Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 150/5340-17	
AIRPORTS	
EFFECTIVE: 1/25/68	

SUBJECT: STANDBY POWER FOR NON-FAA AIRPORT LIGHTING SYSTEMS

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1. PURPOSE. This advisory circular describes standards acceptable for the design, installation, and maintenance of standby power for non-agency owned airport visual aids associated with the National Airspace System (NAS).

2. APPLICABLE PUBLICATIONS. Technical publications listed under Bibliography, Appendix 1, provide guidance and detailed information as may be required.

3. HOW TO OBTAIN THIS CIRCULAR. Obtain additional copies of this circular, AC 150/5340-17, Standby Power for Non-FAA Airport Lighting Systems, from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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Director, Airports Service

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1. BACKGROUND. Agency policy requires that visual aids associated with facilities in the National Airspace System (NAS) and the national system of airports have a definite configuration for electrical power. This advisory circular contains electrical power details acceptable for non-agency owned lighting aids associated with these systems.

2. ELECTRICAL POWER CONFIGURATIONS. The three basic configurations are listed below. Drawings of these configurations are shown in Figure 1.

   a. Configuration "A".

      (1) Configuration "A" provides the lighting system with electrical power from an engine generator within 15 seconds after the failure of the prime electrical power source that is furnished by a utility company. The transfer of power in the system is automatic.

      (2) Certain airports have been designated continuous power airports to insure that the agency maintains a basic system independent of commercial power sources in the event of a widespread loss of commercial power. A listing of the continuous power airports is in Appendix 3. The lighting systems on the designated runway of a continuous power airport that have configuration "A" power are as follows:

         (a) Runway centerline and touchdown zone lights.

         (b) Runway edge lights and the taxiway lights associated with this runway.

         (c) Apron perimeter lights (not flood lights).

   b. Configuration "B".

      (1) Configuration "B" provides the lighting system with power from an alternate prime power source within 15 seconds after failure of the prime power source. The transfer of power in the system is automatic.

      (2) Runway centerline lights, touchdown zone lights, and high intensity runway lights for Category II operations have configuration "B" or higher power. Configuration "B" power provides acceptable reliability and operational availability of the facilities. Details concerning Category II operations are contained in Advisory Circular 120-20, Criteria for Approval of Category II Landing Weather Minima.

c. Configuration "C". Configuration "C" consists of connections of the facility to a prime power source. There are no provisions for alternate prime power or engine generator sets. All lighting aids not covered in configurations "A" and "B" are in configuration "C". Even though standby power is not required for configuration "C", a higher grade configuration of power is encouraged for airport lighting systems where a second source can be provided at a reasonable cost.

3. DESIGN. The power systems at all facilities should be designed to meet the requirements of the applicable electrical codes. The detailed design requirements for the systems in this advisory circular are flexible to permit the equipment to be installed and operated with minimum changes to the power distribution system at the airport.

a. Configuration "A" Power.

(1) KVA Requirements. Prior to the selection of standby power equipment, determine the kilovolt ampere (KVA) input to the regulators as follows:

(a) Set the regulator to supply maximum output current.

(b) Energize the regulator with the lighting load connected.

(c) Measure the volts and amperes at the regulator's input terminals. Only qualified personnel should make the measurements at the high voltage input of the regulator.

(d) Calculate the input KVA by multiplying the measured volts times the measured amperes and dividing by 1000. Normally the measured KVA input to the regulator is less than the calculated KVA input.

(e) If the regulator does not have rated load connected to the output circuit, calculate the KVA input to the regulator with rated load connected. This can be calculated by dividing the rated kilowatts (KW) of the regulator by the regulator's efficiency and power factor. Typical calculations are shown in Figure 2.

(2) Power and Control.

(a) Design the system to provide an automatic changeover from the prime power to the engine generator equipment within 15 seconds after a power failure occurs. The detailed design requirement for the installation may vary to

conform with local conditions, but no variations are permitted in the systems performance requirements. A typical system diagram is shown in Figure 3.

(b) If the engine generator set is not designed to operate continuously under a no-load condition, provide a relay or some other protective device as shown in Figure 3. This relay prevents the engine generator set from operating under a no-load condition in case a power failure occurs when the regulator's remote control switch is in the off position. This is accomplished by by-passing the control switch used to control on-off operation of the regulator. The maintenance of some engine generator equipment is increased when the equipment is operated continuously under a no-load condition.

(3) Space and Ventilation. Provide adequate space and ventilation for the engine generator equipment. The required space, ventilation, and engine exhaust provisions will be controlled by the KVA rating of the engine generator, the design characteristics of the equipment, and the space required to maintain the engine generator set and its auxiliary equipment. The engine generator should be located as close as practical to the constant current regulator it is serving. A typical equipment layout and typical floor spaces are shown in Figure 4.

b. Configuration "B" Power.

(1) Connection Requirements. Connections for this configuration are obtained by one of the methods listed below. Drawings of these wiring diagrams and connections are shown in Figures 5 and 6.

(a) Connection to two separate commercial generating plants with separate feeders from each plant.

(b) Connection to two continuous separate feeders from a single commercial generating plant.

(c) Connection at two different substations to a commercial power network fed from more than one generating plant. Separate feeders are provided from the substations.

(2) Dual Feeders. These feeders are separated to the extent that electrical malfunction or physical damage is unlikely to result in outage of both.

c. Configuration "C" Power. This configuration, as shown in Figure 7, has no provisions for standby power; however, configuration "A" or "B" is encouraged for all visual aids where it can be provided at a reasonable cost.

d. Emergency Lighting. An adequate number of flare pots or equivalent battery-powered emergency lights should be available at all lighted airports for emergency use. Commercially available equipment has design characteristics acceptable for local application under emergency conditions.

e. Remote Operations. If specified in the plans, a remote controlled switch may be provided to simulate a power failure and permit operation of the standby power equipment by isolating the commercial power. This switch may be used for preventive maintenance operational checks.

4. EQUIPMENT AND MATERIAL.

a. Engine Generator Set. The engine generator set is designed to meet the applicable industry standards and code requirements.

(1) General Requirement. Provide a set, for installation in a shelter, that is automatic, quick starting, and capable of carrying rated load at all ambient temperatures between 20°F. and 120°F. Where ambient temperatures below 20°F. are anticipated, supplemental shelter heat should be specified. This equipment is required to carry rated load within 15 seconds after a power failure. The output voltage of the generator is a value acceptable for connection to the input of regulators in accordance with Advisory Circular 150/5345-21. Generators required for operation of regulators in accordance with Advisory Circular 150/5345-10A have a step-up transformer, if required, between the regulators and generator. The output frequency of the generator is 60 hertz plus or minus commercially acceptable tolerances. Additional details concerning the engine generator set are contained in Appendix 4.

(2) Exhaust System. Provide exhaust silencers (mufflers) and pipes as required for the particular installation. The exhaust pipes, when required, are black steel in accordance with Federal Specification WW-P-406, Weight A, Class 1.

(3) Batteries. Provide batteries that have a terminal voltage suitable for starting the engine generator and a minimum watt hour rate as specified in Specification FAA-E-2204. Provide racks for the batteries as required.

(4) Battery Charger. Provide a battery charger with the engine generator set to assure reliable service from the standby equipment.

b. Transformer. Provide, if required, a step-up transformer to make the output voltage of the engine generator set compatible with the input voltage to the regulator. Transformers may also be used to step down primary power and permit the use of low voltage automatic transfer switches. The transformers are commercial equipment conforming to the applicable industry and electrical standards. The transformer is rated to supply the required input KVA to the equipment without the transformer overheating.

c. Fuel Storage Tank.

(1) Provide the fuel storage tank for the engine generator set with capacity adequate to provide reliable operation for the minimum period of time established by local requirements. If no emergency operating periods have been established locally, provide adequate fuel tank capacity for at least 24 hours continuous operation. When selecting a particular size, consider the time required to replenish the fuel supply, the availability of fuel, the accessibility of fuel under adverse conditions, fuel required for maintenance test runs (paragraph 8c), and the frequency of maintenance inspections of the fuel tank and supply. A typical fuel consumption for a diesel engine driven generator set is 2.5 gallons per kilowatt per 24-hour time period at rated load. A typical fuel consumption for a gasoline engine driven generator set is 4.0 gallons per kilowatt per 24-hour time period at rated load.

(2) Select a fuel tank that meets the requirements of the National Fire Code and local codes. Provide fuel lines from the engine generator set to the tank as required by the equipment's design.

d. Mounting Pads. If required, provide a mounting pad (foundation) for the engine generator set in accordance with the manufacturer's instructions and the plans for the installations.

e. Conduit and Wiring. Provide all conduit and wiring in the vault or engine generator shelter in accordance with the requirements of the National Electrical Code and local codes.

f. Radiator Air Duct. Provide, if required, an air duct from the engine radiator to a wall opening. The air intake should be adequate for proper operation and cooling of the equipment.

g. Switchboard.

(1) Provide a switchboard with the engine generator set. This equipment has provisions to switch the input to the regulator from the prime power source to the standby engine generator within the required time interval after power failure is detected. Use at least a voltage sensing device to detect a power failure. When prime power is restored, the input to the regulator is switched from the standby power source to the prime power source. The automatic transfer switch meets the performance requirements of FAA-E-2204. The type of automatic switch used with the engine generator is acceptable for configuration "B" installations.

(2) Provide the switchboard with proper terminals for connecting the prime power source, the load, and the batteries. The switchboard should also include safety devices consisting of low oil cutout, high temperature cutout, overcrank cutout, and overspeed cutout. The equipment is in accordance with the applicable electrical and industry standards.

(3) Provide a by-pass switch as indicated in Figure 3 to permit running the engine generator on manual start-stop to facilitate servicing.

5. INSTALLATION.

a. Configuration "A".

(1) Engine Generator Set and Accessories. Install the engine generator and its accessories in accordance with the manufacturer's instructions and the plans for the installation. The completed installation should meet all requirements of the National Electrical Code and local codes. A typical installation is shown in Figure 4.

(a) Air Intake. Provide access to an adequate quantity of air for the intake of the engine generator. A typical air intake system is shown in Figure 4. A wind baffle fence or other suitable provision may be installed to reduce the back pressure imposed on the engine generator exhaust hood by hurricane force winds. These winds can result in the overheating of some engine generator equipment that is available.

(b) Exhaust System.

1 Support the exhaust pipe when it is installed through a wall. Where metal plates or metal sleeves are required, use a layer or layers of fireproof vibration absorbent material conforming to Federal Specification HH-I-570. This material is at least 1/8-inch thick. If the exhaust piping and muffler are not protected, paint them with heat resistant aluminum paint conforming to Federal Specification TT-P-28.

2 When the exhaust pipe terminates in a vertical direction, install exhaust pipe rain cap unless otherwise specified.

(c) Batteries, Battery Charger, and Battery Rack. Install the batteries, battery charger, and battery rack at the location indicated in the plans for the installation. Place the electrolyte in the battery cells after the batteries are in their final position.

(2) Fuel Storage Tank and Lines. Install the fuel storage tank and lines in accordance with the equipment manufacturer's instructions and local code requirements. Locate the tank at the place indicated in the plans.

(3) Transformer. Install the step-up transformer at the location indicated in the plans. Make connections to the transformer in accordance with the equipment manufacturer's instructions.

(4) Mounting Pads. Install the mounting pad at the location indicated in the plans. The size and construction of the pad are as specified in the plans for the installation.

(5) Switchboard. Install the switchboard at the location indicated in the plans. A typical location of this equipment is shown in Figure 4. The installation shall meet all applicable code requirements.

(6) Conduit and Wiring. Install conduit and wiring in accordance with the National Electrical Code and local code requirements.

b. Configuration "B". The configuration "B" power is normally installed by the utility company(s); however, assurance should be obtained that the installation will meet the configuration and design requirements of paragraphs 2b and 3b, respectively.

c. Configuration "C". There are no provisions for the installation of standby power with a particular performance requirement. However, the installation of a power configuration higher than "C" is encouraged for all visual aids.

6. INSPECTION.

a. Engine Generator Set.

(1) Inspect the engine generator set and its accessories to obtain assurance that the equipment is installed in accordance with the equipment manufacturer's instructions.

(2) Check the mounting of the engine and generator to determine if the equipment is securely mounted.

(3) Check all pipes, conduits, and accessories to determine if each item is securely fastened.

(4) Check all wiring to determine if it is correct and that all connections are secure.

b. Fuel Storage Tank and Line. Inspect the fuel storage tank and lines to determine if the equipment is properly installed and that there are no fuel leaks.

c. Batteries. Check all connections to determine if they are secure and that the electrolyte in the battery cells is at the proper level.

d. Output Voltage. Check the output from the engine generator set to determine if the voltage is adequate for the regulator's input power and control circuits. Make this check prior to connecting the regulator to the engine generator set.

7. TESTS.

a. Engine Generator Set.

(1) Conduct tests recommended in the manufacturer's instructions.

(2) Test the installation by operating the system continuously for at least one hour. In addition, simulate at least 10 power failures and check the starting time of the engine generator equipment.

(3) Test the operation of all safety devices furnished with the engine generator equipment.

b. Switchboard. Test the operation of components used to obtain an automatic transfer of power from the prime source to the standby equipment.

c. Batteries. Test the batteries to determine if the specific gravity is within the range recommended by the manufacturer.

8. MAINTENANCE.

a. General. The equipment manufacturers issue specific instructions for their engine generator equipment. These instructions contain information obtained through experience and they are provided to assure reliable and efficient service from the equipment. In view of this, the instructions should be read, understood, and followed. Only qualified personnel should be allowed to maintain the engine generator set and its accessories.

b. Engine Generator Set. Perform preventive maintenance on the engine generator set in accordance with equipment manufacturers instructions.

c. Operation Check. Unless otherwise specified, make a weekly operational check of the engine generator equipment by operating the emergency equipment for one hour minimum while it is supplying the constant current regulator.

d. Vault or Shelter. Keep the enclosure housing of the engine generator set and its accessories clean and uncluttered to prevent dirt from accumulating in control compartments and to allow equipment to be accessible at all times. Warning signs should be legible and mounted in conspicuous locations.

e. Tank and Fuel Line. Check fuel tank covers and fuel line after each refueling to determine that these components are secure.

f. Spare Parts. Stock adequate spare parts for maintenance purposes.

APPENDIX 1. BIBLIOGRAPHY

1. Obtain copies of the following publications from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

   a. AC 120-20, Criteria for Approval of Category II Landing Weather Minima.

   b. AC 150/5345-10A, Specification for L-828 Constant Current Regulator With Stepless Brightness Control.

   c. AC 150/5345-11, Specification for L-812 Static Indoor Type Constant Current Regulator Assembly; 4KW and 7½KW; With Brightness Control for Remote Operation.

   d. AC 150/5345-21, Specification for L-813 Static Indoor Type Constant Current Regulator Assembly; 4KW and 7½KW; For Remote Operation of Taxiway Lights.

2. Obtain copies of Specification FAA-E-2204, Engine Generator Sets, 5KW to 300KW may be obtained from the Federal Aviation Administration, Systems Standards Branch, RD-420, 800 Independence Avenue, S.W., Washington, D.C. 20590.

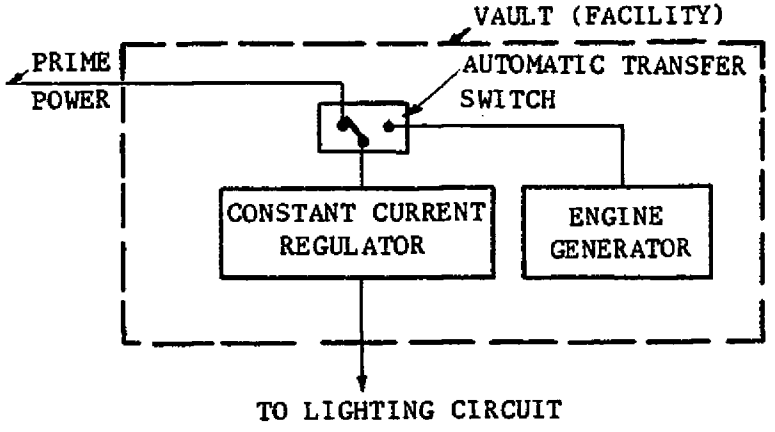
3. Copies of the following Federal specifications may be obtained from the Business Service Center of General Services Administration Regional Offices.

   a. HH-I-570, Insulation blanket, thermal (asbestos, for temperatures up to 1,000°F.).

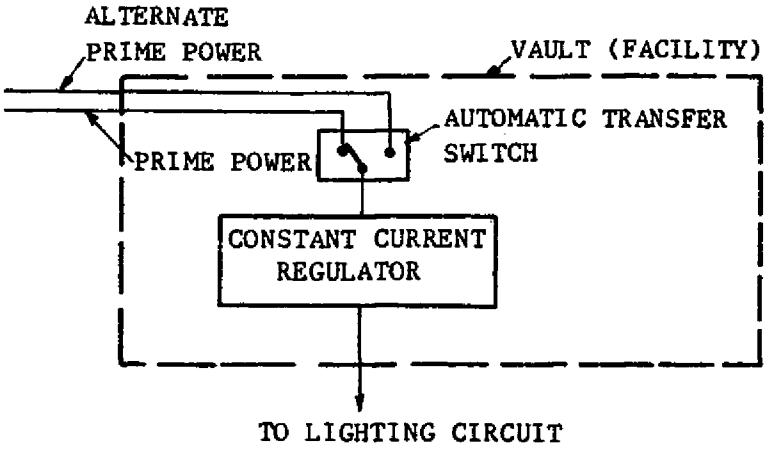
   b. TT-P-28, Paint, aluminum, heat resisting (1200°F.).

   c. WW-P-406, Pipe, steel (seamless and welded) (for ordinary use).

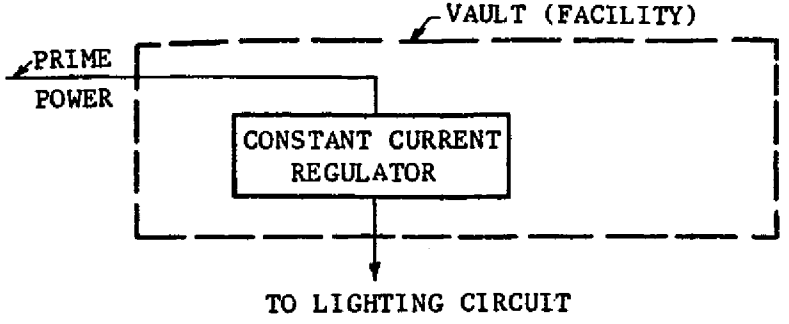
4. Copies of the National Electrical Code and National Fire Code may be obtained from the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.



CONFIGURATION "A"



CONFIGURATION "B"



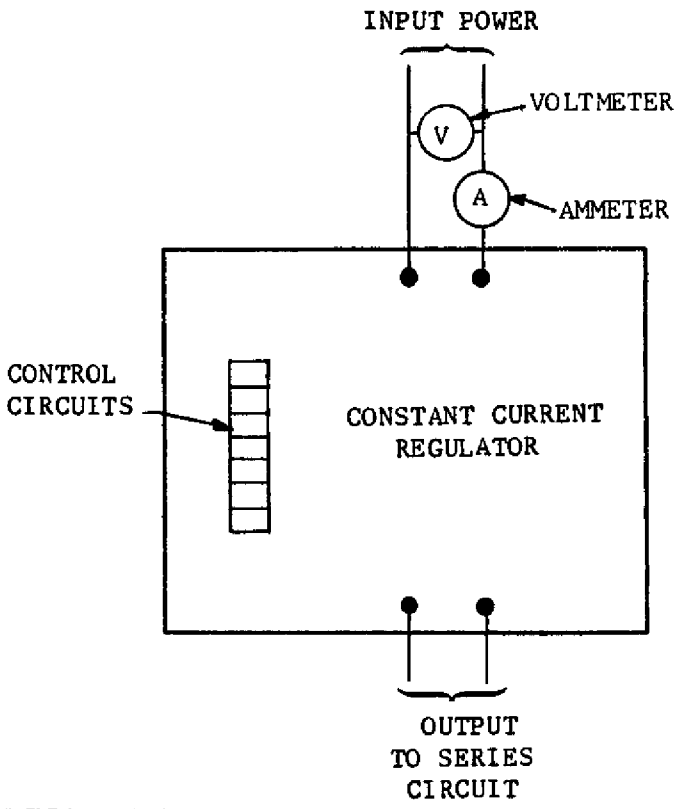
CONFIGURATION "C"

NOTES:

1. Configurations "A" and "B" require the transfer of power within 15 seconds.

2. A power configuration higher than "B" and "C" is encouraged for airport lighting aids where a second source can be provided at a reasonable cost.

FIGURE 1. ELECTRICAL POWER CONFIGURATIONS



NOTES:

1. Only qualified personnel should take voltage and current measurements.

2. Suitable meters should be used to take voltage and current readings.

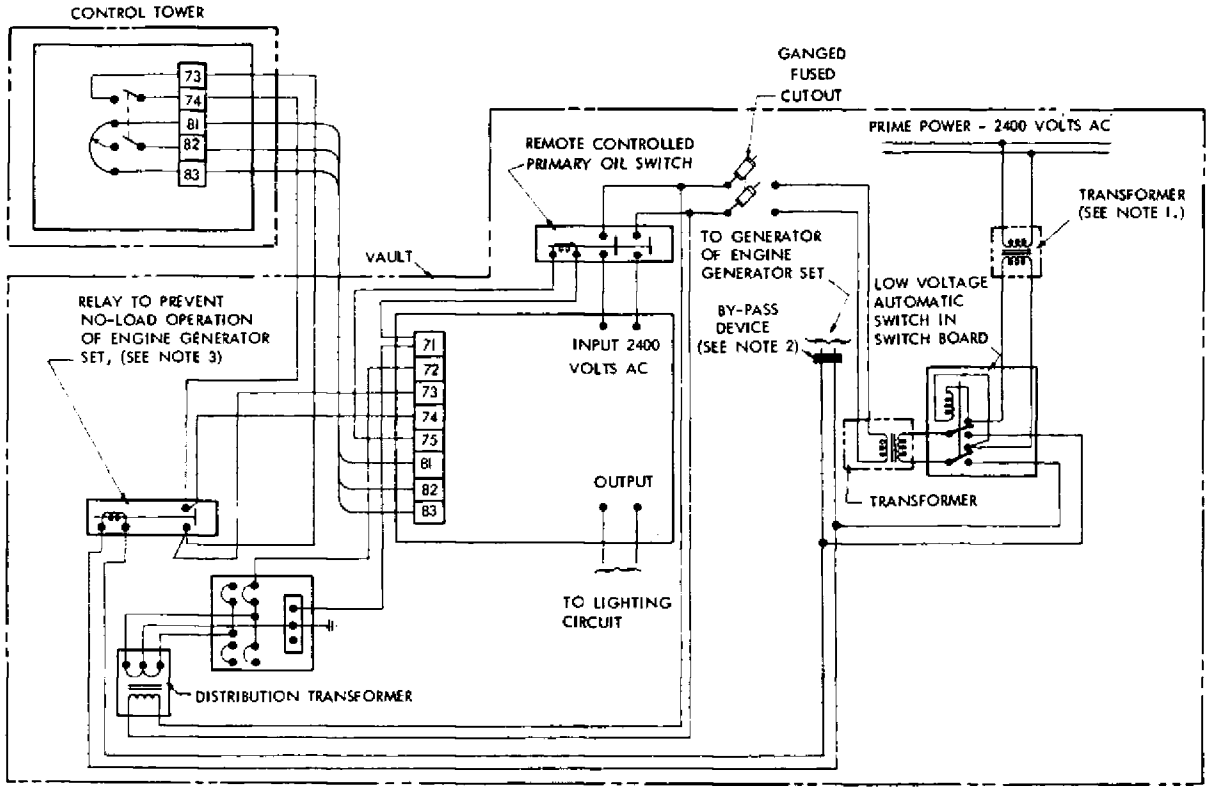
TYPICAL CALCULATIONS

1. Measured KVA
   a. Volts = 2400V
   b. Amperes = 17.0A
   c. KVA Input = $\frac{\text{Volts x Amperes}}{1000}$ $\frac{2400 \times 17.0}{1000}$ = 40.8KVA

2. Calculated KVA
   a. KW = 30
   b. Efficiency = 0.92 (obtain this value from applicable advisory circular for regulator, e.g., Specification L-828)
   c. Power Factor = 0.7 (same as note for b. above)
   d. KVA Input = $\frac{\text{KW}}{\text{Efficiency x Power Factor}}$ $\frac{30}{0.92 \times 0.7}$ = 46.6KVA

3. It is normal for the measured KVA to be less than the calculated KVA, however, the calculated KVA should be used for design purposes. The difference in the values can be caused by the regulator having a higher efficiency and power factor than the values used in the calculations or by the load on the regulator.

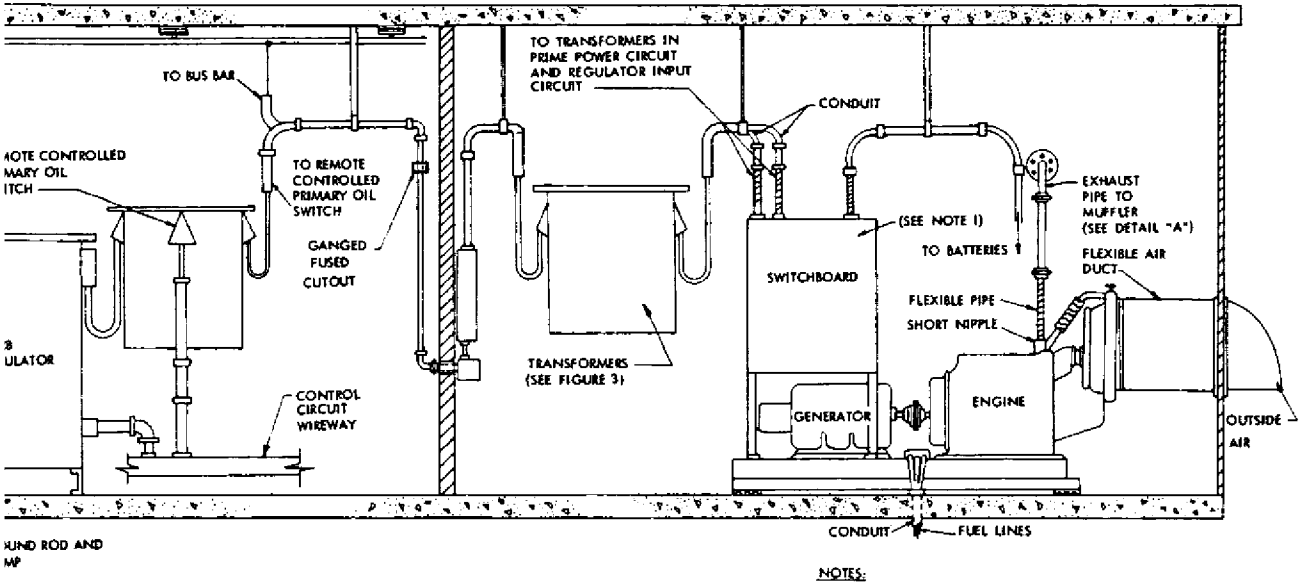
FIGURE 2. TYPICAL KVA INPUT REQUIREMENTS



NOTES:

1. TRANSFORMERS IN THE PRIME POWER AND THE REGULATOR INPUT CIRCUITS ARE NOT REQUIRED IF A SUITABLE HIGH VOLTAGE AUTOMATIC SWITCHING SYSTEM IS USED.
2. PROVIDE A BY-PASS SWITCH TO PERMIT RUNNING THE ENGINE GENERATOR ON MANUAL START-STOP TO FACILITATE SERVICING.
3. THE RELAY SHOWN IN REGULATOR'S CONTROL CIRCUIT IS NOT REQUIRED IF ENGINE GENERATOR SET IS DESIGNED TO OPERATE UNDER NO-LOAD CONDITIONS.

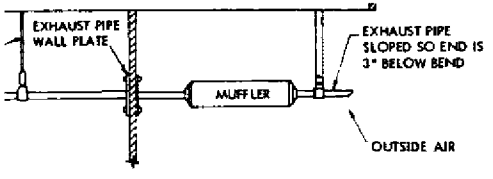
FIGURE 3. TYPICAL WIRING DIAGRAM FOR CONFIGURATION "A" POWER



EQUIPMENT LAYOUT FOR CONFIGURATION "A" POWER

NOTES:

1. THE SWITCHBOARD IS NOT REQUIRED TO BE MOUNTED ON THE ENGINE GENERATOR MOUNTING PAD. IT MAY BE WALL MOUNTED OR INSTALLED AT ANY CONVENIENT LOCATION.
2. TYPICAL FLOOR SPACES FOR A 37.5 KVA ENGINE GENERATOR SET WITH AUXILIARY EQUIPMENT AND A 75 KVA ENGINE GENERATOR SET WITH AUXILIARY EQUIPMENT ARE 12' WIDTH X 16' LENGTH AND 15' WIDTH X 17' LENGTH, RESPECTIVELY.



DETAIL "A"

FIGURE 4. TYPICAL EQUIPMENT LAYOUT FOR CONFIGURATION "A" POWER

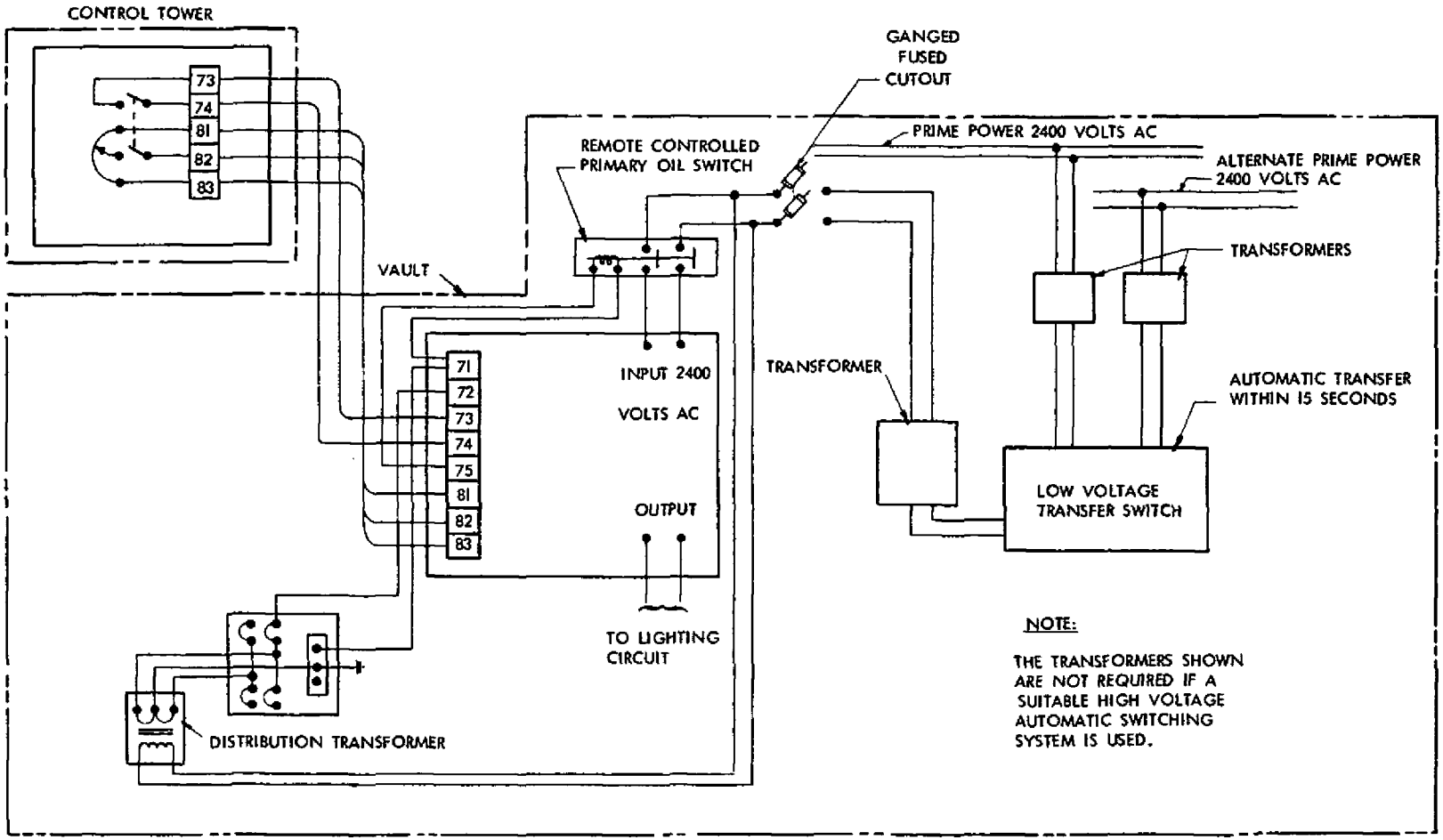
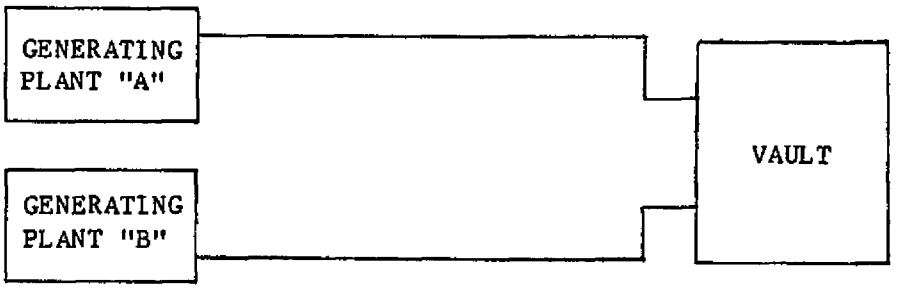
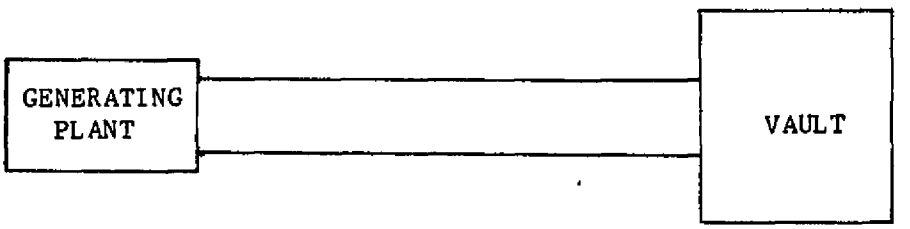


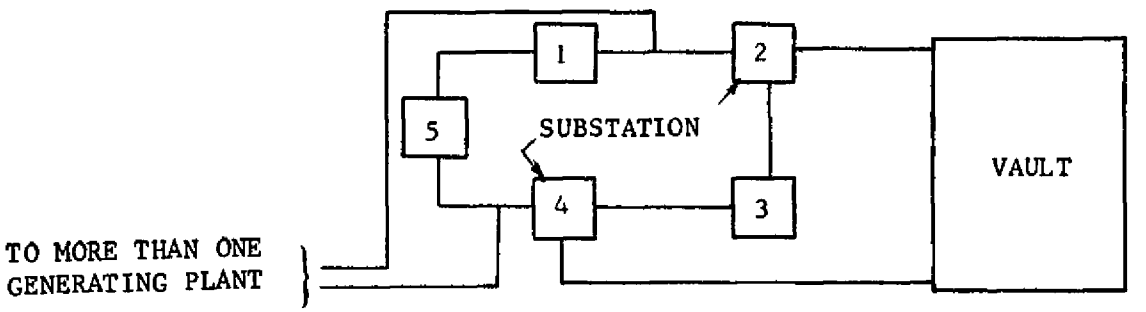
FIGURE 5. TYPICAL WIRING DIAGRAM FOR CONFIGURATION "B" POWER



CONNECTION TO TWO SEPARATE COMMERCIAL GENERATING PLANTS WITH SEPARATE FEEDERS FROM EACH PLANT



CONNECTION TO TWO CONTINUOUS SEPARATE FEEDERS FROM A SINGLE COMMERCIAL GENERATING PLANT



CONNECTION AT TWO DIFFERENT SUBSTATIONS TO A COMMERCIAL POWER NETWORK FED FROM MORE THAN ONE GENERATING PLANT

FIGURE 6. TYPICAL CONNECTION REQUIREMENTS FOR CONFIGURATION "B" POWER

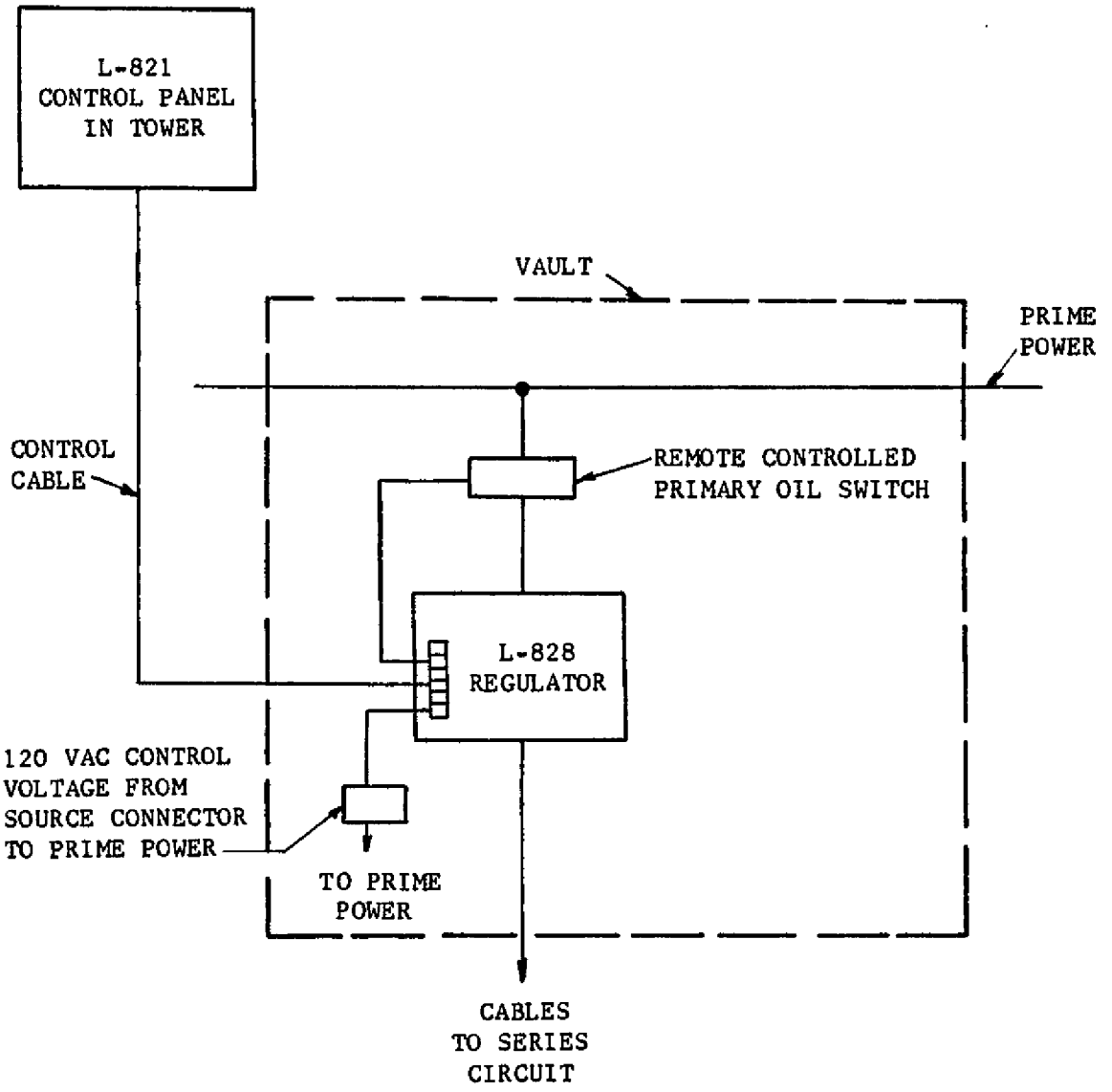


FIGURE 7. TYPICAL WIRING DIAGRAM FOR CONFIGURATION "C" POWER

APPENDIX 3. CONTINUOUS POWER AIRPORTS

Albuquerque (ABQ)
Andrews AFB (ADW)
Atlanta (ATL)
Baltimore (BAL)
Bismarck (BIS)
Boise (BOI)
Boston (BOS)
Chicago (ORD)
Chicago (MDW)
Charlotte (CLT)
Cincinnati (CVG)
Cleveland (CLE)
Dallas (DAL)
Denver (DEN)
Des Moines (DSM)
Detroit (DTW)
El Paso (ELP)
Great Falls (GTF)
Houston (HOU)
Indianapolis (IND)
Jacksonville (JAX)
Kansas City (MCI)
Los Angeles (LAX)
Memphis (MEM)
Miami (MIA)
Milwaukee (MKE)
Minneapolis (MSP)
Nashville (BNA)
Newark (EWR)
New Orleans (MSY)
New York (JFK)
New York (LGA)
Oklahoma City (OKC)
Omaha (OMA)
Ontario, California (ONT)
Philadelphia (PHL)
Phoenix (PHX)
Pittsburgh (PIT)
Reno (RNO)
Salt Lake City (SLC)
San Antonio (SAT)
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San Francisco (SFO)
St. Louis (STL)
Seattle (SEA)
Tampa (TPA)
Tulsa (TUL)
Washington (DCA)
Washington (DIA)
Wichita (ICT)

APPENDIX 4. ENGINE GENERATOR EQUIPMENT PERFORMANCE REQUIREMENTS

1. REFERENCED SPECIFICATION. Specification FAA-E-2204, Engine Generator Sets, 5KW to 300KW, may be used as a guide in selecting standby power equipment. Inasmuch as the requirements for airport lighting are not as rigid as those for supplying power to radar and communication facilities operated and maintained by our agency, the requirements in FAA-E-2204 may be modified as indicated in paragraph 2 below.

2. MODIFICATION TO SPECIFICATION FAA-E-2204, PAGES 3-24:

3. REQUIREMENTS

3.1 Description

Modify to permit transfer switches to be mounted on the wall instead of on the engine generator.

3.2.2 Interchangeability

Delete. Not applicable.

3.2.4 Painting

Modify to eliminate any certain color, to permit use of manufacturers' standard colors.

3.2.7 Spare Parts

Delete

3.2.8 Nameplate and Serial Numbers

Delete requirements for FAA standard nameplate. All other nameplates should be required.

3.2.10 Instruction Book

Delete all reference to Specification FAA-D-2160.

3.3.2 Engine Description

In the second paragraph this specification states that the "Maximum brake horsepower and speed of the engine shall be as specified in the Classification Table, Figure 1." This Classification Table should be modified to delete the developed horsepower at synchronous speed and permit higher speed on the larger plants.

3.3.11 Governor and Frequency Regulation

Close tolerances on frequency requirements may be relaxed. Standard commercial tolerance is acceptable.

3.4.1 Generator

Eliminate the requirement for parallel operation.

3.4.11 Load Test Jacks

Load test jacks are not required and should be eliminated.

3.4.13 Automatic Power Transfer Equipment

Modify this item to permit the transfer switch and equipment to be mounted on the wall adjacent to the engine generator.

3.4.13.1 Automatic Transfer Switch

Modify to permit wall mounting.

4. INSPECTION AND TESTS

5. PREPARATION FOR DELIVERY

All reference to the tests and inspections shown in 4.1 to 5.3.1, pages 28-33 inclusive, should be deleted. However, the manufacturer should certify that the plant furnished will meet the above tests.

Page 43 - CLASSIFICATION TABLE

Develop HP at Synch. Speed

Delete developed HP at synchronous speed. The manufacturer must supply an engine of sufficient horsepower rating to develop the full KVA rating of the plant.

Maximum Speed RPM

Increase all 1200 RPM to 1800 RPM.

U. S. GOVERNMENT PRINTING OFFICE : 1968 O - 291-370

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