before the date set for the opening of bids, or consideration cannot be given them.

SPECIFICATIONS, TYPE 2

Gasoline driven electric generating set, 60 cycles alternating current, semiautomatic, frequency regulation for teletype, or other systems requiring frequency regulations

A. APPLICABLE SPECIFICATIONS.

A-1. The specifications enumerated below of the issue in effect on the date of the Invitation for Bids are made a part of this specification.

American Standards for Rotating Electrical Machinery.
Electrical Safety Code for Electrical Installations and Wiring.

B. TYPE.

B-1. This specification covers a semiautomatic controlled, permanently mounted, gasoline engine driven, alternating current, electric generating set, mounted on a rigid base or chassis, for installation on concrete foundation.

C. MATERIALS AND WORKMANSHIP.

C-1. *Materials.*—The materials for each part of the set shall be as specified herein. All parts subject to corrosion in a damp, salt, tropical climate shall be suitable to withstand corrosion or suitably protected from corrosion. Where a definite material is not specified, the material used shall be of the best quality normally used for the purpose in good commercial practice.

C-2. *Workmanship.*—All parts of the generating set and controls shall be manufactured and finished in a thoroughly workmanlike manner. All dimensions shall be held as close as is consistent with good shop practice.

D. GENERAL REQUIREMENTS.

D-1. There are no general requirements applicable to this specification.

E. DETAIL REQUIREMENTS.

E-1. *General.*—The set shall consist of a gasoline engine, direct-connected to an alternating current generator; a built-in or direct-connected exciter; a switch gear for semiautomatic and manual operation, control, and protection of the set; a rigid metal base, tools, accessories, spare parts, instruction books, etc., all as described herein. The complete set shall be permanently mounted on a common subbase provided with proper holes, bolts, bushings, etc., for installation on concrete foundation. The general design shall be such as to produce a workmanlike, practical and satisfactory machine without the use of unproven devices. The equipment is intended for emergency standby operation and the design will be such that a nontechnical operator can, with a period of special training of not more than 1 week in duration, operate the generating set without difficulty in the dark. The set is intended to provide electric power primarily for *teletype systems*, with possible additions of electric lighting and powering of small electric motors. Such additional loads shall not comprise more than 10 percent of the total rated capacity of the generating set.

E-2. *Capacity.*—The set shall be capable of delivering continuously, at an engine speed of not to exceed 1,800 revolutions per minute an output not less than that specified in the table of sizes for type 2, in paragraph E-3, for the size required in the accompanying proposal.

E-3. Table of sizes for type 2.

Size	Kilowatt rating (capacity)	Rated voltage	Intermittent overload 1 hour (percent, minimum)	Engine horsepower delivered to generator shaft, minimum	Number of cylinders, minimum	Maximum piston speed
A.....	1.5	110	20.0	5.0	2	<i>Ft. min.</i> 825
B.....	3.0	110	20.0	7.0	2	825
C.....	5.0	110	20.0	14.0	4	850
D.....	7.5	110	25.0	18.0	4	900
E.....	10.0	110	25.0	24.0	4	1,150
F.....	15.0	110	25.0	38.0	6	1,150

E-4. *Engine.*—The gasoline engine shall be of a water-cooled, four-stroke cycle, vertical or V type, having the number of cylinders, horsepower delivered to the generator shaft, and piston speed, as specified in E-3, table of sizes for type 2. Operating speed shall not exceed 1,800 revolutions per minute. All power requirements as defined by this specification shall be obtained with ordinary standard, straight (unblended) gasoline, not exceeding 68 octane. The power requirements are based on standard conditions of sea level with atmospheric pressure of 14.7 pounds per square inch and ambient temperature of 60° F. The engine shall be of a standard commercial design that has proved satisfactory in extensive generating set use, and shall be one

for which spare parts are readily obtainable throughout the United States. Lubrication of engines having plain bearing crankshaft and camshaft shall be by means of either the *force-feed* and splash type, or *force-feed* type with gear-driven oil pump, and so arranged that lubrication will be maintained under all conditions of service. Lubrication of engines equipped with antifriction bearing camshaft and crankshaft may be by means of the constant level or splash type. Magneto ignition shall be provided and the entire ignition system must be shielded effectively to prevent radio interference. The engine shall be equipped with a suitable gasoline filter, a mechanical fuel pump with flexible fuel line lead, and a mechanical governor which shall control the speed as elsewhere specified herein. The muffler shall be of the high-

Municipal Signaling Systems

est grade and shall effectively silence exhaust noise. Suitable fittings shall be provided to make proper connections from exhaust manifold to remote exhaust outlet and 15 feet of flexible exhaust tubing shall be supplied for connection thereto. The carburetor shall be equipped with suitable air filter and back-fire trap with provisions made to trap or drain all excess fuel which might drip from carburetor bowl under conditions of over-choking. The carburetor, fuel pump and all of other similar parts shall be constructed of corrosion resisting materials suitable to withstand a damp, salt, tropical climate, or otherwise protected against corrosion by suitable means such as plating, enameling, etc. The complete engine unit including radiator and accessories shall be so arranged that all parts are readily accessible.

E-4a. Starting.—The unit shall be provided with controls, such that a semiautomatic start may be accomplished at any moment when normal supply is shut off. At the moment of power-line failure, an automatic transfer switch shall open its initial connection with the power line, connect the demand circuit with the alternating-current output of the electric generator and set into operation the cranking circuit of the starting system on the engine. A safety switch shall be provided in the cranking circuit such that electric cranking will cease after approximately 10 seconds if the engine fails to start. A manual reset shall be incorporated in the safety switch to permit further operation. Any proposed control system shall be of a proven type and full description of same, together with proof of unfailing reliability *must* be submitted with the bid at the time of opening. Provision for manual starting of the unit shall be made in case battery condition is too low to permit cranking electrically. Cranking may be accomplished by means of the generator exciter or automotive accessory toy. Provision shall be made for recharging of the starting battery. Starting voltage shall not be less than 12 volts and batteries for starting shall consist of a pair of 6-volt units, connected in series. An automatic choke shall be provided. The path of the hand crank shall be unobstructed.

E-4b. Cooling system.—The engine shall be equipped with a suitable type cooling system, including radiator of ample size, ventilating fan of the pusher type, and water pump—if required. Thermal-syphon systems are allowed. The system shall provide sufficient cooling capacity to keep the engine at a temperature which will insure economical and satisfactory operation when powering the generator under full rated load and with a maximum circulating water temperature of not more than 100° F. above an ambient temperature of 100° F. The engine block and radiator shall be provided with suitable water drains. A suitable protective grille shall be provided for the radiator.

E-4c. Fuel tank.—A fuel tank shall be provided, having a capacity of at least 55 gallons, and shall be suitable for underground installation. It shall be arranged for either gravity or pump feed to the engine, and shall be located not more than 15 feet away from the generating plant, horizontally, or not more than 6 feet below the level of the fuel pump on the engine. All necessary fittings shall be provided and shall include suitable filler pipe and cap, vent pipe, supply outlet fittings, 25 feet of copper fuel line tubing, line water trap with fittings, etc. Fuel tank shall be treated inside with a protective coating of nonmetallic material suitable to reduce corrosion from effects of water and from such corrosive elements as may occur in standard grades of gasoline. The tank shall be coated on the exterior in a commercially acceptable manner for protection against corrosion due to contact with the damp earth.

E-5. Generator.—A 60-cycle single-phase, alternating current, continuous rating, semiclosed, self-ventilated generator as defined by the American Standards for Rotating Electrical Machinery shall be provided. The generator shall have a rated full load capacity as specified in E-2 and in E-3 (Table of sizes). The generator shall fulfill this capacity requirement under full service conditions including the heating effects obtained with the entire equipment assembled for operation. The exciter shall be either built-in or direct-connected to the generator shaft. All coil and winding insulation shall conform with class B insulation as defined by the American Standards for Rotating Electrical Machinery and all temperature measurements and tests shall be in accordance with American Standards for the type of equipment supplied. The coils and windings shall be thoroughly treated with an oil and water resisting insulation compound. At intervals following successive applications of compound or varnish, the coils shall be thoroughly baked. The whole machine shall be insulated and protected for continuous operation in a damp, salt, tropical atmosphere and provision shall be made to prevent failure of insulation due to condensation of moisture upon metallic parts. The terminal leads from the generator shall be brought through the frame, with suitable insulating bushings. The generator shaft shall be provided with antifriction bearing or bearings.

E-5a. Overload.—The generator shall operate satisfactorily in all particulars at loads up to and including full rated load plus overload as stated in table (E-3) at unity power factor without objectionable noise, vibration or heating. It shall be capable of delivering full rated load plus overload at unity power factor continuously for at least 1 hour and withstand a dead short circuit across the terminals for 5 seconds without injury.

E-6. Voltage and frequency.—Voltage regulation shall be accomplished by inherent regulation contained in the generator and exciter, and by the addition of an approved external regulating device. The external regulating device shall operate automatically to maintain the specified regulation without hunting. A proven and reliable voltage regulator, similar and equal to and interchangeable with, Westinghouse silverstar regulator shall be furnished and of a type that can be easily mounted on the panel board of the plant. Regulators of the carbon pile, vibrating contact type, or regulators that have not been in similar service with satisfactory performance for 2 years prior to the issuance of this specification, will not be acceptable. Failure of any part of the voltage regulator shall not cause the exciter shunt field to become inactive in function. The governor of the engine, the windings of the generator and exciter, and the voltage regulator shall be so designed and adjusted that regardless of the temperature (within the limits specified for operation elsewhere herein) of either the engine, generator or exciter, the following frequency and voltage regulation shall be maintained.

1. **Frequency.**—At all loads between no load cold and rated full load hot (at all ambient temperatures within the operating range specified elsewhere herein) the frequency must be within the range of 59 to 61 cycles. No variations outside these limits are permitted. At any selected steady load the frequency shall not vary more than 0.5 cycle.

2. **Voltage.**—The generator must be capable of being adjusted to deliver rated full load amperes at any voltage selected between 220 and 240 or 110 and 120 volts and maintain the voltage regulation specified below at any of such adjustments. With adjustments made for the generator to deliver rated full load amperes cold at a selected voltage, the actual delivered voltage at any load (such load to be at a power factor between 80 and

Municipal Signaling Systems

100 percent) between no load cold and rated full load amperes hot must be within a range of 98 to 102 percent of the selected full-load cold voltage except that momentary fluctuations outside the limits of this range are permitted as follows:

(1) Rise to 103 or drop to 97 percent of the selected full-load cold voltage when the existing load is suddenly varied by an amount not exceeding 10 percent of the generator-rated amperes.

(2) Rise to 112 or drop to 88 percent of the selected full-load cold voltage when the existing load is suddenly varied by an amount between 11 and 50 percent of the generator-rated amperes.

(3) Rise to 125 or drop to 75 percent of the selected full-load cold voltage when the existing load is suddenly varied by an amount between 51 and 100 percent of the generator-rated amperes.

It is to be understood that the above-mentioned momentary voltage variation requirements do not apply if the load resulting from the sudden load variation exceeds the rated full load amperes of the generator, and if the power factor of the increment load or resulting load is not between 80 and 100 percent.

At any steady load, the voltage, in addition to being within the range specified above, shall be constant to the extent that the needle of the switchboard voltmeter shall not pulsate and to the extent that a recording of such voltage by an Esterline recording voltmeter shall be practically a straight line free from any sharp fluctuations.

The wave form of the output voltage shall be nearly sinusoidal, having a total harmonic distortion not exceeding 10 percent at any load from zero to rated output when a pure resistance load is being fed.

(Note.—The contractor is cautioned that the necessary testing equipment must be on hand to measure this distortion at the time of inspection. A string oscillograph with photographic attachment is considered necessary to make this test. The photographic attachment must be capable of photographing a zero line for the wave being photographed. The Fischer-Hinnen method shall be used to calculate distortion of the wave form.)

E-6a. Control.—The set shall be arranged for manual control, in addition to the semiautomatic control circuit. Provision shall be made through necessary switches so that by a simple change of switch positions a manual start by means of hand cranking or push-buttons may be made. Provision shall be made for manual stopping of the engine at any time by means of push-button or toggle-switch control, without a tendency for battery cranking to set in. All necessary controls for semiautomatic operation must be supplied.

E-7. Switchboard.—A substantially constructed switchboard panel, of impregnated, homogeneous, ebony asbestos, compound, or other similarly suitable material, with all instruments and other devices suitably mounted thereon, shall be supplied. The instruments shall consist of one voltmeter with scale of 0-150 volts alternating current; one ammeter with scale of sufficient spread to indicate at least 130 percent of rated amperage, and one zero center direct current ammeter to indicate the charging rate to the battery. One main circuit breaker with overload protection shall also be conveniently mounted upon the panel. A rheostat control for battery charge-rate adjustment shall be provided. The instruments shall be furnished complete with all fuses, shunts, etc., necessary for their proper operation. Each instrument and device on the panel shall be identified by stamped designation plates, stenciled with paint, or suitable identification on the

particular piece of equipment. The complete switchboard panel shall be arranged for most convenient installation near the generating unit for wall mounting or on pipe standards. A wiring diagram, showing all electrical circuits as well as identification of all terminals shall be provided, whether painted on the face of the panel, or mounted in a suitable unexposed part of the panel or control boxes, and protected by suitable covering or clear sheath.

E-8. Wiring.—All wiring and other current carrying parts shall be proportioned so that no undue heating will occur when the set is operated under the most severe conditions. Connections shall be secured so as to prevent contact with the frame or moving parts and resist movement under stress of normal vibration. All wiring shall be in accordance with the latest edition of the Electrical Safety Code for Electrical Installations and Wiring.

E-9. Base.—The generating unit shall be mounted on a substantial subbase or chassis of cast iron or pressed steel, unless an oversized oil sump base is provided for this purpose. In case of the latter construction, all sections of such base shall be of generous size and proportion, designed particularly for the purpose, and not a conversion of base type oil pan for gasoline engine, as such. The base shall be extended a sufficient distance to the rear so as to provide ample footing for the balance of the complete assembly. Shock-resisting bushings, or other type of vibration dampening shall be provided with the unit so that ample cushioning may be established between unit and concrete base.

E-10. Finish.—The machine shall be finished in accordance with the best commercial practice. All exposed parts and surfaces shall be properly primed and given two coats of best grade machinery enamel.

E-11. Name plates.—The engine and generator shall be provided with manufacturer's name plates bearing the serial numbers, dates, and name of the manufacturer, together with all other pertinent information usually furnished. Identification plates shall be attached to each of the boxes containing automatic control devices.

E-12. Tools, accessories, spare parts, etc.—

E-12a. All tools, accessories, and spare parts necessary for the operation and maintenance of the generating set shall be supplied. Tools and spare parts shall include the following:

Tools

Set of standard open end wrenches for all removable nuts, caps, and plugs.
Set of special wrenches, extensions, spanners and accessories required for removal and maintenance of all parts. One oil can.

Spare parts

Set spark plugs.
Set intake valves.
Set exhaust valves.
Set valve springs.
Set valve keys.
Set cork and copper gaskets.
Set ignition breaker points.
Set water hoses.
Set hose clamps.
One distributor cap.
Two fan belts.
One oil filter removal cartridge.
One flexible fuel line connection.

Municipal Signaling Systems

Electric spares

One set generator brushes.

One set generator brush springs.

Ten fuses of each kind and capacity used on the set.

A set is the amount required for one engine or one generator. All tools and accessories shall be of the best quality and shall be acceptable to the contracting agent. All spare parts shall be furnished by the manufacturer of the original equipment and shall be interchangeable therewith.

E-13. Container.—A container of wood or metal, provided with a 1½-inch padlock complying with Federal Specification No. FF-P-101, type VI-A, with two duplicate keys, shall be provided for the tools, spare parts, accessories, and instruction books. The container shall be arranged with suitable compartments to secure and protect the parts in a manner so as to be readily accessible. A holder shall be provided for an oil can in an accessible position.

E-14. Instruction books.—The contractor shall furnish at each generating plant four copies of a complete instruction book covering the assembly, description of operation, adjustment, maintenance, and replacement of parts. This manual shall include a wiring diagram and a detailed parts list having pictures or drawings with part numbers for each part of the generating set. The manual shall also include a complete description of the measures that must be taken in order to operate the set at temperatures as low as -10° F. The instructions and parts lists shall be distributed as follows:

Two copies packed with each generating plant.

Two copies mailed direct to the contracting agent.

E-15. Standard products.—The equipment supplied under this specification shall be new and unused and shall be essentially standard products of the manufacturers; shall be the manufacturer's latest approved designs, and shall be in regular production in order that prompt and continuing service and delivery of parts may be guaranteed.

E-16. Ruggedness.—The equipment to be furnished under this specification shall have demonstrated by extensive satisfactory commercial use the ruggedness essential not only for employment under the type of service for which it is herein intended, but also to withstand shock of usual means of transportation. The contracting agent may require the bidder to show evidence of the extensive satisfactory commercial use of the equipment he proposes to furnish.

E-17. Guaranty.—All materials and workmanship shall be of the highest grade and shall be free from any defects or imperfections. Any defect clearly due to the faulty design or to faulty material or workmanship, which may develop within 1 year after completion of the contract, unless otherwise specified, shall be made good by and at the expense of the contractor. Corrections or replacements required because of faulty design, etc., shall be made within the continental limits of the United States by the contractor, at his expense and at the convenience of the contracting agency, at the plant of the manufacturer.

F. METHOD OF INSPECTION AND TEST.

F-1. Inspection.—The contractor shall, at all working hours permit the entrance of representatives

or inspectors of the contracting agent, who shall have the right to follow the material through all the processes of manufacture, tests, packing, and shipping, to determine compliance with this specification. Each generating set shall be inspected to see that it is constructed, finished, and packed in accordance with the requirements set forth in this specification.

F-2. Tests.—The complete equipment shall be given such operating and other tests as may be necessary to assure compliance with these specifications and including the tests described herein. When tests are made at the factory, the contractor shall furnish all the necessary facilities and testing instruments therefore without expense to the contracting office. The contractor shall also furnish such information as may be necessary to determine whether or not the materials used are as specified. The manufacturer shall be held responsible for any defects in material or workmanship which are of such a nature that they could not be detected by careful inspection or tests.

F-2a. Voltage regulation test.—The set shall be operated at full load until the generator temperature becomes approximately constant. From full load, the load shall gradually reduce to no load, taking voltage readings at full load, three-quarter load, one-half load, one-quarter load, and no load. All other such tests as may be necessary to determine full compliance with paragraph E-6 requirements shall be made.

F-2b. Limited operating test.—The set shall be operated at full load for one continuous period of not less than 2 hours after warm-up is complete. During this test the set shall operate without excessive heating or wear of any part. Each set shall be given the voltage regulation test and the limited operating test.

G. PACKING AND MARKING.

G-1. Packing.

G-1a. All parts, liable to rust, shall be thoroughly slushed with a rust-preventing grease.

G-1b. For domestic shipment, the unit shall be packed in accordance with the best commercial practice in order to assure safe delivery. For export shipment, when required, it shall be enclosed in wood containers, conforming to the standard practice for export shipment.

G-2. Marking.—The marking for shipment shall be in accordance with the best commercial practice, and in accordance with instructions which accompany the official order.

H. NOTES.

H-1. Information, cuts, descriptions, etc.—The bidder is required to submit full catalog cuts, descriptions, drawings, diagrams, and all details concerning the equipment he intends to furnish under the proposal. Lack of such information will constitute an insufficient bid and will be disregarded by the contracting officer in consideration for award. Telegraphic bids will not be considered.

H-2. Questions, comments.—All questions or comments arising from the contents of this specification or proposal shall be submitted at least 5 days before the date set for the opening of bids, or consideration cannot be given them.

SPECIFICATIONS, TYPE 3

A. APPLICABLE SPECIFICATIONS.

A-1. The specifications enumerated below of the issue in effect on the date of the Invitation for Bids are made a part of this specification.

American Standards for Rotating Electrical Machinery.

Electrical Safety Code for Electrical Installations and Wiring.

B. TYPE.

B-1. This specification covers a semiautomatic controlled, permanently mounted, Diesel engine driven, a. c., electric generating set, mounted on rigid base for installation on a concrete foundation.

C. MATERIALS AND WORKMANSHIP.

C-1. *Materials.*—The materials for each part of the set shall be as specified herein. All parts subject to corrosion in a damp, salt, tropical climate shall be suitable to withstand corrosion or suitably protected from corrosion. When a definite material is not specified, the material used shall be of the best quality normally used for the purpose in good commercial practice.

C-2. *Workmanship.*—All parts of the generating set and controls shall be manufactured and finished in a thoroughly workmanlike manner. All dimensions shall be held as close as is consistent with good shop practice.

Diesel driven electric generating set, 60 cycles alternating current, semiautomatic, nonfrequency regulation for use in case of power failure.

D. GENERAL REQUIREMENTS.

D-1. There are no general requirements applicable to this specification.

E. DETAIL REQUIREMENTS.

E-1. *General.*—The set shall consist of a Diesel engine, direct connected to an alternating current generator; a built-in or direct-connected exciter; a switchgear for automatic and manual operation, control, and protection of the set; a rigid metal base; tools, accessories, spare parts, instruction books, etc., as described herein. The complete set shall be permanently mounted on a common subbase provided with proper holes, bolts, bushings, etc., for installation on a concrete foundation. The general design shall be such as to produce a workmanlike, practical, and satisfactory machine without the use of unproven devices. The equipment is intended for emergency stand-by operation and the design shall be such that an average nontechnical operator can, with a period of special training of not more than 1 week duration, operate the generator set without difficulty in the dark. The set is intended to provide electric power for lighting and for power, including electric motors, where the power factor of such load will vary from unity to 0.8 (approximately).

E-2. *Capacity.*—The set shall be capable of delivering continuously, at an engine speed of not to exceed 1,200 revolutions per minute, not less than that specified in table, paragraph E-3, at 110-220 volts, alternating current, with frequency of 60 cycles.

E-3. Table of sizes for type 3.

Size	Kilowatt rating	Rated voltage	Frequency control from 60 cycles (maximum variation)	Intermittent overload (1 percent) 1 hour (minimum)	Number of cylinders, engine (minimum)	Maximum piston speed	Engine horsepower delivered to generator shaft (minimum)
						<i>Ft./min.</i>	
a.	12.0	110/220	±2	20.0	4	900	36
b.	20.0	110/220	±2	20.0	6	900	48
c.	32.0	110/220	±2	20.0	6	1,050	78
d.	50.0	110/220	±2	20.0	6	1,200	118

E-4. *Engine.*—The Diesel engine shall be of a water-cooled, vertical type, having the number of cylinders, horsepower delivered to the generator shaft, and rated speed, as specified in E-3, table of sizes for type 3. All power requirements as defined by this specification shall be obtained with ordinary standard fuel which shall consist of a neutral distillate petroleum fuel oil, characteristics of which are defined elsewhere herein. The power requirements are based on standard conditions of sea level with atmospheric pressure at 14.7 pounds per square inch and ambient temperature of 60° F. The engine shall be of a standard commercial design that has proven satisfactory in extensive generating set use, and shall be one for which spare parts are readily obtainable throughout the United States. Positive cold starting shall be readily accomplished by means of electric and manual cranking. The combustion chambers, valves, ports, nozzles, etc., shall be so arranged and designed as to produce high

combustion efficiency, clean exhaust, and long hours of service between servicing of injection system. Crankcase and cylinders shall be of cast iron, with removable dry type sleeves of special alloy to resist high heat and wear. Pistons shall be of suitable material, heat-treated, and equipped with at least five piston rings. The engine lubrication system shall be of the full pressure type and shall consist mainly of positive gear type pump with pressure regulation which shall lift oil from a large capacity oil base through drilled or cast passages to all main, connecting rod, and camshaft bearings, and to water pump drive shaft, valve rocker arms, wrist pins, and to timing and idler gears. Lubrication of the cylinder walls may be by means of splash from connecting rods and main bearings. An oil viscosity indicator shall be furnished to indicate the condition of the lubricating oil. Fuel filter of the dual type shall be provided so that all foreign material may be removed before fuel enters the high pressure pump. High pressure

Municipal Signaling Systems

pump and injection nozzles shall be of highest grade obtainable from domestic manufacture and shall be of a type which may be serviced at many points within the United States. Nozzles shall be of the nonclogging type. A suitable governor shall be mounted on the engine capable of controlling speed to within 5 percent total variation from no load to full load. The muffler shall be of a type consistent with the size of the engine and shall effectively silence the exhaust noise. Suitable fittings and connections shall be supplied with the muffler so that installation may be made to carry exhaust fumes a distance of 15 feet from the generating unit. All parts and materials shall be of such material or coated in such a manner as to protect against corrosion in damp, salt, tropical atmosphere. The complete engine unit, including cooling radiator and accessories, shall be so arranged as to be readily accessible.

E-4a. Starting.—The unit shall be provided with controls such that a semiautomatic start may be accomplished at any moment when power supply is shut off. Any system of controls which may be proposed by the bidder should be adequately described in detail. Wiring diagrams with complete description of operation should accompany bid in time for opening. Unfailing reliability is of utmost importance and proof of successful operation of the system proposed is required. No unproven systems will be considered. The entire unit shall be provided with all accessories, such as starting motor, battery charging facility, and all relays, switches, etc., which may be necessary for complete operation. The path of the hand crank shall be unobstructed.

E-4b. Cooling system.—The engine shall be equipped with a suitable type cooling system, including radiator of ample size, ventilating fan of the pusher type, and water pump. The system shall provide sufficient cooling capacity to keep the engine at a temperature which will insure economical and satisfactory operation when operating the power generator continuously under full rated load, and with a maximum circulating water temperature of not more than 100° F. above an ambient temperature of 100° F. The engine block and radiator shall be provided with suitable water drains. A suitable protective grille shall be provided for the radiator.

E-4c. Fuel tank.—A fuel tank shall be provided having a capacity of 100 gallons and shall be suitable for underground installation. It shall be arranged for pump feed to the engine, and will be located not more than 15 feet from the generator, or not more than 6 feet below the level of the fuel pump on the engine. All necessary fittings shall be provided and shall include suitable filter pipe and cap, vent pipe, supply outlet fittings, line water trap and fittings, etc. Fuel tank shall be treated inside with a protective coating of non-metallic material suitable to reduce corrosion from the effects of water and from such corrosive elements as may occur in standard grades of fuel. The tank shall be coated on the exterior in a commercially acceptable manner to protect from corrosions due to contact with the damp earth.

E-4d. Fuel.—The generating unit shall be capable of satisfactory operation when a neutral distillate petroleum fuel oil of the following characteristics is used:

1. Viscosity at 100° F. 35 seconds, minimum.
(Saybolt Universal)
(preferably 40 to
70)..... 100 seconds, maximum.
2. Sulphur (by weight)..... 2.0 percent, maximum.
3. Conradson carbon..... 0.2 percent, maximum.

4. Ash content..... 0.02 percent, maximum.
5. Moisture and Sediment (B&W) by volume... 0.05 percent, maximum.
6. Flash..... 150° F.
7. Pour point at least as low as.....—20° F.
8. Ignition and burning qualities to be equal to No. 1-D:
Cetane number, minimum..... 50.
Diesel index number, minimum..... 45.
Viscosity-gravity number, maximum..... 0.86.
Boiling point gravity number, maximum. 188.

E-5. Generator.—A 60-cycle, single-phase, three-wire, alternating-current generator as defined by the American Standards for Rotating Electrical Machinery shall be provided. The generator shall have a rated full-load capacity as specified in paragraphs E-2 and E-3. The generator shall fulfill this capacity requirement under full service conditions including the heating effects obtained with the entire equipment assembled for operation. The exciter shall be either built-in or direct-connected to the generator shaft. All coil and winding insulation shall conform with class B insulation as defined by American Standards for Rotating Electrical Machinery, and all temperature measurements and tests will be in accordance with American Standards for the type of equipment supplied. The coils and windings shall be thoroughly treated with an oil and water-resisting insulating compound. At intervals following successive applications of compound or varnish, the coils shall be thoroughly baked. The whole machine shall be insulated and protected for continuous operation in a damp, salt, tropical atmosphere and provision shall be made to prevent failure of insulation due to condensation of moisture upon metallic parts. The terminal leads from the generator shall be brought through the frame with suitable insulating bushings. The generator shaft shall be provided with antifriction bearing or bearings.

E-5a. Overload.—The generator shall operate satisfactorily in all particulars at loads up to and including 120 percent of full-load rating at unity power factor without objectionable noise, vibration, or heating. It shall be capable of developing 120 percent of full-load rating at unity power factor continuously for at least one hour and on a dead short circuit across the terminals for 5 seconds without injury.

E-5b. Voltage regulation.—The generator voltage at unity power factor shall not vary more than 12 percent of full-load voltage at all points between no load and full load, when the generating set is completely assembled and operating under normal conditions. The voltage regulation shall be inherent, that is, obtained without the use of separate voltage regulation devices.

E-6. Control.—The set shall be arranged for manual control, in addition to the semiautomatic control circuit. Provision shall be made through necessary switches so that by a simple change of switch positions, manual start by means of hand-cranking may be made. Provision shall be made for manual stopping of the engine at any time without a tendency for battery cranking to set in. All necessary controls for semiautomatic operation must be supplied.

E-7. Switchboard.—A substantially constructed switchboard panel of impregnated, homogeneous, ebonyl asbestos compound or other similarly suitable material

Municipal Signaling Systems

with all instruments and other devices suitably mounted thereon, shall be supplied. The instruments shall include one alternating-current voltmeter, 0-300 volts; two alternating-current ammeters scaled to include overload, oil pressure gage, water temperature gage, and ammeter to show battery charging rate. One main circuit breaker with overload protection shall also be conveniently mounted upon the panel. The instruments shall be furnished complete with all fuses, shunts, etc., necessary for their proper operation. All other devices necessary for indication or control of the set shall be conveniently arranged. Each instrument and device on the panel shall be identified by stamped designation plates, stenciled with paint, or suitable identification on the particular piece of equipment. The complete switchboard panel should be arranged for most convenient installation near the generating unit, whether arranged for wall mounting, or in pipe standards. A wiring diagram showing all electrical circuits as well as identification of all terminals shall be provided, whether painted on the face of the panel, or mounted in a suitable unexposed part of the panel or control boxes, and protected by suitable covering or clear shielac.

E-8. Wiring.—All wiring and other current-carrying parts shall be proportioned so that no undue heating will occur when the set is operated under the most severe conditions. Connections shall be so secured as to prevent contact with the frame or moving parts and resist movement under stress of normal vibration. All wiring shall be in accordance with the latest edition of the Electrical Safety Code for Electrical Installations and Wiring.

E-9. Base.—The generating unit shall be mounted upon a substantial subbase of cast iron or pressed steel. Base shall be extended a sufficient distance so as to provide ample footing for balance of complete assembly. Shock-resisting bushings, or other type of vibration dampening shall be provided with the unit so that ample cushioning may be established between unit and concrete base.

E-10. Finish.—The machine shall be finished in accordance with best commercial practice. All exposed parts shall be properly primed and given two coats of best grade machinery enamel.

E-11. Nameplates.—The engine and generator shall be provided with manufacturer's nameplates bearing the serial numbers, dates and names of the manufacturer, together with all other pertinent information usually furnished. Identification plates shall be attached to each of the boxes containing the automatic control devices.

E-12. Tools, accessories, spare parts, etc.

E-12a. All tools, accessories and spare parts necessary for the operation and maintenance of the generating set shall be supplied. Tools and spare parts shall include the following:

Tools

- Set of standard open-end wrenches for all removable nuts, caps, and plugs.
- Set of special wrenches, extensions, spanners and accessories required for removal and maintenance of all parts.
- Hammer, screw driver, pliers, adjustable pipe-wrench (small), adjustable open-end wrench (small), adjustable open-end wrench (large).

Spare parts

- Oil-filter cartridge.
- Two fan belts.

Set of water hoses and clamps.

Piston, wrist pin, connecting-rod assembly, with bearings.

Set engine gaskets, complete.

Set of valves, complete (engine).

Standard set replacements for injector system.

Electric spares

One set generator brushes (each kind).

One set generator brush springs (each kind).

Ten fuses of each kind and capacity used on the set.

A set is the amount required for one engine or one generator. All tools and accessories shall be of best quality and shall be acceptable to the contracting agent. All spare parts shall be furnished by the manufacturer of the original equipment and shall be interchangeable therewith.

E-13. A container of wood or metal, provided with a 1½ inch padlock complying with Federal Specification No. FF-P-101, type VI-A, with two duplicate keys, shall be provided for the tools, spare parts, accessories, and instruction books. The container shall be arranged with suitable compartments to secure and protect the parts in a manner so as to be readily accessible. A holder shall be provided for an oil can in an accessible position.

E-14. Instruction books.—The contractor shall furnish for each generating plant 4 copies of a complete instruction book covering the assemblage, description, operation, adjustment, maintenance, and replacement of parts. This manual shall include a wiring diagram and a detailed parts list having pictures or drawings with part numbers for each part of the generating set. The manual shall also include a complete description of the measures that must be taken in order to operate the set at temperatures as low as -10° F. The instructions and parts lists shall be distributed as follows:

Two copies packed with each generating set.

Two copies mailed direct to the contracting agent.

E-15. Standard products.—The equipment supplied under this specification shall be new and unused and shall be essentially standard products of the manufacturers; shall be the manufacturers' latest approved designs and shall be in regular production in order that prompt and continuing service and delivery of parts may be guaranteed.

E-16. Ruggedness.—The equipment to be furnished under this specification shall have demonstrated by extensive satisfactory commercial use the ruggedness essential not only for employment under the type of service for which it is herein intended, but to also withstand shock of usual means of transportation. The contracting agent may require bidder to show evidence of the extensive satisfactory commercial use of the equipment he proposes to furnish.

E-17. Guaranty.—All materials and workmanship shall be of the highest grade and shall be free from any defects or imperfections. Any defect clearly due to faulty design or to faulty material or workmanship, which may develop within 1 year after completion of the contract, unless otherwise specified, shall be made good by and at the expense of the contractor. Corrections or replacements required because of faulty design, etc., shall be made within the continental limits of the United States by the contractor, at his expense, and at the convenience of the purchaser, at the plant of the manufacturer.

Municipal Signaling Systems

F. METHOD OF INSPECTION AND TEST.

F-1. The contractor shall, at all working hours, permit the entrance of representatives or inspectors of the contracting agent, who shall have the right to follow the material through all the processes of manufacture, tests, packing and shipping, to determine compliance with this specification. Each generating set will be inspected to see that it is constructed, finished, and packed in accordance with the requirements set forth in this specification.

F-2. *Tests.*—The complete equipment will be given such operating and other tests as may be necessary to assure compliance with these specifications, including the tests described herein. When tests are made at the factory, the contractor shall furnish all the necessary facilities and testing instruments therefor, without expense to the contracting office. The contractor shall also furnish such information as may be necessary to determine whether or not the materials used are as specified. The manufacturer shall be held responsible for any defects in material or workmanship which are of such a nature that they could not be detected by careful inspection or tests.

F-2a. *Voltage and frequency regulation test.*—The set shall be operated at full load until the generator temperature becomes approximately constant. From full load, the load will be gradually reduced to no load, taking voltage and frequency readings at full load, three-fourths load, one-half load, one-fourth load, and no load.

F-2b. *Limited operating test.*—The set shall be operated at full load for one continuous period of not less than 2 hours after warm-up is complete. During

this test the set shall operate without excessive heating or wear of any part. Each set shall be given the voltage and frequency-regulation test and the limited operating test.

G. PACKING AND MARKING.

G-1. *Packing.*

G-1a. All parts, liable to rust, shall be thoroughly slushed with a rust-preventing grease.

G-1b. For domestic shipment, the unit shall be packed in accordance with commercial practice in order to assure safe delivery. For export shipment, when required, it will be enclosed in wood containers, conforming to standard practice for export shipment.

G-2. *Marking.*—The marking for shipment shall be in accordance with the best commercial practice, and in accordance with instructions which accompany official order.

H. NOTES.

H-1. *Information, cuts, descriptions, etc.*—The bidder is required to submit catalog cuts, descriptions, drawings, diagrams, and all details concerning the equipment he intends to furnish under this proposal. Lack of such information will constitute an insufficient bid and will be disregarded by the contracting officer in consideration for award. Telegraphic bids will not be considered.

H-2. *Questions, comments.*—All questions or comments arising from the contents of this specification or proposal shall be submitted by at least 5 days before the date set for the opening of bids, or consideration cannot be given them.

SPECIFICATIONS, TYPE 4

A. APPLICABLE SPECIFICATIONS.

A-1. The specifications enumerated below, of the issue in effect on the date of the Invitation for Bids, are made a part of this specification.

American Standards for Rotating Electrical Machinery.

Electrical Safety Code for Electrical Installations and Wiring.

B. TYPE.

B-1. This specification covers a semiautomatic controlled, permanently mounted, Diesel-engine-driven, alternating-current electric generating set, mounted on a rigid base for installation on a concrete foundation.

C. MATERIALS AND WORKMANSHIP.

C-1. *Materials.*—The materials for each part of the set shall be as specified herein. All parts subject to corrosion in a damp, salt, tropical climate shall be suitable to withstand corrosion or suitably protected from corrosion. Where a definite material is not specified, the material used shall be of the best quality normally used for the purpose in good commercial practice.

C-2. *Workmanship.*—All parts of the generating set and controls shall be manufactured and finished in a thoroughly workmanlike manner. All dimensions shall be held as close as is consistent with good shop practice.

Diesel-driven electric generating set, 60 cycles alternating current, semi-automatic frequency regulation for teletype, or other systems requiring frequency regulations

D. GENERAL REQUIREMENTS.

D-1. There are no general requirements applicable to this specification.

E. DETAIL REQUIREMENTS.

E-1. *General.*—The set shall consist of a Diesel engine, direct connected to an alternating current generator; a built-in or direct-connected exciter; a switchgear for automatic and manual operation, control, and protection of the set; a rigid metal base; tools, accessories, spare parts, instruction books, etc., all as described herein. The complete set shall be permanently mounted on a common subbase provided with proper holes, bolts, bushings, etc., for installation on a concrete foundation. The general design shall be such as to produce a workmanlike, practical, and satisfactory machine without the use of unproven devices. The equipment is intended for emergency stand-by operation and the design shall be such that an average non-technical operator can, with a period of special training of not more than 1 week duration, operate the generator set without difficulty in the dark. The set is intended to provide electric power primarily for *teletype systems*, with possible additions of electric lighting and powering of small electric motors. Such additional loads shall not comprise more than 10 percent of the total rated capacity of the generating set.

E-2. *Capacity.*—The set shall be capable of delivering continuously at an engine speed of not to exceed 1,200 revolutions per minute, an output not less than that specified in the Table of sizes for type 4 (par. E-3), at 110–220 volts, alternating current, 60 cycles, unity power factor.

E-3. Table of sizes for type 4.

Size	Kilowatt rating	Rated voltage	Frequency control from 60 cycles (maximum variation)	Intermittent overload (percent) 1 hour (minimum)	Number of cylinders, engine (minimum)	Maximum piston speed	Engine horsepower delivered to generator shaft (minimum)
a.....	12	110/220	±2	20	4	<i>Ft./min.</i>	36
b.....	20	110/220	±2	20	6	900	48
c.....	32	110/220	±2	20	6	1,050	78
d.....	50	110/220	±2	20	6	1,200	118

E-4. *Engine.*—The Diesel engine shall be of a water-cooled, vertical type, having the number of cylinders, horsepower delivered to the generator shaft, and rated speed, as specified in E-3, table of sizes for type 4. All power requirements, as defined by this specification shall be obtained with an ordinary standard fuel which shall consist of a neutral distillate petroleum fuel oil, characteristics of which are defined elsewhere herein. The power requirements are based on standard conditions of sea level with atmospheric pressure at 14.7 pounds per square inch, and ambient temperature of 60° F. The engine shall be of a standard commercial design that has proved satisfactory in extensive generating set use and shall be one for which spare parts are readily obtainable throughout the United States. Positive cold starting shall be readily accomplished by

means of electric and manual cranking. The combustion chambers, valves, ports, nozzles, etc., shall be so arranged and designed as to produce high-combustion efficiency, clean exhaust, and long hours of service between servicing of the injection system. Crankcase and cylinders shall be of cast iron, with removable dry-type sleeves of special alloy to resist high heat and wear. Pistons shall be of suitable material and heat-treated, equipped with at least five piston rings. The engine lubrication system shall be of the full pressure type and shall consist mainly of positive gear type pump with pressure regulation which shall lift oil from a large capacity oil base through drilled or cast passages to all main, connecting rod, and camshaft bearings, and to water pump drive shaft, valve rocker arms, wrist pins, and to timing and idler gears. Lubrication of the

Municipal Signaling Systems

cylinder walls may be by means of splash from connecting rods and main bearings. An oil viscosity indicator shall be furnished to indicate the condition of the lubricating oil. Fuel filter of the dual type shall be provided so that all foreign material may be removed before fuel enters the high-pressure pump. High-pressure pump and injection nozzles shall be of the highest grade obtainable from domestic manufacture and shall be of a type which may be serviced at many points within the United States. Nozzles shall be of the nonlogging type. A suitable governor shall be mounted on the engine capable of controlling speed as elsewhere specified herein. The muffler shall be of a type consistent with the size of the engine and shall effectively silence the exhaust noise. Suitable fittings and connections shall be supplied with the muffler so that installation may be made to carry exhaust fumes a distance of 15 feet from the generating unit. All parts and materials shall be of such material or coated in such a manner as to protect against corrosion in damp, salt, tropical atmosphere. The complete engine unit, including a cooling radiator and accessories shall be so arranged as to be readily accessible.

E-4a. Starting.—The unit shall be provided with controls such that a semiautomatic start may be accomplished at any moment when power supply is shut off. Any system of controls which may be proposed by the bidder should be adequately described in detail. Wiring diagrams with complete description of operation should accompany the bid in time for opening. Unfailing reliability is of utmost importance and proof of the successful operation of the system proposed is required. No unproved systems will be considered. The entire unit shall be provided with all accessories, such as starting motor, battery-charging facility, and all relays, switches, etc., which may be necessary for complete operation. The path of the hand crank shall be unobstructed.

E-4b. Cooling system.—The engine shall be equipped with a suitable type cooling system, including radiator of ample size, ventilating fan of the pusher type, and water pump. The system shall provide sufficient cooling capacity to keep the engine at a temperature which will insure economical and satisfactory operation when operating the power generator continuously under full rated load, and with a maximum circulating water temperature of not more than 100° F. above an ambient temperature of 100° F. The engine block and radiator shall be provided with suitable water drains. A suitable protective grille shall be provided for the radiator.

E-4c. Fuel tank.—A fuel tank shall be provided, having a capacity of 100 gallons and suitable for underground installation. It shall be arranged for pump feed to the engine, and shall be located not more than 15 feet from the generator or not more than 6 feet below the level of the fuel pump on the engine. All necessary fittings shall be provided and shall include suitable filler pipe and cap, vent pipe, supply outlet fittings, line water trap, and fittings, etc. The fuel tank shall be treated inside with a protective coating of a nonmetallic material suitable to reduce corrosion from effects of water and from such corrosive elements as may occur in standard grades of fuel. The tank shall be coated on the exterior in a commercially acceptable manner for protection against corrosion due to contact with the damp earth.

E-4d. Fuel.—The generating unit shall be capable of satisfactory operation when a neutral distillate petroleum fuel oil of the following characteristics is used:

1. Viscosity at 100° F.	35 seconds, minimum. (Saybolt Universal) (preferably 40 to 70).
2. Sulfur (by weight).....	2 percent, maximum.
3. Conradson carbon.....	0.2 percent, maximum.
4. Ash content.....	0.2 percent, maximum.
5. Moisture and sediment (B.S.&W.) by volume.	0.05 percent, maximum.
6. Flash.....	150° F.
7. Pour point at least as low as.....	20° F.
8. Ignition and burning qualities to be equal to No. 1-D:	
Cetane No., minimum.....	50.
Diesel Index No., minimum.....	45.
Viscosity, gravity No., maximum.....	0.85.
Boiling point gravity No., maximum.....	188.

E-5. Generator.—A 60-cycle, single-phase, three-wire, alternating-current generator as defined by the American Standards for Rotating Electrical Machinery shall be provided. The generator shall have a rated full load capacity as specified in paragraphs E-2 and E-3. The generator shall fulfill this capacity requirement under full service conditions including the heating effects obtained with the entire equipment assembled for operation. The exciter shall be either built-in or direct-connected to the generator shaft. All coil and winding insulation shall conform with class B insulation as defined by American Standards for Rotating Electrical Machinery and all temperature measurements and tests will be in accordance with American Standards for the type of equipment supplied. The coils and windings shall be thoroughly treated with an oil and water-resisting insulating compound. At intervals following successive applications of a compound or varnish, the coils shall be thoroughly baked. The whole machine shall be insulated and protected for continuous operation in a damp, salt, tropical atmosphere and provisions shall be made to prevent failure of insulation due to condensation of moisture upon metallic parts. The terminal leads from the generator shall be brought through the frame with suitable insulating bushings. The generator shaft shall be provided with antifiction bearing or bearings.

E-5a. Overload.—The generator shall operate satisfactorily in all particulars at loads up to and including 120 percent of full load rating at unity power factor without objectionable noise, vibration, or heating. It shall be capable of developing 120 percent of full load rating at unity power factor continuously for at least 1 hour and on a dead short circuit across the terminals for 5 seconds without injury.

E-6. Voltage and frequency.—Voltage regulation shall be accomplished by inherent regulation contained in the generator and exciter, and by the addition of an approved external regulating device. The external regulating device shall operate automatically to maintain the specified regulation without hunting. A proved and reliable voltage regulator similar and equal to and interchangeable with, Westinghouse Silverstat Regulator shall be furnished and shall be of a type that can be easily mounted on the panel board of the plant. Regulators of the carbon pile, vibrating contact type, or

Municipal Signaling Systems

regulators that have not been in similar service with satisfactory performance for 2 years prior to the issuance of this specification, will not be acceptable. Failure of any part of the voltage regulator shall not cause the exciter shunt field to become inactive in function. The governor of the engine, the windings of the generator and exciter, and the voltage regulator shall be so designed and adjusted that regardless of the temperature (within the limits specified for operation elsewhere herein) of either the engine, generator or exciter, the following frequency and voltage regulation shall be maintained.

1. **Frequency.**—At all loads between no load cold and rated full load hot (at all ambient temperatures within the operating range specified elsewhere herein) the frequency must be within the range of 59 to 61 cycles. No variations outside these limits are permitted. At any selected steady load, frequency shall not vary more than 0.5 cycle.

2. **Voltage.**—Generator must be capable of being adjusted to deliver rated full load amperes at any voltage selected between 220 and 240 or 110 and 120 volts and maintain the voltage regulation specified below at any of such adjustments. With adjustments made for the generator to deliver rated full load amperes cold at a selected voltage, the actual delivered voltage at any load (such load to be at power factor between 80 and 100 percent) between no load cold and rated full load amperes hot must be within a range of 98 to 102 percent of the selected full load cold voltage except that momentary fluctuations outside the limits of this range are permitted as follows:

(1) Rise to 103 or drop to 97 percent of the selected full load cold voltage when the existing load is suddenly varied by an amount not exceeding 10 percent of the generator-rated amperes.

(2) Rise to 112 or drop to 88 percent of the selected full load cold voltage when the existing load is suddenly varied by an amount between 11 and 50 percent of the generator-rated amperes.

(3) Rise to 125 or drop to 75 percent of the selected full load cold voltage when the existing load is suddenly varied by an amount between 51 and 100 percent of the generator-rated amperes.

It is to be understood that the above-mentioned momentary voltage variation requirements do not apply if the load resulting from the sudden load variation exceeds the rated full load amperes of the generator, and if the power factor of the increment load or resulting load is not between 80 and 100 percent.

At any steady load, the voltage, in addition to being within the range specified above, shall be constant to the extent that the needle of the switchboard voltmeter shall not pulsate and to the extent that a recording of such voltage by an Esterline recording voltmeter shall be practically a straight line free from any sharp fluctuations.

The wave form of the output voltage shall be nearly sinusoidal, having a total harmonic distortion not exceeding 10 percent at any load from zero to rated output when a pure resistance load is being fed.

(NOTE.—The contractor is cautioned that the necessary testing equipment must be on hand to measure this distortion at time of inspection. A string oscillograph with photographic attachment is considered necessary to make this test. The photographic attachment must be capable of photographing a zero line for the wave being photographed. The Fischer-Hinnen method will be used to calculate distortion of the wave form).

E-6a. **Control.**—The set shall be arranged for manual control, in addition to the semiautomatic control circuit. Provision shall be made through

necessary switches so that by a simple change of switch positions manual starting may be made by means of hand-cranking. Provision shall be made for manual stopping of the engine at any time without a tendency for battery cranking to set in. All necessary controls for semiautomatic operation must be supplied.

E-7. **Switchboard.**—A substantially constructed switchboard panel of impregnated, homogeneous, ebony asbestos compound or other similarly suitable material with all instruments and other devices suitably mounted thereon, shall be supplied. The instruments shall include one alternating current voltmeter, 0-300 volts, two alternating current ammeters scaled to include overload, oil pressure gage, water temperature gage, and ammeter to show battery charging rate. One main circuit breaker with overload protection shall also be conveniently mounted upon the panel. The instruments shall be furnished complete with all fuses, shunts, etc., necessary for their proper operation. All other devices necessary for indication or control of the set shall be conveniently arranged. Each instrument and device on the panel shall be identified by stamped designation plates, stenciled with paint, or suitable identification on the particular piece of equipment. The complete switchboard panel should be arranged for most convenient installation near the generating unit, whether arranged for wall mounting, or on pipe standards. A wiring diagram showing all electrical circuits as well as identification of all terminals shall be provided, whether painted on the face of the panel, or mounted in a suitable unexposed part of the panel or control boxes, and protected by a suitable covering or clear shellac.

E-8. **Wiring.**—All wiring and other current carrying parts shall be proportioned so that no undue heating will occur when the set is operated under the most severe conditions. Connections shall be so secured as to prevent contact with the frame or moving parts and resist movement under stress of normal vibration. All wiring shall be in accordance with the latest edition of the Electrical Safety Code for Electrical Installations and Wiring.

E-9. **Base.**—The generating unit shall be mounted upon a substantial subbase of cast iron or pressed steel. Base shall be extended a sufficient distance so as to provide ample footing for balance of complete assembly. Shock resisting bushings, or other type of vibration dampening, shall be provided with the unit so that ample cushioning may be established between the unit and the concrete base.

E-10. **Finish.**—The machine shall be finished in accordance with the best commercial practice. All exposed parts shall be properly primed and given two coats of best grade machinery enamel.

E-11. **Nameplates.**—The engine and generator shall be provided with manufacturer's nameplates bearing the serial numbers, dates, and names of the manufacturer, together with all other pertinent information usually furnished. Identification plates shall be attached to each of the boxes containing the automatic control devices.

E-12. **Tools, accessories, spare parts, etc.**—

E-12a. All tools, accessories, and spare parts necessary for the operation and maintenance of the generating set shall be supplied. Tools and spare parts shall include the following:

Tools

Set of standard open end wrenches for all removable nuts, caps and plugs.

Set of special wrenches, extensions, spanners, and accessories required for removal and maintenance of all parts.

Municipal Signaling Systems

Hammer, screw driver, pliers, adjustable pipe-wrench (small), adjustable open end wrench (small), adjustable open end wrench (large).

Spare parts

Oil filter cartridge.

Two fan belts.

Set of water hoses and clamps.

Piston, wristpin, connecting rod assembly, with bearings.

Set engine gaskets, complete.

Set of valves, complete (engine).

Standard set replacements for injector system.

Electric spares

One set generator brushes (each kind).

One set generator brush springs (each kind).

Ten fuses of each kind and capacity used on the set.

A set is the amount required for one engine or one generator. All tools and accessories shall be of the best quality and shall be acceptable to the contracting agent. All spare parts shall be furnished by the manufacturer of the original equipment and shall be interchangeable therewith.

E-13. A container of wood or metal, provided with a 1½-inch padlock complying with Federal Specification No. FF-P-101, type VI-A, with two duplicate keys, shall be provided for the tools, spare parts, accessories, and instruction books. The container shall be arranged with suitable compartments to secure and protect the parts in a manner as to be readily accessible. A holder shall be provided for an oil can in an accessible position.

E-14. *Instruction books.*—The contractor shall furnish for each generating plant four copies of a complete instruction book covering the assemblage, description, operation, adjustment, maintenance and replacement of parts. This manual shall include a wiring diagram and a detailed parts list having pictures or drawings with part numbers for each part of the generating set. The manual shall also include a complete description of the measures that must be taken in order to operate the set at temperatures as low as -10° F. The instructions and parts lists shall be distributed as follows:

Two copies packed with each generating set.

Two copies mailed direct to the contracting agent.

E-15. *Standard products.*—The equipment supplied under this specification shall be new and unused and shall be essentially standard products of the manufacturers; shall be the manufacturers' latest approved designs, and shall be in regular production in order that prompt and continuing service and delivery of parts may be guaranteed.

E-16. *Ruggedness.*—The equipment to be furnished under this specification shall have demonstrated by extensive satisfactory commercial use the ruggedness essential not only for employment under the type of service for which it is herein intended, but also to withstand shock of usual means of transportation. The contracting agent may require the bidder to show evidence of the extensive satisfactory commercial use of the equipment he proposes to furnish.

E-17. *Guaranty.*—All materials and workmanship shall be of the highest grade and shall be free from any defects or imperfections. Any defect clearly due to faulty design or to faulty material or workmanship, which may develop within 1 year after completion of the contract, unless otherwise specified, shall be made good by and at the expense of the contractor. Correc-

tions or replacements required because of faulty design etc., shall be made within the continental limits of the United States by the contractor, at his expense, and at the convenience of the purchaser, at the plant of the manufacturer.

F. METHOD OF INSPECTION AND TEST.

F-1. *Inspection.*—The contractor shall permit the entrance of representatives or inspectors of the contracting agent, who shall have the right to follow the material through all the processes of manufacture, tests, packing, and shipping, to determine compliance with this specification. Each generating set shall be inspected to see that it is constructed, finished, and packed in accordance with the requirements set forth in this specification.

F-2. *Tests.*—The complete equipment will be given such operating and other tests as may be necessary to assure compliance with these specifications, including the tests described herein. When tests are made at the factory, the contractor shall furnish all the necessary facilities and testing instruments therefor, without expense to the contracting office. The contractor shall also furnish such information as may be necessary to determine whether or not the materials used are as specified. The manufacturer shall be held responsible for any defects in material or workmanship which are of such a nature that they could not be detected by careful inspection or tests.

F-2a. *Voltage and frequency regulation test.*—The set shall be operated at full load until the generator temperature becomes approximately constant. From full load, the load will be gradually reduced to no load, taking voltage and frequency readings at full load, three-fourths load, one-half load, one-fourth load, and no load.

F-2b. *Limited operating test.*—The set shall be operated at full load for one continuous period of not less than 2 hours after warm-up is complete. During this test the set shall operate without excessive heating or wear of any part. Each set shall be given the voltage and frequency regulation test and the limited operating test.

G. PACKING AND MARKING.

G-1. *Packing.*—

G-1a. All parts, liable to rust, shall be thoroughly slushed with a rust-preventing grease.

G-1b. For domestic shipment, the unit shall be packed in accordance with commercial practice in order to assure safe delivery. For export shipment, when required, it will be enclosed in wood containers, conforming to standard practice for export shipment.

G-2. *Marking.*—The marking for shipment shall be in accordance with the best commercial practice, and in accordance with instructions which accompany official order.

H. NOTES.

H-1. *Information, cuts, descriptions, etc.*—The bidder is required to submit full catalog cuts, descriptions, drawings, diagrams, and all details concerning the equipment he intends to furnish under this proposal. Lack of such information will constitute an insufficient bid and will be disregarded by the contracting officer in consideration for award. Telegraphic bids will not be considered.

H-2. *Questions, comments.*—All questions or comments arising from the contents of this specification or proposal shall be submitted by at least 5 days before the date set for the opening of bids, or consideration cannot be given them.

SPECIFICATIONS, TYPE 5

A. APPLICABLE SPECIFICATIONS.

A-1. *Specifications.*—The specifications enumerated below of the issue in effect on the date of the Invitation for Bids are made a part of this specification.

American Standards for Rotating Electrical Machinery.
Electrical Safety Code for Electrical Installations and Wiring.

B. TYPE.

B-1. This specification covers various sizes of portable type, gasoline-engine driven, alternating current, electric generating sets.

C. MATERIALS AND WORKMANSHIP.

C-1. *Materials.*—The materials for each part of the equipment shall be as specified herein. Where a definite material is not specified, the materials used shall be of the best quality normally used for the purpose in good commercial practice.

C-2. *Workmanship.*—All parts of the generating set shall be manufactured and finished in a thoroughly workmanlike manner. All dimensions shall be held as close as is consistent with good shop practice.

Portable electric generating set, 60 cycles alternating current

D. GENERAL REQUIREMENTS.

D-1. *General.*—The set shall consist of an air or water-cooled gasoline engine, as specified in paragraph D-2a for the size and type required, the engine to be directly connected to an alternating current generator, complete in all detail including tools, accessories, spare parts, instruction books, etc., all as described herein. The general design shall be such as to produce a workmanlike, practical and workable machine without the use of unproven devices. The equipment is intended for emergency, portable operations and its design shall be such that an average nontechnical operator can operate the set without difficulty. The unit shall be compact and arranged so as to afford maximum portability.

D-2. *Capacity.*—The generating set shall be capable of delivering the designated power continuously at 110 volts, alternating current, 60 cycles, and at unity power factor. The capacity of the generating set shall be as specified in the invitation to bid according to size designation as listed in table for sizes, paragraph D-2a.

D-2a.

Size	Kilowatt rating	Over-load 1 hour minimum	Frequency regulation from 60 cycles, maximum (deviation)	Engine horse-power delivered to generator shaft, minimum	Rated speed revolutions per minute, maximum	Number of cylinders engine, minimum	Piston speed engine, maximum	Method of cooling engine	Type of mounting assembly	Housed or open type	Type of panel or switch board required	Overall weight (dry) (maximum)
		<i>Percent</i>					<i>Ft./min.</i>					<i>Pounds</i>
A.....	0.35	20.0	±1.5	1.0	1,800	1	700	Air.....	Skid.....	Open.....	A	95
B.....	.50	20.0	±1.5	1.7	1,800	1	830	do.....	do.....	do.....	A	150
C.....	.75	20.0	±1.5	2.0	1,800	1	830	do.....	do.....	do.....	A	165
D.....	1.0	20.0	±1.5	2.5	1,800	1	830	do.....	do.....	do.....	A	170
E.....	1.5	20.0	±1.5	3.0	1,800	2	830	do.....	do.....	do.....	A	145
E-1.....	1.5	20.0	±1.5	4.0	1,800	1	830	Water.....	do.....	Housed.....	B	310
F.....	2.0	20.0	±1.5	2.0	1,800	2	830	do.....	do.....	do.....	B	570
G.....	3.0	20.0	±1.5	7.0	1,800	2	830	do.....	do.....	do.....	B	575
H.....	5.0	20.0	±1.5	14.0	1,800	4	830	do.....	do.....	do.....	B	840
H-1.....	5.0	20.0	±1.5	16.0	1,700	4	830	do.....	do.....	do.....	B	1,375
I.....	7.5	20.0	±1.5	22.0	1,800	4	1,150	do.....	do.....	do.....	B	1,380
J.....	10.0	20.0	±1.5	24.5	1,800	4	1,150	do.....	do.....	do.....	B	1,450

D-3. *Engine.*—The gasoline engine shall be of a four-cycle type, having the number of cylinders, capable of satisfactorily operating the generator continuously at full rated load at maximum rated speed, as designated in paragraph D-2a, for the size required, and shall have sufficient surplus capacity for operation at designated overload for a period of at least 1 hour without overheating or detonation. All power requirements as defined by this specification shall be obtained with ordinary standard (straight) unblended gasoline of 68 octane. The engine shall be of a standard commercial design that has proved satisfactory in generating set use and shall be one for which spare parts are readily obtainable throughout the United States. A high-tension magneto, impulse coupling (sizes H-1 through J) and distributor shall be provided. The magneto shall be suitably insulated with sufficient high-grade baked varnish to withstand a damp, salt, tropical climate. The engine shall be equipped with a suitable

air filter, a mechanical governor to control speed within 5 percent, a mechanical fuel pump (if required) and an effective type muffler. The governor shall control the speed to within 5 percent from no load to full load. The carburetor shall be equipped with a suitable air filter. The carburetor, fuel pump, and all other similar parts or accessories shall be constructed of corrosion-resisting materials suitable to withstand damp, salt, tropical climate, or otherwise protected against corrosion by suitable means such as plating, or enameling, etc. The complete engine unit shall be so arranged that all parts are readily accessible. A suitable fuel tank having a capacity for at least 4 hours operation of the set at full-rated load shall be provided and conveniently mounted as part of the unit. It shall be arranged for either gravity or pump feed to the engine. The tank shall be provided with a suitable filler cap, protected vent and all necessary connections to the engine.

Municipal Signaling Systems

D-3a. Cooling.—Water-cooled engines shall be provided with a cooling system including radiator, fan, etc., capable of keeping the engine at a temperature which will insure economical and satisfactory operation when operating the power generator continuously under full rated loads and with a maximum circulating water temperature rise of not more than 100° F. over an ambient temperature of 100° F. The engine block and radiator shall be provided with suitable water drains. A suitable protective grille shall be provided for the radiator.

D-3b. Cooling.—Air-cooled engines shall be so designed that adequate cooling is accomplished throughout the maximum output range. A cooling blower shall be integral with the engine and provide an ample supply of cooling air to all cooling surfaces such that no overheating effects will be obtained. At 120 percent of full load, no seizing, detonation, pre-ignition or other similar conditions shall be noticeable after 1 hour of operation on standard grades of gasoline fuel of 68 octane rating, at an ambient temperature of 100° F. and at sea-level atmospheric pressure.

D-4. Generator.—A 60-cycle, single-phase, alternating-current, continuous rating, self-ventilated, splash-proof generator as defined by American Standards for Rotating Electrical Machinery shall be provided. The generator shall have a rated full load capacity as designated in the Table of sizes for type 5 (D-2a) which is a part of this specification. This capacity requirement is under full service conditions including the heating effects obtained with the entire equipment assembled for operation. All coil and winding insulation shall conform with class B insulation as defined by American Standards Association and all temperature measurement tests shall be made in accordance with said standards for the type of equipment supplied. The coils and windings shall be thoroughly treated with an oil and water resisting insulating compound. At intervals following successive applications of compounds of varnish, the coils shall be thoroughly baked. The whole machine shall be insulated and protected for continuous operation in a damp, salt, tropical atmosphere, and provision shall be made to prevent failure of insulation due to condensation of moisture upon metallic parts. The terminal leads from the generator shall be brought through the frame with suitable insulating bushings. The generator shaft shall be provided with antifriction bearing or bearings.

D-4a. Overload.—The generator shall operate satisfactorily in all particulars at all loads up to and including 120 percent of rated full load without objectionable noise vibration or heating. It shall be capable of operating at 20 percent overload continuously for at least 1 hour and on a dead short-circuit across the terminals for 30 seconds without injury.

D-4b. Voltage regulation.—The generator voltage at unity power factor shall not vary more than 13 percent of full-load voltage at all points between no load and full load, when the generating set is completely assembled and operating under normal conditions. The voltage regulation shall be inherent, that is, obtained without the use of separate regulating devices.

D-4c. Frequency regulation.—The generator output frequency shall not exceed 1.5 cycles variation from 60 cycles at any point between no load and full rated load and the average frequency change shall not be more than 0.5 cycle for a given change in load of 10 percent of full load rating between no load and full load.

D-5a. Control and switchgear.—All units or sizes of the open type shall be started by means of a rope or hand crank and arranged for manual control. The engine shall be started manually by hand cranking and stopped by short-circuiting the magneto by means of a suitable push-button switch. A small panel shall be conveniently mounted on the set and shall contain the stop-button, 0-150 volt alternating current voltmeter, and a pair of twist-lock receptacles. Receptacles shall contain a suitable cap or plug for subsequent use with extension cord. The above-described control and switchgear shall be known as type A, as shown in table D-2a.

D-5b. Control and switchgear.—All units or sizes of the housed or closed type shall be arranged for manual starting with magneto ignition by means of a hand crank or rope. The engine shall be stopped by short-circuiting the magneto by means of a suitable push-button switch. A suitable ammeter, voltmeter, circuit-breaker, water-temperature indicator, gasoline gage, oil-pressure gage, stop-push-button, main power terminals and outlet for trouble or service light shall be provided and mounted upon a suitably insulated panel. The instrument panel shall be arranged within the sheet-metal housing in such a manner as to be readily accessible to the operator, and shall be enclosed and protected from the elements of weather. A carburetor choke control shall be convenient to the hand crank location. This control shall be known as type B as shown in table D-2a.

D-6. Wiring.—All wiring and other current-carrying parts shall be proportioned so that no undue heating will occur when the set is operated under the most severe conditions. Connections shall be so secured as to prevent contact with the frame or moving parts. All wiring shall be in accordance with the latest edition of the Electrical Safety Code for Electrical Installation and Wiring.

D-7. Mounting and housing.—All units shall be mounted on suitable skids for portable field service. Units of the open type (without housing) shall be provided with conveniently located carrying handles, so arranged that when the unit is transported by means of these handles, no undue tipping or condition of unbalance will exist. The enclosed units (housed) shall be in metal housings which shall have adequate ventilation to prevent the engine and generator from overheating when operating. Metal carrying handles which telescope or fold so as to be out of the way when the set is operating, shall be provided. The number of handles to be furnished are dependent upon the weight of the generating set, that is, a sufficient number of handles shall be furnished so that the set may be easily carried.

D-8. Finish.—The machine shall be finished in accordance with best commercial practice. All exposed parts shall be properly primed and given two coats of high-grade machinery enamel.

D-9. Nameplates.—The engine and generator shall be provided with manufacturers' nameplates bearing the serial numbers, dates, and names of the manufacturers, together with all other pertinent information usually furnished.

D-10. Tools, accessories, spare parts and containers.—

D-10a. All tools, accessories and spare parts necessary for the operation and maintenance of the generating set shall be supplied. Tools, accessories, and spare parts shall include the following:

Municipal Signaling Systems

Tools

Hammer.
Screwdriver.
Pliers.
Set of standard fixed open end wrenches for all removable nuts, caps and plugs.
Set of special wrenches, extensions, spanners and accessories required for removal and maintenance of all parts.

Accessories

Engine crank or rope as required for manual start.
Oil can.
Funnel for filling fuel tank.

Engine spares

Set piston rings (one complete replacement).
Set spark plugs.
Set intake valves.
Set exhaust valves.
Set valve springs.
Set valve keys.
Set cork and copper gaskets.
Magneto interrupter.
Connecting rod with bearings.
Two fan belts (if used).

Electric spares

One set generator brushes (each type used).

A set is the amount required for one engine or for one generator. All tools and accessories shall be of good quality, acceptable to the contracting agent. All spare parts shall be furnished by the manufacturers or the original equipment.

D-10b. *Container*.—A container of wood or metal, provided with a 1½-inch padlock complying with Federal Specification No. FF-P-101, type VI-A, with two duplicate keys, shall be provided for the tools, spare parts, accessories, and instruction books. The container shall be arranged with suitable compartments to secure and protect the parts in a manner so as to be readily accessible. A holder shall be provided for the oil can in an accessible position.

D-11. *Instruction books*.—The contractor shall furnish for each generating set two copies of a complete instruction book covering the assemblage, description, operation, wiring diagram, lubrication, adjustment, maintenance, and replacement of parts. This manual shall include a detailed parts and price list having pictures with parts numbers for each part of the complete unit. Photographs or drawings of the general assembly of the generating set shall be provided. The manual shall include a complete description of the measures that must be taken when operating the generating set at temperatures as low as -10° F. The instruction book, parts lists, etc., shall be bound together in a suitable cover to form one complete volume. Both copies of the instruction book shall be boxed for shipment with the set, unless otherwise specified by the contracting agent.

D-12. *Standard products*.—The equipment supplied under this specification shall be new and unused and shall be essentially standard products of the manufacturers; shall be the manufacturers' latest approved designs, and shall be in regular production in order that prompt and continuing service and delivery of parts may be guaranteed.

D-13. *Ruggedness*.—The equipment to be furnished under this specification shall have demonstrated by extensive satisfactory use the ruggedness essential not only for employment under the extreme conditions encountered in the field but also to withstand transportation in a truck over rough country roads at speeds up to 25 miles an hour. The contracting agent may require the bidder to show evidence of the extensive satisfactory commercial use of the equipment he proposes to furnish.

D-14. *Guarantee*.—All materials and workmanship shall be of the highest grade and shall be free from any defects or imperfections. Any defect clearly due to faulty design or to faulty workmanship or material, which may develop within one year after completion of the contract, unless otherwise specified, shall be made good by and at the expense of the contractor.

E. DETAIL REQUIREMENTS.

E-1. *Engines*.—The gasoline engine shall conform to paragraphs D-3 and D-3a, and shall deliver the power designated in Table D-2a for the sizes required. Horsepower, as designated in table D-2a, is net horsepower, available for transmission directly to the generator shaft at the rated revolutions per minute. The bidder shall be required to show proof that the engine he proposes to furnish for the size required is capable of such output.

E-2. The generators shall conform to paragraph D-5 and shall have nominal rated capacities as indicated in table D-2a, for the size and type required.

E-3. *Weight*.—The complete generating set, exclusive of tools, accessories, spare parts, etc., shall not exceed the weights as designated in Table of sizes (D-2a) for the size or type required. Weights given in Table of sizes are dry weights for the complete equipment, ready to operate.

F. METHODS OF INSPECTION AND TEST.

F-1. *Inspection*.—The contractor shall at all working hours permit the entrance of representatives or inspectors of the contracting agent, who shall have the right to follow the material through all the processes of manufacture, tests, packing, and shipping to determine compliance with this specification. Every facility, including suitable office space and equipment, shall be given the inspectors for the proper execution of their work. The contractor shall make, at his own expense, and previous to test by the contracting agent, or his representatives, sufficient tests to insure that the units conform to the specifications in all respects. Each generating set will be inspected to see that it is constructed, finished, and packed in accordance with the requirements set forth in this specification.

F-2. *Tests*.—The complete equipment will be given such operating and other tests as may be necessary to assure compliance with these specifications, including the tests described herein. When tests are made at the factory, the contractor shall furnish all the necessary facilities therefor without expense to the contracting agency. The contractor shall also furnish such information as may be necessary to determine whether or not the materials used are as specified. The manufacturers shall be held responsible for any defects in material and workmanship which are of such a nature that they could not be detected by careful inspection or tests.

F-2a. *Voltage and frequency regulation test*.—The set shall be operated at full load until the generator

Municipal Signaling Systems

temperature becomes approximately constant. From full load the load will be gradually decreased to no load, taking voltage and frequency readings at full load, three-fourth load, one-half load, one-fourth load, and no load.

F-2b. The set shall be operated at full load for 4 hours. During this test the set shall operate without excessive heating or wear of any part. This 4-hour period may be a part of the run-in period, at the discretion of the manufacturer.

G-1. *Packing.*—

G-1a. All parts liable to rust shall be thoroughly slushed with a rust-preventing grease.

G-1b. For domestic shipment, the unit shall be packed in accordance with commercial practice in order to insure safe delivery. For export shipment, when required, it will be enclosed in wood containers, conforming to best commercial practice.

G-2. *Marking.*—The marking for shipment shall be in accordance with the usual commercial practice, or as specifically mentioned in purchase order.

H. NOTES.

H-1. *Information, cuts, descriptions, etc.*—The bidder is required to submit full catalog cuts, descriptions, drawings, diagrams, and all details concerning the equipment he intends to furnish under the proposal. Lack of such information will constitute an insufficient bid and will be disregarded by the contracting officer in consideration for award. Telegraphic bids will not be considered.

H-2. *Questions and comments.*—All questions or comments arising from the contents of this specification or proposal shall be submitted by at least 5 days before the date set for the opening of bids, or consideration cannot be given them.