AC EMERGENCY POWER
BUILDING ENGINEERING
STANDBY AC PLANTS

CONTENTS PAGE

1. GENERAL

1.01 This section is issued to replace AT&T Section 760-240-120 Issue 1, October 1977 which is no longer standard in Southwestern Bell. This section should now be adapted to Southwestern Bell procedures. It is issued to set forth the guidelines for selecting the type of standby AC power plant and the building considerations.

1.02 Whenever this section is reissued the reason for reissue will be listed in this paragraph.

1.03 It is the policy of Southwestern Bell to normally provide standby power under the most economical of the following alternatives:

1. A 24-hour battery reserve supported by a portable engine-alternator.
2. A 3-hour (plus travel time) battery supply supported by a stationary engine-alternator with manual operation.
3. A 3-hour battery reserve supported by a stationary engine-alternator with automatic start and load control.

1.04 An orderly process of migration from one of the above listed conditions to another requires that the change be in conjunction with, and a part of the major equipment growth job that causes the increase in requirement. The costs involved will therefore be included in the state construction program and six-year plan.

1.05 Specific extenuating conditions should be considered and sound engineering judgement exercised in the application of these guidelines. As an example, a remote inaccessible site may require a greater degree of protection than if in a more favorable location.

1.06 Details on economic study techniques may be found in technical planning statement 78-008: "Economic Study Guidelines for Capital Expenditures."

1.07 The power plant equipment contained in Section 760-240-901SW is either manufactured by Western Electric Company or manufactured by another vendor to a Western Electric KS-specification. For other power plant equipment rated as "standard" for Southwestern Bell use, consult Southwestern Bell's "Supplies and Telecommunications Products Catalog," its associated Southwestern Bell Engineering Letters (SWEL's), and the documentation provided by each vendor. Also, consult the Catalog to determine if the equipment rated as "standard" by AT&T in the section is also rated as "standard" for use within Southwestern Bell.

- Terms commonly used for these AC power plants include "emergency," "reserve," "auxiliary," and "standby." Standby is used throughout this manual in conformance with the definition in Article 750 of the National Electric Code.

- Set(s) or engine(s) used herein will mean engine-alternator set(s).

2. SELECTION GUIDELINES

2.01 Stationary Vs Portable Standby Engines
All central offices, radio, and repeater stations should be equipped with adequate battery reserve or engine-alternator sets as defined in Part 1. The use of portable sets will probably be found to be attractive only in small locations, such as a CDO with about 3,000 lines or less or a small repeater station. New stored program offices should be equipped with a stationary standby plant since the electronic processor is susceptible to damage if operated under certain reduced voltage conditions.

When office conditions do not specifically require coverage by a stationary standby plant, life cycle costs of providing such equipment should be compared with the life cycle costs of providing a <u>minimum</u> battery reserve of 24 hours considering such factors as:

1. Accessibility of the location.
2. Reliability of the commercial AC service - (consider the history of power interruptions).
3. Criticality of the load.
4. Availability of floor space.
5. Cost of routine runs (plus travel).
6. Cost of modifications to service and house service board.
7. Portable sets require storage space, maintenance, and periodic operation with a load.
8. Transport of portable engines during emergencies can be hindered by roads blocked by fallen trees, snow, or water.
9. To accomplish any savings, a single portable set should be assigned to several offices, yet a commercial power failure may affect a number of offices in the same area at the same time.

2.02 Diesel Vs Gas-Turbine Engines
Use Table A for a listing of the AC Standby Plants that are "standard." Consult the "Supplies and Telecommunications Products Catalog" for additional listings and for updated listings of units rated as "standard."

The selection of a gas-turbine versus a diesel-driven alternator depends upon several factors weighed by the particular site requirements. Consider the following factors:

- Unit Cost. Turbine sets typically cost more (basic material prices).
- Installation cost. Diesels of large capacity, greater than 250 kW, cost more to install than comparable turbines, making total initial cost about the same.
- Size. Diesels typically require more floor area and ceiling height.
- Weight. Diesels are typically heavier requiring basement or reinforced floor location.
- Vibration. Diesels typically generate more vibration, thus requiring installation on specially prepared floors and isolation pads.

- Fuel Storage. Turbines typically consume more fuel for equal run times, thus requiring large storage tanks and fuel quantities for the same reserve time (see Table A). However, extra tankage and stored fuel costs only about $3.00 per kW.
- Fuel Usage. Turbines typically require less running time for proper routining to ensure the same high availability, thus resulting in lower overall fuel usage.
- Air Handling. Turbines require less total air for cooling and combustion, thus requiring less building ductwork for air handling.
- Audible Noise. Turbines are more effectively silenced by relatively inexpensive means because they generate higher frequency noise from the compressor and turbine wheels.
- Loading. Turbines may be operated at partial loads for extended periods without adverse effects. Diesels, however, must be loaded at least to 30 percent of capacity (see Section 155-191-301[1]) to prevent "wet stacking." Wet stacking is caused by unseated piston rings that lower combustion pressures and temperatures and allow the exhaust stack to emit lubricating oil. These conditions cause excessive air pollution (smoke) and more rapid engine deterioration leading to more frequent maintenance.

Some of the above factors and some factors listed in Table A are "intangibles" - monetary value is difficult to establish for them. Consider these factors as swaying decisions in those cases where the total costs of the alternatives are essentially equal.

2.03 Automatic Vs Manual Control

All standard turbine engines have automatic controls with provision for manual operation. Standard diesels can be ordered with either manual or automatic controls.

If automatic start operation is provided, automatic load administration will also be necessary.

Automatic control should be provided for new unattended or partially attended single-engine sites with less than 1,600 amperes of load. Retrofit of existing locations in this category shall be implemented in conjunction with ongoing activity over a period of years, as "triggers" occur, rather than immediately, and should be justified on an individual basis.

The additional cost of automatic operation is to be justified on the basis of economic factors which include the following:

1. The history of power interruptions.
2. Accessiblity of the location during bad weather.
3. The cost differential for automatic equipment.
4. The cost of necessary additions and modifications to the service entrance and house service board.
5. The cost to modify HVAC mechanical and distribution equipment for automatic operation.

6. The cost to modify or replace manual controls on mechanical systems.
7. The existence of critical AC loads that are not fed by a DC to AC inverter.
8. Effect on battery life if deep discharge is planned.

For large, new, offices, automatic operation may be considered in order to reduce the possibility of operator error in paralleling and load administration. In such a case, the above factors apply and, in addition, the need for comprehensive training to maintain the automatic system and to bypass it and operate in manual mode in case of failure of the automatic system must be addressed.

Refer to EL 6941 (IL 80-10-235) for information on conversion kits to convert manual KS-engines to automatic operation. Also, RL 79-03-014 recommends the use of automatic operation for some new engine installations. EL 6926 (IL 80-10-078) recommends the necessary transfer devices for automatic operation of KS-engine sets.

2.04 Single Vs Multiple Engines

You must decide whether to select single or multiple engines to power the standby bus for each telephone building. Follow the guidelines in Section 3, Power Systems Engineering Manual[2] weighing these factors:

- Capital expenses are deferred with the use of multiple engines by installing capacity only as needed. For example, the first set in a new site could be sized for the immediate load plus the projected five-year load. Then engines could be added, as required, for each additional five-year growth projection. Reliability is greater with multiple engines since the loss of one set does not mean the loss of all the essential loads.
- Overall floor space for a single large set is generally less than for multiple sets, assuming an equal kW rating for the system.
- In sizing a single diesel set, remember that loading on a single diesel must be at least 30 percent of capacity (see Section 155-191-301[1]). This requirement is more easily met with multiple sets installed in increments as needed.
- More switchgear is required for a multiple set installation. Also, installation costs and maintenance expenses will be higher. However, these "added" expenses may result in lower present worth of annual charges (PWAC) because they are deferred. See Section 3, Power Systems Engineering Manual[2].

2.05 Multiple Sets - Should They Be Paralleled?

If multiple sets are used, they could be used singly (each with its own bus and load) or the sets could be paralleled (see Figure 1). See Table C for the advantages and disadvantages associated with paralleling multiple sets.

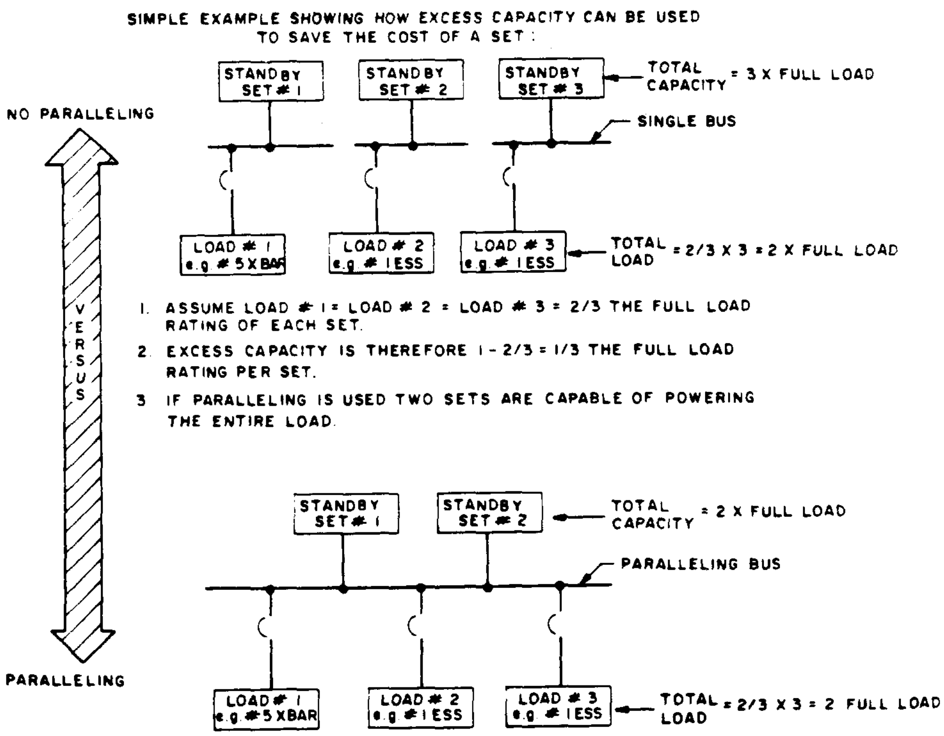

Figure 1. Multiple sets (used in parallel or discreetly).

2.06 Automatic Vs Manual Paralleling

Tables D and E describe the relative advantages and disadvantages of automatic and manual paralleling. Consider the fundamental trade-off between the equipment costs of automatic paralleling versus the training/reliability costs of manual paralleling. (See Section 3, Power Systems Engineering Manual[2] for an example of a typical analysis procedure.)

2.07 Single Vs Dual Bus Distribution

Figures 2 and 3 show simplified dual and single bus configurations respectively,* which can be used in telephone operating company buildings. The dual bus system is more flexible and reliable for the following reasons:

- Failure of one bus does not result in complete failure of the system because selected loads can be powered through the remaining bus.

*There are many variations of each configuration used throughout the Bell System. Figures 2 and 3 are simplified schematics for illustrative purposes only.

FIGURES 2 AND 3

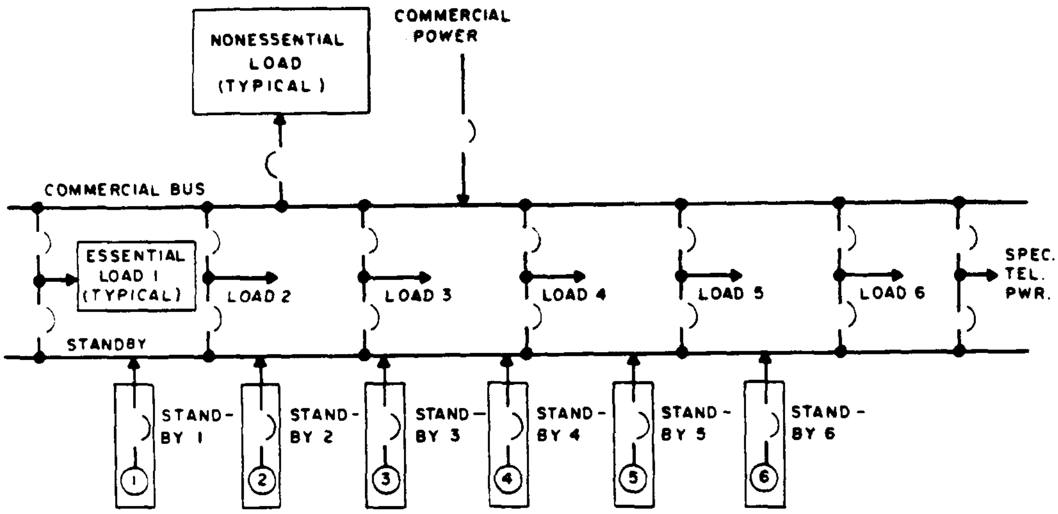

Figure 2. Dual bus.

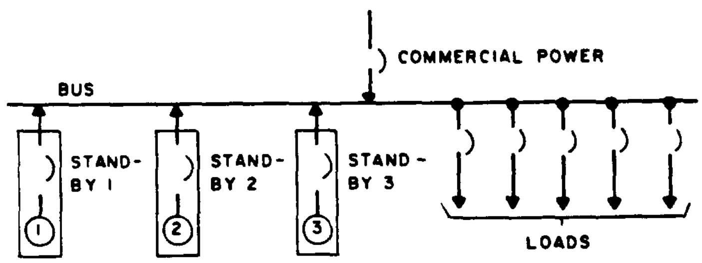

Figure 3. Single bus.

- Selected loads are switchable between the standby and the commercial bus thereby providing brownout protection for these selected loads and also permitting reduction of power company demand charges during peak load conditions by powering part of the office with standby sets.

- Provides the ability to switch special telephone operating company power loads to the standby bus during emergencies but not during normal engine routining.

On the other hand, single bus systems are lower in costs, especially when they are combined with an onset transfer switch. This option is only available on the smaller diesels (115, 75, 45, and 30 kW). When used, the switch eliminates the need for a building circuit breaker (see Figure 4). However, the following restrictions apply:

- It is not possible to use an onset transfer switch with a multiple-set installation; hence, no growth is possible.

- Commercial power passes through the engine-alternator electrical cabinet; therefore, it is not possible to isolate the engine for "cold" repairs unless a bypass switch is added to the system.

- Building loads, including those nonessential loads that are disconnected during commercial power failures, cannot exceed the rating of the onset transfer switch.

For the above reasons it is generally recommended that single bus be considered for use in small offices and the dual bus system be used for large offices where multiple sets are frequently used.

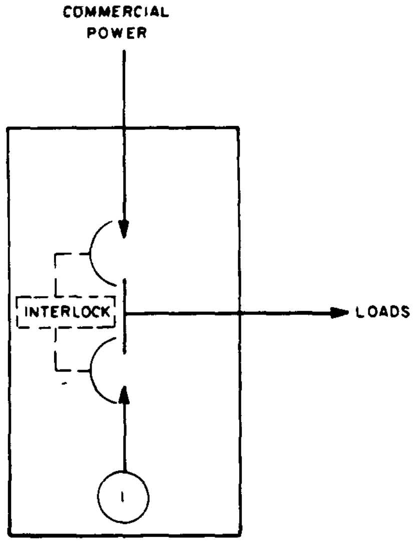

Figure 4. Single bus configuration with onset transfer.

2.08 Voltage Level

Electric utility practices and economics dictate the distribution system and voltage level used throughout the building. The building engineer decides the level to use on the commercial power while the power engineer specifies the standby set to be used. Close coordination between these two groups is required to design a fully integrated commercial power and standby power system that will efficiently and economically serve the AC power needs of the building. To perform this function, the power engineer should be thoroughly familiar with the recommendations discussed in Section 760-400-100[4]. Generally, the voltage level of the standby power set(s) should be the same as the voltage level of the commercial power supply to the essential loads.

However, when there are long feeder runs between the set and the standby bus, the use of a higher generated voltage together with a stepdown transformer and a disconnect switch might be more economical. Figure 5 illustrates two alternative solutions for three representative situations that may be encountered.

In each case, (a), (b), and (c), comparisons can be made between the installed cost of the set plus all associated equipment and hardware for each of the two alternatives presented (for example, ba and bb). For these two alternatives, a cost comparison would be the installed cost of the low-voltage set + (feeder cost/ft.) x (length of feeder) against cost of the high voltage set + (feeder cost/ft.) x (length of feeder) + cost of disconnect switch and stepdown transformer.

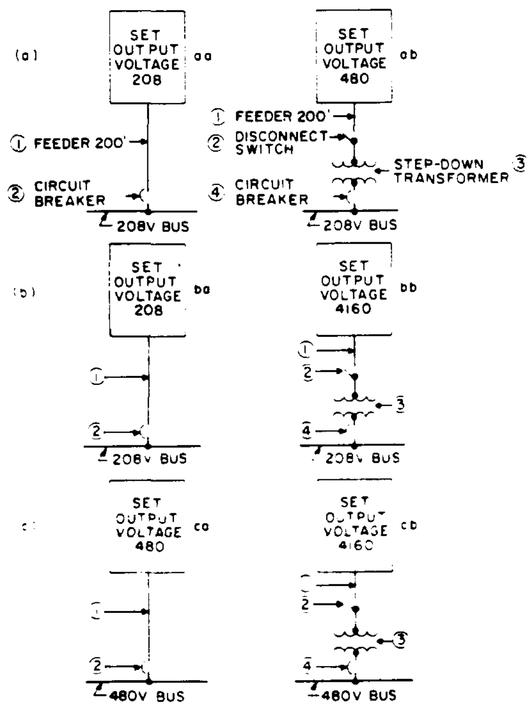

Figure 5. Voltage level options.

Note that the cost of the circuit breaker is not included because the cost is the same for both alternatives. Basically, the comparison is between a large, expensive feeder and a small feeder plus cost of the peripheral gear needed to step the voltage down to the bus value. The following example illustrates actual economical comparisons for the three basic alternatives.

Using the above principles, a typical economic selection study was done comparing the various cases shown on Figure 5. CUCRIT 3 (see Section 3, Power Systems Engineering Manual[2]) was used to make the cost comparisons. Figure 6 is a typical data sheet made up for use with the CUCRIT program for case aa with varying feeder lengths. Figure 7 is a sample of the input-output data produced when the program is run. The output data has been underlined (see Section 3, Power Systems Engineering Manual[2] for complete details).

2.09 Single- Or Three-Phase Alternator? Generally, only small central offices and some repeater stations use single-phase AC power. A standard standby diesel set, rated at 22 kW, 240 volt, 3 wire plus ground is available for use in these applications. For buildings having loads greater than 30 kW, three-phase is recommended if available from the power company.

2.10 Determining Engine Requirements A review of the location power requirements is to be made in conjunction with any major addition of equipment and the power data forecast chart (PDFC) posted with the current load forecast. The specific instructions for the PDFC are this review and the resultant documentation, which will provide the basis for informed planning and design of suitable power equipment.

FIGURE 6

PROGRAM NAME - CUCRIT

X4AA
Input File Name

01	0	0
Plan #	Gross Receipts Tax Rate (%)	Revenue Trend Rate (%)

EX4PLNAA
Plan Title

EXAMPLE 4 - TRANSFORMERS VS. CABLE - PLAN AA
Plan Description

9	1977	01	1978	20
Study Month	Study Year	Start Month	Start Year	Length

MUST BE SAME FOR ALL PLANS TO BE COMPARED

LINE NO 5-199	•	FCOST ($000)	PLACEMENT DATE MO PLCT	PLACEMENT DATE YR PLCT	MO TRK	TERMINATION DATE FIRD EXP (LAST MO)	TERMINATION DATE LYR EXP (LAST YR)	N	LS RATE	CIR RATE	EXPEN ($000)	MAINT ($000)	DOR	DESCRIPTION	ACCOUNT NO
5	•	193.8	1	78	2	12	97	0	0	0	446	0	0	ENGSET	221-47
10	•	13.3	1	78	2	12	97	0	0	0	.31	0	0	50FTCBL	221-47
	•														
	•														
10	•	26.5	1	78	2	12	97	0	0	0	.61	0	0	100FTCBL	221-47
10	•	39.8	1	78	2	12	97	0	0	0	.92	0	0	150FTCBL	221-47
10	•	53.0	1	78	2	12	97	0	0	0	1.22	0	0	200FTCBL	221-47
10	•	66.3	1	78	2	12	97	0	0	0	1.52	0	0	250FTCBL	221-47
10	•	79.5	1	78	2	12	97	0	0	0	1.85	0	0	300FTCBL	221-47
	•														
	•														
	•														
	•														

• BLANK

Figure 6. Typical CUCRIT data sheet.

FIGURE 7

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                              EX4PLNAA
             EXAMPLE4-TRANSFORMERS VS CABLE-PLAN AA

                         FORMAL INPUT REPORT

       STUDY DATE -    9/1977               LENGTH OF STUDY - 2Ø YRS.
       STUDY STARTS - 1/1978                GROSS RECEIPTS TAX- Ø.Ø7.
                                            REVENUE TREND RATE- Ø.07.

ITEM            FCOST   EXPEN   MAINT    PLCT  TERM   SVC   %   ACCT
NO   DESCRIPT. ($ØØØ)  ($ØØØ)  ($ØØØ)   DATE  DATE   LIFE DOR  CODE
---- --------- ------  ------  ------   ----  ----   ---- ---  ----
  5 ENGSET     103.3    4.5     Ø.Ø     1/78  12/97  2Ø   Ø.Ø  221-47
 1Ø 5ØFICABL    13.3    0.3     Ø.Ø     1/78  12/97  2Ø   Ø.Ø  221-47

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Ø9/16/77  CAPITAL UTILIZATION CRITERIA EXECUTIVE SUMMARY  VERS 3.3

                 EX4PLNAA      VERSUS EX4PLNAB

EX4PLNAA   EXAMPLE4-TRANSFORMERS VS CABLE-PLAN AA
EX4PLNAB   EXAMPLE4-TRANSFORMERS VS CABLE-PLAN AB

                          NON-TRENDED($ØØØ)         TRENDED($ØØØ)

*NON-DISCOUNTED    EX4PLNAA      EX4PLNAB      EX4PLNAA      EX4PLNAB
 INPUT SUMMARY     --------      --------      --------      --------
    CAPITAL REQTS.     2Ø7.1         2Ø8.1         211.2         212.2
    EXPENSE REQTS.       Ø.Ø           Ø.Ø           Ø.Ø           Ø.Ø
    CO. REVENUES         Ø Ø           Ø Ø           Ø Ø           Ø Ø

*PRESENT WORTH EXPEND  267.5         268.8         272.8         274.1

  CUCRIT PERFORMS A FINANCIAL EVALUATION BASED UPON THE CAPITAL,
  EXPENSE, AND REVENUE DIFFERENCES BETWEEN TWO PLANS.  THE EVALUATORS
  WHICH THE PROGRAM GENERATES ONLY DESCRIBE THE ECONOMIC WORTH OF THE
  DIFFERENCES IN CAPITAL, EXPENSE AND/OR REVENUES BETWEEN THE PLANS,
  AND ARE NOT ATTRIBUTABLE TO EITHER PLAN INDIVIDUALLY.
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Figure 7. CUCRIT input-output data.

When an engine-alternator is already installed, the projected kW requirements for the end-of-power-engineering period (normally two to three years) must be checked against the capacity of the engine. If the engine is adequate to handle the projected load, no action need be taken.

If an initial installation of an engine is warranted or if an existing engine is not adequate to handle the projected load, the new engine-alternator arrangement should usually be sized to handle requirements for an 8 to 10-year period. Depending upon floor space availability, an existing engine may either be replaced with a larger engine or left in place and paralleled with one or more new (same or different size) engines. In some cases, floor space considerations may warrant provision of a larger or smaller engine than that required to handle the 8 to 10-year projected load. In addition, the minimum load placed on an engine should not be less than 30 percent of its full kW machine rating.

2.11 Engine Start Equipment
Almost all diesel engine-alternator sets are arranged for electric start via a dedicated string of engine start batteries. Some of the larger diesel engines utilize compressed air for starting. All of the gas turbines are electric start.

If electric starting is utilized, separate strings of start batteries should be provided for each engine installed in an office to insure start reliability. Adequate, essential AC power must be available for the input requirements of the start battery charger.

Presently, the most common battery used for engine starting is the lead-acid. Another alternative would be the use of an equivalent nickel-cadium battery, which is more costly.

2.12 Reuse or Modification of Diesel Engines
When reuse of an engine at another location is proposed, it may be advisable to recondition the engine. Local engine distributors or factory representatives may be consulted for major engine service and reconditioning.

Existing 60 kW engines operating at 1,200 RPM can be modified to increase output to 100 kW. In some instances, it may be more economical to modify an engine rather than install a paralleling or replacing set. Newer 60 kW engines, operating at 1,800 RPM, cannot be modified for 100 kW operation. A detailed cost estimate should be obtained from the firm engaged to handle the modification. The modification usually consists of:

1. Replacement of the alternator.
2. Replacement or modification of the control panel.
3. Modification of the outside air intake and exhaust system.
4. Engine reconditioning.

3. AC STANDBY PLANT LOADS

3.01 A standby plant should be adequate to support the telephone equipment loads, essential building loads and special loads during a commercial power failure. In some smaller offices, all building equipment may be capable of being supplied AC power from the standby plant.

Included in the essential building load are those items which must remain operative to ensure the safety of either the building or its occupants or to maintain service. Ensure that all auxiliary equipment associated with and necessary for the operation of the standby plants (oil coolers, exchange fans, fuel pumps, etc.) is terminated on the essential bus of a Central Office. In order to determine present end-of-power-engineering period or future (such as 10 years) load requirements, the total telephone equipment drains must be determined and converted to kW requirements. The essential building load must then be determined and added to the telephone equipment load, resulting in the total kW demand to be placed on the standby engine-alternator in the event of a commercial power failure.

3.02 Essential Loads

Those loads that must operate during prolonged loss of commercial power and can tolerate an interruption of 10 seconds or more are classified as essential loads. These loads should be powered from the standby power source. Table F lists the recommended essential loads that fall into this category.

3.03 Special Telephone Power Loads

During a bonafide commercial power failure, all essential loads are switched to the standby source. However, during simulated power failures, when the standby plant equipment is exercised, certain types of loads are kept on the commercial power source and are not switched. These loads have been classified as special telephone power loads. Only essential loads that have well-defined reasons should be included in this category. Remember that one of the important reasons for routining the standby power plant together with its loads is to uncover and resolve system problems before a bonafide power failure occurs. Therefore, it is recommended that the special telephone power loads be included in a planned plant routine once a year.

An operational support system that requires protected power is so defined in the Southwestern Bell Technical Planning statement for that respective system. Such systems should be accessed to the standby power bus via the "Special Telephone Power" switch and the demand load included when sizing the standby engine.

(Note that the provision of special telephone power requires a two bus system - see Figure 2.)

3.04 Nonessential Loads

Nonessential loads are defined as loads that can experience long periods of commercial power interruption (hours to days) without needing some form of AC backup. Generally, these loads are not switchable to the standby source. However, in some installations provision is made to permit manual switching of these types of loads to the standby source where excess capacity is available for future growth or to use the nonessential load to meet minimum loading requirements on diesels.

4. ENGINE FUEL

4.01 Quantity

It is recommended that sufficient fuel be stored so that the engine-alternator plant can be continuously operated at maximum rated load for a minimum period as specified in paragraph 4.02. Local requirements and criticality of circuits involved may increase this period (two weeks maximum). Fuel consumption rates are specified in the controlling equipment section and/or in Tables A and B.

4.02 Fuel Requirements

Virtually all gas turbine or diesel engine fuels are unsatisfactory for long-term storage as delivered by the supplier. When properly treated with an inhibitor, the useful life of a fuel is anticipated to be 10 years.

Buried tanks are provided where day tanks alone are not adequate to provide the necessary fuel reserve. Fuel tanks are available in either buried or floor-mounted (day tank) arrangements. Different fuels are usually required for diesel and gas-turbine engines. However, when both types of sets are used in the same building, they may be operated from the same fuel supply (see Section 065-320-301[8]). The only diesel set limited to other than a normal fuel supply is the KS22344 (22 kW) Guardian engine which must use ASTM 975, 1-D water white kerosene or ASTM 2800, GT1 fuel with lube oil added if the outside temperature of the site is expected to go below +20°F.

Tank size should be based on supplying enough fuel (at the full load rating of the standby plant) for:

1. 72 hours of operation (at 75 percent tank capacity) up to 700 kW total standby plant capacity.

2. 72 hours of operation (at 1,500 gallons less than the full tank capacity) for standby plants above 700 kW.

If calculated running time (based on demand load) should fall below 72 hours, tank facilities should be upgraded utilizing the following criteria:

1. Locations whose running time capability is less than 24 hours should be upgraded on a next job basis.

2. Locations whose running time is between 24 hours and 48 hours should be upgraded on a next major power job basis.

3. Locations whose running time is between 48 hours and 72 hours should be upgraded when major standby plant effort is required (i.e., replacing an engine, adding an engine, etc.).

Keep in mind that the actual reserve in offices having a variable load would be somewhat greater than this calculated figure since the engine's maximum output (and fuel consumption rate) would not be expected for the full 24-hour period.

If a new buried tank is being installed, a 10-year design period should be used. In certain instances, a larger or smaller tank may be required:

1. The minimum size day tank installed should be 275 gallons. National Fire Protection Association (NFPA) code specifies that:

   a. If unenclosed, a tank (or tanks) of 660-gallon capacity may be installed, or

   b. if enclosed by a fire-protective wall (can be in the same room as an engine), the maximum installed day tank capacity is limited to 1,320 gallons but not more than 660 gallons shall be connected to one engine.

2. Accessibility of the office, especially during severe weather, may dictate a longer reserve.

3. Availability of fuel may dictate a longer reserve.

4. If the tank being added is the last one that can be installed on the site, then the design period should be the exhaust date of the building site.

5. In some of the larger toll offices, a smaller reserve may be provided because of the limited space available for burying fuel

tanks. In such a case, plans must be available for providing additional fuel.

For engines with fuel consumption rates between 2.86 and 5.73 GPH (30-48 kW), one 660-gallon tank should be provided. For larger engines, buried tanks should be considered whenever the fuel consumption rate for the design period exceeds 5.73 GPH.

4.03 Sizing Fuel Reserve

As an example of determining fuel reserve, the following standby engine data has been determined:

	Present	End-of-Power-Engineering Period 1984	Estimated 1992
kW Load	51.7	144.8	252
Engine Size, kW	60	435	435

The existing 60 kW diesel engine employs a 275-gallon day tank. There is not sufficient room in the basement to parallel the 60 kW with another engine. Therefore, a roof-mounted 435 kW gas turbine is being provided. There is room at the site for burying fuel tanks. At the end of the power-engineering period, the engine will operate at 33.3 percent of its capacity. The fuel consumption rates from Table A and Section 802-980-154[24] are:

Full Load	60 GPH
3/4 Load	50 GPH
1/2 Load	42 GPH
No Load	24 GPH

Interpolating, the end-of-power-engineering fuel consumption rate would be:

$$24\text{GPH} + \frac{.33 - 0}{.50 - 0}(42-24) =$$

$$24\text{GPH} + .666\ (18) = 24\text{GPH} + 12\text{GPH} = 36\text{GPH}$$

To provide a 72-hour reserve at 75 percent tank:

$$\frac{36\text{GPH}\ (72\ \text{Hrs})}{.75} = 3,456 \text{ Gallons for 1984}$$

and in 1992, the set has a 57.9 percent load. Therefore,

$$42 + \frac{.579 - .5}{.75 - .5}(50 - 42) = 42 + 2.5 = 44.5\text{GPH}$$

The 72-hour reserve would be:

$$\frac{44.5\ (72)}{.75} = 4,272 \text{ Gallons for 1992}$$

Therefore, since this is a newly installed buried tank, provide enough tank to supply the 72-hour reserve for at least 10 years. At full load, the reserve requirement would be:

$$\frac{60\text{GPH}\ (72\ \text{hours})}{.75} = 5,760 \text{ Gallons}$$

The choice is then to provide either a 4,000 gallon or a 6,000 gallon buried tank depending upon economics and the previously listed selection criteria.

5. ENGINE PERFORMANCE

5.01 Exhaust Emissions

Use Tables G and H for the pollution measurements of the AC Standby Plants currently rated as Southwestern Bell "standard."

5.02 Acoustic Noise

The AT&T standard engine-alternator sets are acoustically treated to keep noise at a comfortable level -- below that specified by the Occupation, Safety and Health Administration (OSHA). The measured sound pressure levels for the engine room and exhaust system are shown in the 802 Section series for each engine-alternator set. Regard the acoustical data presented in the sections as a measure of the attenuation supplied by the acoustical treatment, and only as an estimate of the sound pressure IX-29 levels to be expected in a specific installation. The measured sound pressure levels in a particular installation will be affected by the characteristics of the room in which the set is installed.

5.03 Temperature and Altitude Derating

The actual output kW rating of turbine and diesel sets is related to altitude and combustion air input temperature. Therefore, to meet load kW requirements at a specific site, establish its altitude and determine the highest expected outdoor temperature for the location (can be obtained from weather bureau historical data). Then use the derating table in the equipment section for a given set to determine the size required to meet maximum load requirements under worse case environmental conditions. Below, Table M is an example showing kW derating of the 2,500-kW (KS-20460, L2 and L4) set. Note that the Bell System standard rating is at 90°F and 1,500 ft. altitude for turbines and 110°F and 1,500 ft. for diesels.

Table M

MAXIMUM ALTERNATOR OUTPUT POWER (kW) FOR VARIOUS ALTITUDES AND COMPRESSOR INLET AIR TEMPERATURES*

2500 kW Nominal Rating

Altitude In Feet Above Mean Sea Level	Compressor Air Inlet Temperature in Degrees F				
	70	80	90	100	110
0	2852	2724	2595	2457	2328
1500	2696	2574	2500	2321	2200
2000	2646	2527	2407	2279	2159
3000	2549	2433	2318	2194	2079
4000	2453	2342	2231	2111	2001
5000	2359	2252	2145	2030	1924
6000	2269	2166	2013	1952	1850
7000	2186	2086	1983	1877	1778
8000	2047	2002	1906	1804	1709

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* Output calculated under the following conditions:

- Turbine inlet temperature = 1855°F
- Inlet restriction = 4.5" H_2O
- Static exhaust back pressure = +6.0" H_2O
- Power factor of load = 0.80

6. ENGINEERING CONSIDERATIONS

6.01 Once the size of the standby plant necessary to handle the projected requirements has been determined, certain other engineering decisions must be made. These items and the responsibility for these decisions are summarized in Tables I and J.

6.02 Engine Exhaust Systems

Section 802-006-180[10] covers general considerations concerning exhaust systems. Specific requirements are contained in the controlling equipment section and in Section 802-006-150[11] for the smaller diesel engines. Attention needs to be paid to the following:

- Have local pollution ordinances been met and, if required, have environmental impact statements been issued? (See paragraph 5.01.)
- Have exhaust pipes or ducts been sized properly to keep back pressures within acceptable limits?
- Have inlet ducts been sized to keep air restriction pressures within acceptable limits?
- Are physical layout arrangements such that interference with room and building air handling equipment has been avoided and does not interfere with any neighbors? (See Section 12, Power Systems Engineering Manual[12].)
- Have insulating coverings been specified for all exposed surfaces of the exhaust system located within the building in accordance with the applicable ED drawing?

- Inlet air and exhaust air building terminations must be positioned to avoid recirculation of hot exhaust gases into room and/or engine intake ducts thus derating the available power.

- Has linear expansion and contraction of the pipe or duct system with temperature changes been taken into consideration in the design in accordance with the controlling ED drawing?

6.03 Engine Room Environment

The required room environment for engine-alternator sets is specified in the controlling equipment section. The normal operating temperature range for diesels is 40°F to 110°F. At temperatures below 40°F, cold starting aids, such as coolant heaters and/or an ether starting device, will be required and should be specified. Gas turbines are designed to operate in temperatures from -20°F to +110°F, including starting at the low temperature without specifying additional equipment. This permits installation in minimal enclosure structures such as on roofs of buildings. However, under these conditions take special precautions to ensure fuel flow in cold temperatures and that the fuel cloud point is below -20°F (see Section 065-320-301[8]).

Section 760-555-151[6] specifies a recommended power equipment room operating temperature range of 40°F to 100°F. However, the short-term range can go up to 120°F. Both the standard diesel and gas-turbine engines will operate satisfactorily at this temperature but at a reduced power output (see paragraph 5.03). Accordingly, a plan for manual sequential shedding of load on those engines at full capacity should be devised for periods of extreme high temperature operation. Both types of engines can operate in the recommended operating and short-term humidity ranges of this section.

6.04 Engine Room Intake And Ventilation Systems

The intake air and ventilation system for diesels must supply air for combustion and radiator cooling and air to remove the heat loss from the engine-alternator, silencer, and exhaust pipe. Normally, the radiator fans are large enough to cool the radiator and remove some of the heat loss. The equipment section for each set lists the heat losses from the engine set, silencer, and exhaust pipe, as well as the excess ventilating capacity of the radiator fan. If the excess fan capacity is not sufficient to handle the engine room heat load, an auxiliary fan will be required. Use Section 802-010-150[13] to calculate the size of this fan. To reduce the size of the auxiliary fan, the silencer and exhaust pipe should be insulated. Also, a windbreak may be required to deflect head winds that will reduce the exhaust fan effectiveness of the radiator or auxiliary ventilation system. Ventilating equipment covered by specification KS-5592-01 is available for AT&T standard diesel sets.

For turbines the combustion air should be ducted directly from the building exterior to the gas-turbine sets. As inlet combustion air temperature increases, the maximum output power for the turbine decreases. Combustion air should be obtained from the coolest source possible - usually outside air. Use an inlet duct that is as short as possible so there are the least possible inlet restrictions. This type of duct shall have shutters at the combustion air intake building opening. However, louvers or a protective hood are needed to keep snow and rain out of the inlet duct. A ½-inch mesh bird screen is also required. Where it is not possible to duct combustion air, the building wall opening for the combustion air inlet should have shutters to prevent unnecessary lowering of engine room temperature during cold weather when the set is not running. Air filters are only required in areas of high dust concentration.

The gas-turbine sets are air cooled. Heat is removed from the turbine casing primarily by radiation and convection. It is also absorbed by the lubricating oil, which is then cooled by its passage through a radiator. The equipment section for each set shows heating loads imposed on the ventilating system by the engine and associated equipment. With combustion air ducted directly to the engine, the engine room ventilating equipment only needs to furnish air to remove heat rejected to the engine room from the engine, alternator, air cooler, electrical equipment, and engine room exhaust piping. However, some or all of these heat losses may be handled by ducting. See ED drawings also referenced in the controlling equipment section for specific ducting recommendations.

Typical arrangements illustrating the various components of a complete installation are shown in Section 12, Power Systems Engineering Manual[12].

6.05 Main Feeder Conductor Sizing

Section 802-004-151[14] explains the general rules for determining conductor size. In modern plants, the main feeders are sized to carry the full load current rating of the sets listed in Tables A and B.

6.06 Short Circuit Study

The NEC[15] requires that all devices used in the AC power distribution system (the standby power source and its connecting circuits are considered to be a part of this system) intending to break current, shall have an interrupting capacity rating (ICR) equal to or larger than the available short-circuit current. The device supplier is required to furnish the ICR, but the user must determine the maximum value of available short-circuit current at the point in the circuit where the device is used. The NEC[15] describes the step-by-step procedure used in calculating this value.

6.07 Selectivity Of Protection Devices (Fuses And/Or Circuit Breakers)

A fully selective AC power distribution system is one in which the protection device closest to the point where a short circuit (or overcurrent) occurs will open (clear the circuit) before any of the devices in series with it ("looking" back towards the source) open. This is shown schematically in Figure 8. To determine the degree of selectivity a particular system has, plot the time-current curves for the protection devices (see Section 802-004-151[14] and Figure 8). The degree of selectivity used in a system is a matter of trade-offs against costs. Fully selective systems are generally too costly and therefore not recommended. In large multiple standby systems, using 435-kW units or greater, selectivity should be incorporated between the breaker in the standby set and the first load feeder device. Of course, if you can obtain a greater degree of selectivity at no extra cost, you should do so. In small systems, especially when standby sources are used whose output circuit breaker is the molded-case type without solid-state control (225-kW set or lower), selectivity cannot be obtained.

6.08 Ground Fault Protection

Section 760-400-165[16] describes the Bell System point of view on ground fault protection. Follow the two rules described in detail in the section:

FIGURE 8

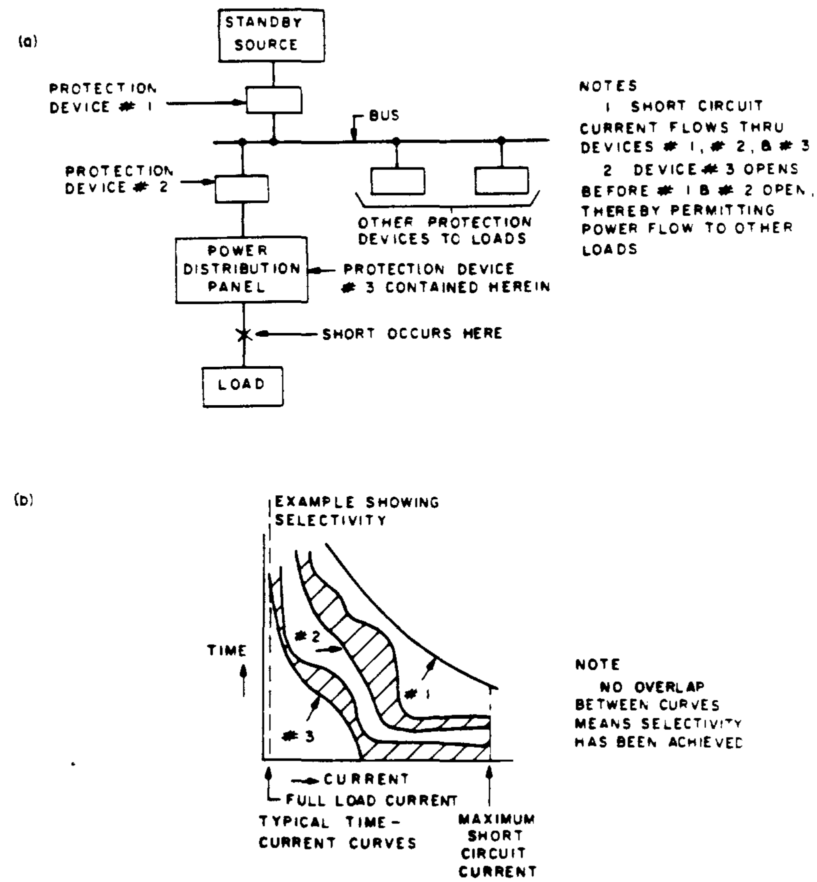

Figure 8. (a) Fully selective AC power distribution system.
(b) Typical time-current curves.

- All sets whose generated voltage is 480V (line-to-line) or greater shall use some form of ground fault protection.

- All 480V systems or greater shall use a lightning arrester to absorb inductive energy so that exposure to the formation of arcing faults will be minimized.

6.09 Grounding

Frame grounding of standby power sets should be done in accordance with the standard rules described in Section 802-001-198[17]. However, the method of grounding the alternator neutral is dependent upon system configuration. The large majority of standard sets of 480V or less are three phase-four wire systems with an occasional single phase-three wire unit. When these are located in areas where solidly grounded commercial power systems are used (most areas of the country), do not ground the sets neutral by connecting it to the frame grounding wire at the set. If the neutral is connected to the frame ground, as shown in Figure 9, the following two rules will be violated.

- Since the neutral is common to both the commercial and the standby power source and since the commercial power neutral is already grounded, grounding the neutral at the set results in two grounding connections to the neutral within the building permitting normal neutral current to flow in the framework. This kind of grounding is "forbidden" by the NEC[18].

- Where ground fault detection is required, grounding the neutral at two points will lead to false operation of the sensing device,* because part of the normal neutral current will flow in the frame ground paths.

An acceptable method of grounding the sets neutral is to connect it to the neutral of the commercial power. In addition, make the neutral and the phase lead of the set the

*A net summing type of sensing device is assumed to be used (see Section 760-400-165[16]).

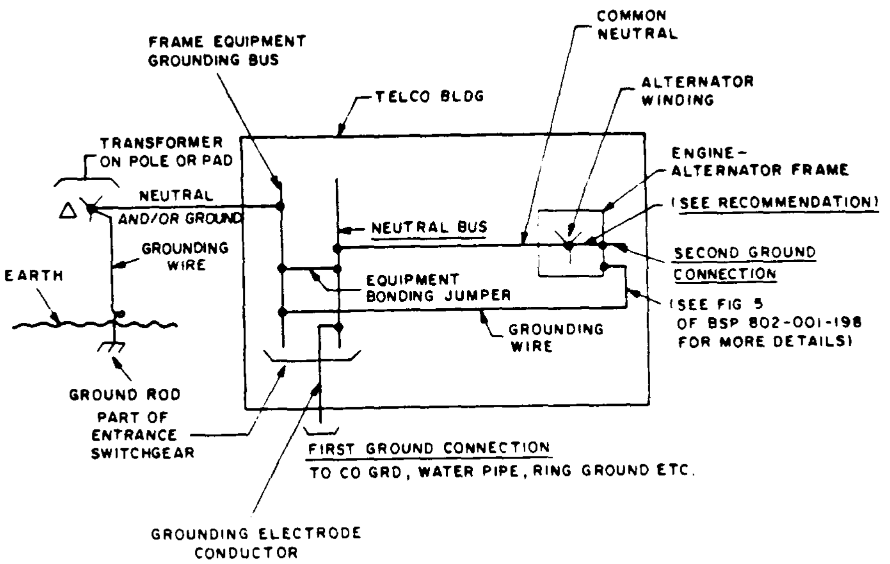

Figure 9. NOT RECOMMENDED—Two-point neutral ground connection.

same size. This will minimize the impedance of short-circuit paths thereby permitting enough current to flow, under short-circuit conditions, to make the protection device open, clearing the circuit.

On all sets whose nominal output line-to-line voltage is greater than 480V, the neutral can be solidly or resistively grounded. A direct and continuous connection should be made from the neutral (or the output of the grounding resistor) to the nearest central office ground by means of a grounding conductor whose size meets the requirements of Table 250-94 in the NEC[18]. A second independent connection should also be installed between the neutral (or output of the grounding resistor) to the steel frame of the set. The size of the wire for this connection shall be determined from Table 1 of Section 802-001-198[17].

Grounding systems for sets that do not conform to the above criteria have to be job analyzed and engineered.

6.10 System Alarm Requirements

Use Table K for the individual alarms that are on each of the AC Standby Plants currently rated as "standard" in Southwestern Bell.

6.11 Gas turbines employ air for cooling the engine. Diesel engines are water cooled and two cooling arrangements are available:

1. Engine-mounted radiator.

2. Remote radiator and circulation system.

The set-mounted radiator is pressurized and requires no water piping to the set. Standard radiators are provided with each set. When there is insufficient space available for provision of a set-mounted radiator and the associated air duct or there is no access to the outside for exhaust of the heated air, a remote radiator may be provided.

6.12 Floor Space Considerations

The location of a standby engine-alternator is usually determined at the time a new building or addition is planned. In most locations, the engine-alternator set is located in the basement of the building because of:

1. The weight of the engine.

2. Fuel tank access requirements.

3. Air handling considerations.

The relatively lightweight gas-turbine sets may be located on the roof of a building provided the structure is adequate to handle the weight of the engine. In some of the major multistory buildings, gas-turbine sets are located on intermediate floors. In many locations, no basements have been provided and no floor space is available in the building requiring a stationary engine. In that case, the unit may be located in a separate building or equipment module.

The Building and Equipment Engineers are responsible for selecting the location of any standby engines installed in an office. The floor space selected must, of course, be adequate to handle the standby engine and its associated equipment. Where possible, the engine should be located against a nongrowth wall to avoid relocation when a building addition is required. Considerations should also be given to the availability of intake air (both ventilation and combustion) and the accessibility of the exhaust flue or stack. Building codes now require that all engines be enclosed in a fire wall because of the potential fire hazard associated with the fuel.

7. ECONOMIC EXAMPLE

7.01 The fundamentals of economic analysis and specific procedures to be followed are outlined in Section 3, Power Systems Engineering Manual[2]. It includes a specific example comparing the present worth of expenditures for a single large engine vs small engines incrementally installed at time needed.

8. DECISION TREE SUMMARY

8.01 This section presents the tasks you must perform to select a standby system. The information is presented in the form of a flowchart (see Table L). Use the chart, together with the sections referenced on the charts, as a checklist to determine if all aspects of standby systems have been considered.

9. REFERENCES

1. Section 155-191-301, "Engine-Alternators-Diesel."
2. Power Systems Engineering Manual, Section 3.
3. Telephone Power Systems Products Manual, "System Control Bay."
4. Section 760-400-100, "Building AC Power System."
5. Power Systems Engineering Manual, Section 2.
6. Section 760-555-151, "Atmospheric Environment for Telephone Equipment Space."
7. Section 802-015-158, "Emergency Lighting Equipment, Battery Type for Central Offices."
8. Section 065-320-301, "Engine Fuel Storage Operating Methods."
9. NEBS, X-74300, Section 10.2.
10. Section 802-006-180, "Installation of Internal Combustion Engines and Associated Piping."
11. Section 802-006-150, "Exhaust Line Size Requirements for 20 to 500 kW Stationary Diesel Engine-Alternator Plants."
12. Power Systems Engineering Manual, Section 12.
13. Section 802-010-150, "Ventilating Equipment - for Rooms Having Engine - Driven Generators."
14. Section 802-004-151, "Power Service Equipment and Calculations."
15. NEC, National Electric Code, Section 110-9 et. al.
16. Section 760-400-165, "Ground Fault Protection."
17. Section 802-001-198, "Protective Ground Systems - General Equipment Ground Requirements for AC Service Distribution Systems in Buildings Housing Communication Systems."
18. NEC, National Electric Code, Section 250-21 (a) and (b), 250-23(a), and 250-152(b) and Table 250-94.
19. Section 802-033-150, "AC No-Voltage and Low-Voltage Alarm and Automatic Engine Alarm Equipments."
20. Addendum 790-100-653SW, "Economic Analysis -- Power Systems Engineering Manual."
21. Addendum 790-100-652SW, "Planning -- Power Systems Engineering Manual."
22. Addendum 790-100-662SW, "Layout -- Power Systems Engineering Manual."
23. Southwestern Bell Building/Installation Guide-Standard Engine-Alternators.
24. Section 802-980-154, "Gas Turbine Engine-Driven Alternators - 435 to 500 kW, Equipment Design Requirements."
25. EL 3057 Diesel Engine-Alternators; Performance and Design Criteria. February 4, 1974.
26. EL 6926 Automatic Transfer Switches for use with Standard Engine-Alternators, October 16, 1980.
27. EL 6941 Manual to Automatic Diesel Conversion Kit, October 21, 1980.

28. Southwestern Bell "Supplies and Telecommunication Products Catalog."
29. Southwestern Bell AC power brochure.
30. BSP 760-610-400, "Firesafety Considerations for Standby Engines."
31. National fire codes, Vol. 2, Code 30: Flammable and combustible liquid. National Fire Protection Association.
32. National fire codes, Vol. 3, Code 37: Stationary combustion engines and gas turbines, NFPA.
33. Letter dated August 27, 1979 (File CP 1B15.01G) central office alarm system - TASC.

10. GENERAL REFERENCES

Section 760-640-150, "Internal Combustion Engines."

Section 800-610-155, "Earthquake and Disaster Bracing for Central Office and PBX Equipment."

Section 802-033-150, "AC No-Voltage and Low-Voltage Alarm and Automatic Engine Alarm Equipment."

Section 802-950-152, "Method for Determining Motor Starting Capacity of Engine-Alternators."

Power Data Sheets, Section 6.

Floor Plan Data Sheets, Section 8.4.

AT&T Letter, "Use of Emergency Engine-Alternators," June 3, 1958.

AT&T Letter, "Continuity of Communication and Operational Services during Prolonged Power Failures," February 17, 1967.

EM 770, Power Engineering Manual - Bell System Modernized Toll Engineering Project, AT&T, January 30, 1968.

NFPA No. 37, "Stationary Combustion Engines and Gas Turbines," 1970.

Section 760-400-175, "Procedure for Determining Short-Circuit Currents in AC Power Distribution Systems."

Means Building Construction Cost Data Telephone Power Systems, Products Manual (TPSP Manual).

TABLE A

Eqpt. Spec.	J86657 802-964-156	3SGD45 E7201	3DG75 E7203	4GDT125 E7205	6GDT220 E7209	8VGDT300 E7210	8V92GDT335 E7213	12VGDT440 E7213	16V92GDT670 E7218	16V149GDT1000 E7228	J86654 802-980-154	J86653 802-980-153	J86655 802-980-155
Specification	KS21144	3-53	3-71	4-71T	6-71T	8-71T	8-92T	12-71T	16-92T	16V149T	KS21264	KS21501	KS21879
Vendor Rated Capacity (kw) SWBT Rated Capacity (kw)	24 22	45 30	75 48	125 87	220 153	300 204	335 324	440 402	670 528	1000 853	435/500 435	750/900 748	1250/1500 1254
3-Phase Output Voltage (Volts)	208-240 416-480	208 480 (4160 Can Be Ordered As Special Assembly With Differential Fault Alarm)									208-240 416-480	208,230,240 480 or 4160	480 4160
Type of Set	Single Diesel										Single Turbine		
Type of Control	Manual or Automatic												
Type of Cooling	On Set Rad	On Set Or Remote Radiator									AIR		
Type of Governor	Droop or ISOCH	ISOCH, DROOP											
Speed (RPM)	1600	1800									41800 Turb 1800 Alt	22300 Turb 1800 Alt	18000 Turb 1800 Alt
Fuel Consumption Full Load (Gal/Hr) 3/4 Load 1/2 Load 1/4 Load	2.75 2.20 1.85 1.32	3.51 2.67 2.10 1.70	4.66 3.58 2.54 1.80	7.45 5.76 4.07 2.70	12.23 9.23 6.61 3.50	16.12 12.32 9.14 6.90	18.99 14.06 10.40 6.00	23.90 18.28 12.37 7.00	37.27 28.12 20.39 12.20	62.6 48.6 34.5 23.9	60 50 42 34	106 93 75 52	240 209 180 158
Weight (Lbs)	[illegible]	[illegible]	3340	3950	5000	5500	6200	10,000	13,000	23,000	10,000	15,000	24,500
Unit Dimensions Length (Ft-In) Width Height	3-0 2-10 [illegible]	7-9 2-7 3-10	7-9 2-7 4-2	8-3 2-7 4-1	9-10 4-0 5-10	10-4 4-4 6-4	10-4 4-4 6-4	11-3 4-4 6-4	15-0 4-4 7-7	16-8 6-1 8-5	10-10 4-6 6-0	17-0 5-0 6-0	16-5 5-6 6-2
Recommended Floor Space Length (Ft-In) Width	6-6 3-4	10-9 5-7	10-9 5-7	11-3 5-7	12-10 7-0	13-4 7-4	13-4 7-4	14-3 7-4	18-0 7-4	19-8 9-1	21-3 10-6	24-0 13-0	23-6 12-6
Floor Loading (PSF)	29	35	56	63	56	56	63	96	98	129	45	48	84
Associated Documentation Performance Requirements Operating Methods Requirements & Adjustments	802-964-184 NA NA	SSA41 SSA41 SSA41	SSA33 SSA33 SSA33	SSA34 SSA34 SSA34	SSA35 SSA35 SSA35	SSA36 SSA36 SSA36	SSA43 SSA43 SSA43	SSA37 SSA37 SSA37	SSA43 SSA43 SSA43	SSA40 SSA40 SSA40	802-980-186 155-209-301 155-209-701	802-980-184 155-208-301 155-208-701	802-980-187 155-210-301 155-210-701
Manufacturer	Alturdyne WECo	STEWART & STEVENSON									ONAN WECo	SOLAR WECo	NATCO WECo
Primary Application	Small Attended or Unattended Central Offices/Repeater Stations					Large Attended or Unattended Central Offices							
Warranty (Yrs)	1	5	5	5	5	5	5	5	5	5	1	3	1

Table A
AC STANDBY PLANTS, SWBT STANDARD

TABLE B

EQPT SPEC	J86614 BSP 802 963 152				J86620 BSP 802 963 151			
ENG SET KS SPEC	5574 01				5750			
RATED CAPACITY (KW) @ 0.8 P.F. LAGGING	20	30	40	60	20	30	40	60
AC OUTPUT (60 HZ) VOLTS	115/230	208 240			115 230	208/240		
AC OUTPUT (60 HZ) NO. OF PHASES	1	3			1	3		
TYPE OF SET					DIESEL			
TYPE OF CONTROL	MANUAL				AUTOMATIC			
TYPE OF COOLING	RAD ON SET OR HEAT EXCHANGER				RAD ON SET			
TYPE OF GOVERNOR	DROOP ONLY							
SPEED (RPM)	1200							
FUEL CONSUMPTION @ FULL LOAD @ SEA LEVEL (GAL HR/UNIT)	2.22 2.36	3.17	4.17	6.11	2.22	3.26	4.3	6.18
WEIGHT LBS/UNIT	2850	3475	3650	4300	2950	1575	3750	4400
UNIT DIMENSIONS (FT-IN) LENGTH	5 8	7 0	7 6	8 10	5 8	7 0	7 6	8 10
UNIT DIMENSIONS (FT-IN) WIDTH	2 8	2 10			2 8	2 10		
UNIT DIMENSIONS (FT-IN) HEIGHT					6 0			
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) LENGTH	12 8	14 0	14 6	15 10	12 8	14 8	15 2	16 6
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) WIDTH	9 8	9 10			9 8	9 10		
FLOOR LOADING (PSF)	21	25	26	28	24	25		27
ASSOCIATED SUPPORTING BSPS PERF REQS	802 963 181				802 963 182			
ASSOCIATED SUPPORTING BSPS OPER METHODS	155 128 302	155 128 301			155 145 301	155 145 302		
ASSOCIATED SUPPORTING BSPS REQS & ADJUSTMENTS	155 128 702	155 128 701			155 145 201	155 145 202		
ASSOCIATED SUPPORTING BSPS REPL PARTS & PROC'D	155 128 802	155 128 801				NA		

EQPT SPEC	J86625 BSP 802 963 150		J86627 BSP 802 961 151	J86628 BSP 802 964 150			
ENG SET KS SPEC	15717		15777	15884			
RATED CAPACITY (KW) @ 0.8 P.F. LAGGING	10		500	10	45	60	100
AC OUTPUT (60 HZ) VOLTS	115/230	208/240	208/240 OR 416/480	208/240			
AC OUTPUT (60 HZ) NO. OF PHASES	1	3	3	3			
TYPE OF SET							
TYPE OF CONTROL	MANUAL OR AUTOMATIC			MANUAL			
TYPE OF COOLING	RAD OFF SET OR HEAT EXCHANGER			RAD ON SET			
TYPE OF GOVERNOR			ISOCH DROOP	DROOP ONLY			
SPEED (RPM)	1800		900	1800			
FUEL CONSUMPTION @ FULL LOAD @ SEA LEVEL (GAL HR/UNIT)	1.35		38.0	3.44	5.0	6.29	10.4
WEIGHT LBS/UNIT	1910	1200	15000	2750	3475	3650	4300
UNIT DIMENSIONS (FT-IN) LENGTH	5 6		17 7	5 8	7 0	7 6	8 10
UNIT DIMENSIONS (FT-IN) WIDTH	2 0		3 8	2 8	2 10		
UNIT DIMENSIONS (FT-IN) HEIGHT	4 4		8 5				
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) LENGTH	11 6		24 7	12 8	14 0	14 6	15 10
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) WIDTH	7 10		10 8	9 8	9 10		
FLOOR LOADING (PSF)	21		133	22	25	26	28
ASSOCIATED SUPPORTING BSPS PERF REQS	802 963 180 OR 181		802 961 182 OR 183	802 964 180			
ASSOCIATED SUPPORTING BSPS OPER METHODS	155 172 300 155 172 101		155 174 301 155 174 302	155 176 301	155 176 302		
ASSOCIATED SUPPORTING BSPS REQS & ADJUSTMENTS	155 172 700 155 172 701		155 174 201	155 176 701			
ASSOCIATED SUPPORTING BSPS REPL PARTS & PROC'D	155 172 800 155 172 801		155 174 801	155 176 801			

EQPT SPEC	J86629 BSP 802 964 151				J86630 BSP 802 964 151	J86633 BSP 802 961 150
ENG SET KS SPEC	15890				15899	15954
RATED CAPACITY (KW) @ 0.8 P.F. LAGGING	30	45	60	100	350	
AC OUTPUT (60 HZ) VOLTS	208 240				208/240 OR 416/480	
AC OUTPUT (60 HZ) NO. OF PHASES	3				3	
TYPE OF SET						
TYPE OF CONTROL	AUTOMATIC				MANUAL OR AUTOMATIC	
TYPE OF COOLING					RAD OFF SET OR HEAT EXCHANGER	
TYPE OF GOVERNOR					DROOP ONLY OR ISOCH DROOP	
SPEED (RPM)					1200	900
FUEL CONSUMPTION @ FULL LOAD @ SEA LEVEL (GAL HR/UNIT)	3.44	5.0	6.29	10.4	27.4	28.8
WEIGHT LBS/UNIT	2750	3475	3650	4300	18110	16110
UNIT DIMENSIONS (FT-IN) LENGTH	5 8	7 0	7 6	8 10	14 7	11 3
UNIT DIMENSIONS (FT-IN) WIDTH	2 8	2 10			5 0	3 4
UNIT DIMENSIONS (FT-IN) HEIGHT	6 0				6 8	6 10
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) LENGTH	12 8	14 0	14 6	15 10	21 7	18 3
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) WIDTH	9 8	9 10			12 0	10 4
FLOOR LOADING (PSF)	22	25	26	28	70	85
ASSOCIATED SUPPORTING BSPS PERF REQS	802 964 181				NA	802 961 180 OR 181
ASSOCIATED SUPPORTING BSPS OPER METHODS	155 178 301				155 180 301 155 180 302	155 187 301 155 187 302
ASSOCIATED SUPPORTING BSPS REQS & ADJUSTMENTS	155 178 701				155 180 701	155 187 701
ASSOCIATED SUPPORTING BSPS REPL PARTS & PROC'D	155 178 801				155 180 801 155 180 182	155 187 801 OR 802

EQPT SPEC	J86637 BSP 802 980 151		J86647 BSP 802 964 155	J86638 BSP 802 980 150	J86642 BSP 802 964 151
ENG SET KS SPEC	19896	20542	20627	15992	19587
RATED CAPACITY (KW) @ 0.8 P.F. LAGGING	200		115	750	115
AC OUTPUT (60 HZ) VOLTS			208/240	208.210.240, 480 OR 4160	208/240
AC OUTPUT (60 HZ) NO. OF PHASES			NA	3	3
TYPE OF SET	TURBINE		DIESEL	TURBINE	DIESEL
TYPE OF CONTROL			MANUAL	MANUAL OR AUTO MATIC	AUTOMATIC
TYPE OF COOLING	AIR		RAD ON OR OFF SET	AIR	RAD ON OR OFF SET
TYPE OF GOVERNOR	ISOCH DROOP				
SPEED (RPM)	37050 TURBINE 3600 ALT	36000 TURBINE 3600 ALT	1800	22300 TURBINE 17000 ALT	1800
FUEL CONSUMPTION @ FULL LOAD @ SEA LEVEL (GAL HR/UNIT)	42.0		10.0	94.8	10.0
WEIGHT LBS/UNIT	4200	4400	5700	15250	5700
UNIT DIMENSIONS (FT-IN) LENGTH	8 0		10 5	16 6	10 5
UNIT DIMENSIONS (FT-IN) WIDTH	4 3		2 10	5 0	2 - 10
UNIT DIMENSIONS (FT-IN) HEIGHT	5 2		5 - 3	7 4	5 - 3
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) LENGTH	16 0		14 10	24 0	14 10
RECOMMENDED FLOOR SPACE PER UNIT (FT-IN) WIDTH	12 3		9 - 10	13 0	9 - 10
FLOOR LOADING (PSF)	21	22	39	49	39
ASSOCIATED SUPPORTING BSPS PERF REQS	802 980 182	802 980 183	NA	802 980 180 OR 181	802 964 183
ASSOCIATED SUPPORTING BSPS OPER METHODS	155 205 301	155 206 301 155 773 301	155 195 301	NA	155 189 301
ASSOCIATED SUPPORTING BSPS REQS & ADJUSTMENTS	155 205 701	155 206 701	155 195 701	NA	155 189 701
ASSOCIATED SUPPORTING BSPS REPL PARTS & PROC'D	NA	NA	NA	NA	NA

Table B

900 TYPE AC STANDBY PLANTS, MANUFACTURE DISCONTINUED (MD)

TABLE C

PARALLELING

Advantages	Disadvantages
1. Makes use of excess capacity in separately used sets. Can often save the cost of a set (see Figure 1).	1. A fault on a common paralleling bus (a very unlikely event) results in loss of all the standby sets.
2. Permits closer matching of loads to capacity.	2. If "out-of-sync" paralleling occurs, damage can cause the loss of part or all of the standby sets.
3. Permits easier modular growth.	
4. Increases overall reliability. Loss of one set does not mean loss of the whole load as in the case of a single set. Rather, batteries would begin partial discharge with reserve time greatly extended.	

TABLE D

AUTOMATIC VS MANUAL PARALLELING

Advantages	Disadvantages
Can quickly and smoothly handle all aspects of a commercial power failure without the need for highly-trained personnel.	If the control circuit in an automatic paralleling system should fail, lack of practice can cause personnel to make mistakes when manual control must be used.
Routine test of plant will reveal system problems so they can be corrected.	Initial costs are higher. However, in the long run the cost of automatic control, operation, and maintenance may be less than the cost of manual control, operation, maintenance, and craft training. In addition, possible misoperation at critical moments can cause loss of service or damage to system. See the Telephone Power Systems Products Manual[3] for operating features of the "System Control Bay."
"Out-of sync" paralleling is much less likely to occur.	

TABLE E
MANUAL PARALLELING AND
LOAD MANAGEMENT

Advantages	Disadvantages
Initial costs are lower.	Trained personnel must be available to do the paralleling and load switching any time the commercial power fails as well as when the system is routinely tested. There is risk of misoperation at critical moments, which can cause loss of service or damage to the equipment.
Control equipment is simpler.	

TABLE F

RECOMMENDATIONS FOR POWERING EQUIPMENT AND BUILDINGS
DURING COMMERCIAL POWER FAILURES

Telephone Equipment -	Furnish standby power to maintain full operation of all but recharge rectifiers in all DC plants in the building (see Section 2, Power Systems Engineering Manual[5]). Furnish standby power to maintain full operation of all AC plants supplying power to essential switching and transmission equipment and to the following AC loads: . Clocks and timers. . Convenience outlets in base of all central office equipment frames to provide power for test and repair of essential telephone equipment during power failures. Severe storms, which are often the cause of power failures, can also cause damage to the telephone network thus necessitating immediate test and repair. . Teletypewriters. . Status boards and equipment for network management. . 500-type plants powering the protected and UPS AC loads. . Auxiliary equipment associated with the engine-alternator such as fuel pumps, engine room fans, engine battery chargers, etc. . Antenna deicers, ventilation equipment, navigating lights, etc., at repeater or radio stations where required. . Compressor-Dehydrators used for supplying compressed dry air to outside telephone cables.

TABLE F (Cont'd)

Building Equipment -	Supply power to maintain essential building facilities as: . Sump pumps, house pumps, and fire pumps. . Heating and ventilating. . Cooling (only when ventilation system is inadequate or equipment temperature requirements specified in Section 760-555-151[6] cannot be met otherwise). . Building automation and control systems. . Essential lighting and ventilation for such areas as operator's room, interior corridors, and lavatories. . Door unlocking facilities. . In multistory buildings, make provisions for lowering all elevators to the ground floor. Control operation so that a minimum amount of power is used for elevator service.
In large, fully attended central office buildings, consideration should be given to the following additional loads as being essential.	. Necessary dining room, cooking and food refrigeration equipment (the use of electric ranges, ovens and hot plates should be minimized). . Vending Machines. . Continue operation of at least one elevator in buildings with three or more floors. (Check local codes for more stringent requirements.)
Business Office Equipment -	Power should be supplied for: . Equipment necessary for service order and items of similar importance.

TABLE F (Cont'd)

	. Equipment necessary for protection of company revenues, including bill receipting and other business machines. . Visual signals on office equipment, if AC operated. . Essential lighting.
Emergency Lighting - The emergency lighting system continues to operate until the engine-driven power plant comes on-line and energizes all essential lighting.	Equip the following areas with emergency lighting, as specified in Section 802-015-158[7]: . TSPS positions. . Power equipment rooms. . Battery rooms. . Engine rooms.

TABLE G

Pollution Measurements

STANDARD ENGINE-ALTERNATORS

Engine Alternator		Air Pollutant[1] (Lbs./Hr.)				
KS No.	KW Capacity	CO	NO[3]	HC[4]	Particulate	% Opacity (Smoke)[2]
15929	225	3.95	4.17	0.94	0.36	6.2[8]
19583 20523	30	0.64	0.80	0.396	0.183	4.1[9]
19584 20524	45	0.77	0.97	0.477	0.22	5.0[9]
19585 20525	75	1.30	2.60	0.156	NA	NA
19586 20526	115	2.20	4.39	0.263	0.207	NA
20460	2500	9.54	17.6	0.446	1.39	3.0[5,6]
21264	435/500	1.79	5.94	0.084	0.218	8.0[7]
21501	750/900	6.9	4.15	0.379	0.173	NA

Notes:

1. Pollutant emissions vary with load. These values represent the worst case conditions for the entire load range from zero to full rated kW.
2. Opacity varies with stack diameter. The conversion formula to predict opacity from the measured values reported here is:

$$OP_d = 1-(1-OP_{do})^{d/do}$$

where OP_d = opacity (in decimal form, %/100) from desired stack DIA.
OP_{do} = measured opacity reported here.
d/do = ratio of desired stack diameter to stack diameter corresponding to measured values.

TABLE G (Cont'd)

Pollution Measurements

MD ENGINE-ALTERNATORS

Engine Alternator		Air Pollutant[1] (lbs./hr.)				
KS No.	kW Capacity	CO	NO[3]	HC[4]	Particulate	% Opacity (Smoke)[2]
5574-01	20					
	30					
	40					
	60					
5750	20					
	30	0.137	0.454	0.860	0.210	5.0[10]
	40					
	60					
15521	20					
15717	10					
15777	500					
15890	30					
	45					
	60					
	100	2.09	2.19	1.15	0.270	5.0[11]
15954	350					
15992	750	6.90	4.15	0.379	0.173	NA
19587 20527	115	0.988	6.18	0.578	0.197	8.0[8]
19896 20542	200	10.7	1.47	3.29	0.855	NA

Notes (Cont.)

3. Reported as no equivalent.
4. Reported as CH_4 equivalent.
5. With low smoke combuster.
6. 40-inch diameter stack.
7. 20-inch diameter stack.
8. 10-inch diameter stack.
9. 4-inch diameter stack.
10. 3-inch diameter stack.
11. 8-inch diameter stack.

(NA = not available at present)

TABLE H

Pollution Measurements

STANDARD ENGINE-ALTERNATORS

Engine-Alternator		Air Pollutant[1] (Lbs/Hr.)				
	kW capacity	CO	No[3]	HC[4]	Particulate	% Opacity (Smoke)[2]
<u>Western Electric</u>						
KS22344	22	NA	NA	NA	NA	NA
<u>Stewart & Stevenson</u>						
35GD45/3-53/E7201	30	1.98	1.54	0.090	0.280	3.5
3GD75/3-71/E7203	48	0.99	1.49	0.080	0.320	3.5
4GDT125/4-71T/E7205	87	2.13	1.43	0.110	0.650	3.5
6GDT220/6-71T/E7209	153	4.63	2.07	0.160	0.820	3.5
8VGDT300/8-71T/E7210	204	0.65	3.40	0.230	1.040	3.5
8V92GDT/8-92T/E7213	324	8.31	4.35	0.300	1.060	3.5
12VGDT440/12-71T/E7213	402	7.64	5.09	0.320	1.480	3.5
16V92GDT670/16-92T/E7218	528	8.46	10.29	0.570	2.120	3.5
16V149GDT1000/16V149T/E7228	853	31.08	19.44	3.59	3.980	3.5
<u>Western Electric</u>						
KS21264	435	1.79	5.94	0.084	0.218	8.0
KS21501	748	6.9	4.15	0.379	0.173	NA
KS21879	1254	10.7	6.9	0.4	NA	1.2

NOTE SEE NOTES ON TABLE G.

TABLE I

Other Engineering Considerations

ITEM	RESPONSIBILITY		
	ARCH. ENGR.	TEL. CO. EQUIP. ENGR.	W.E. ENGR.
1. Floor plan layout	X	X	
2. Output voltage		X	
3. Automatic vs manual start		X	
4. Selection of engine start equipment		X	X
5. Sizing exhaust ventilation and air intake systems	X	X	X
6. Radiator location	X	X	
7. Fuel storage system	X	X	X
8. Modifying 60 kW engine for 100 kW operation		X	
9. House service termination	X	X	

TABLE J

Standby Plant Engineering Responsibilities

Item	Resp.		Applies To:	
	Arch	E.E	Diesels	Gas Turb.
1. Items to be tied to emergency AC bus	x	x	x	x
2. Determining load and sizing engine	x	x	x	x
3. Portable or stationary operation		x	x	
4. Diesel or gas turbine operation, where applicable		x	x	x
5. Location of engine and associated equipment	x	x	x	x
6. Should fire wall be provided	x		x	x
7. Engine output voltage	x	x	x	x
8. Manual or automatic start and load transfer	1.	x	x	x
9. Sizing air intake louvers and filters	x		x	x
10. Sizing exhaust flue or stack	x		x	x
11. Sizing auxiliary ventilating equipment	x		x	x
12. Sizing exhaust louvers	x		x	x
13. Remote or engine-mounted radiator	x	x	x	
14. Size and type (buried and/or day) of fuel storage tank		x	x	x
15. Location of fuel tanks	x	x	x	x
16. Recondition and/or modify engine		x	x	
17. House service cabinet termination for emergency engine	x	x	x	x
18. Employing parallel operation of engines	x	x	x	x

NOTES: 1. If Multiple Sets and/or over 1600 amperes load, Arch. Engr. must determine transfer arrangement.

TABLE K

Equipment Specification	J86657 802-964-156	35GD45 E7201	3GD75 E7203	4GDT125 E7205	6GDT220 E7209	8VGDT300 E7210	8V92GDT335 E7213	12VGDT440 E7213	16V92GDT670 E7218	16V149GDT1000 E7228	J86654 802-980-154	J86653 802-980-153	J86655 802-980-155
Engine Specification	KS22344	3-53	3-71	4-71T	6-71T	8-71T	8-92T	12-71T	16-92T	16V149T	KS21264	KS21501	KS21879
Major Alarms													
Ground Fault 480V		OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	x		x
Differential Fault 4160V		Special Assembly 4160 Volt Sets											x
Overcurrent Auto	x	Malfunction Alarm									x	x	x
Control Brkr or Fuse	x	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	x	x	x
Undervoltage													x
Overvoltage	x	x	x	x	x	x	x	x	x	x	x	x	x
Emergency Stop	x	x	x	x	x	x	x	x	x	x	x	x	x
High Vibration													x
Fail to Light											x	x	x
Abort Start													x
High Exhaust Temp											x	x	x
Eng. Under Speed											x		x
Eng. Over Speed	x	x	x	x	x	x	x	x	x	x	x	x	x
High Oil Temp	x										x	x	x
Low Gear Box Oil Pres											x		
Low Eng. Lube Oil Pres.	x	x	x	x	x	x	x	x	x	x		x	x
High Coolant Temp	x	x	x	x	x	x	x	x	x	x			
Reverse Power Parallel		x	x	x	x	x	x	x	x	x	x	x	x
Fail to Rotate Auto	x										x	x	x
Excess Cranking Auto		x	x	x	x	x	x	x	x	x	x	x	x
Fail to Accelerate											x		x
Open Probe											x		x
Low Fuel		x	x	x	x								
Engine Fail		x	x	x	x	x	x	x	x	x			
Minor Alarms													
Minor Contl Breaker											x	x	x
Rectifier Fail	x	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	x	x	x
Prelim High Exh Temp Turb											x	x	x
Prelim High Coolant Temp	x	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT			
Immersion Heater Fail	x	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT			
Commercial Power Fail	x	x	x	x	x	x	x	x	x	x	x	x	x
Fuel System Fail											x	x	x
Oil Sump Heater Fail		OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT			x
Low Battery		x	x	x	x	x	x	x	x	x			

TABLE K
AC STANDBY PLANTS ALARM REQUIREMENTS (SINGLE SET)

TABLE L

Guide for Selecting AC Power Standby System
(SHEET 1)

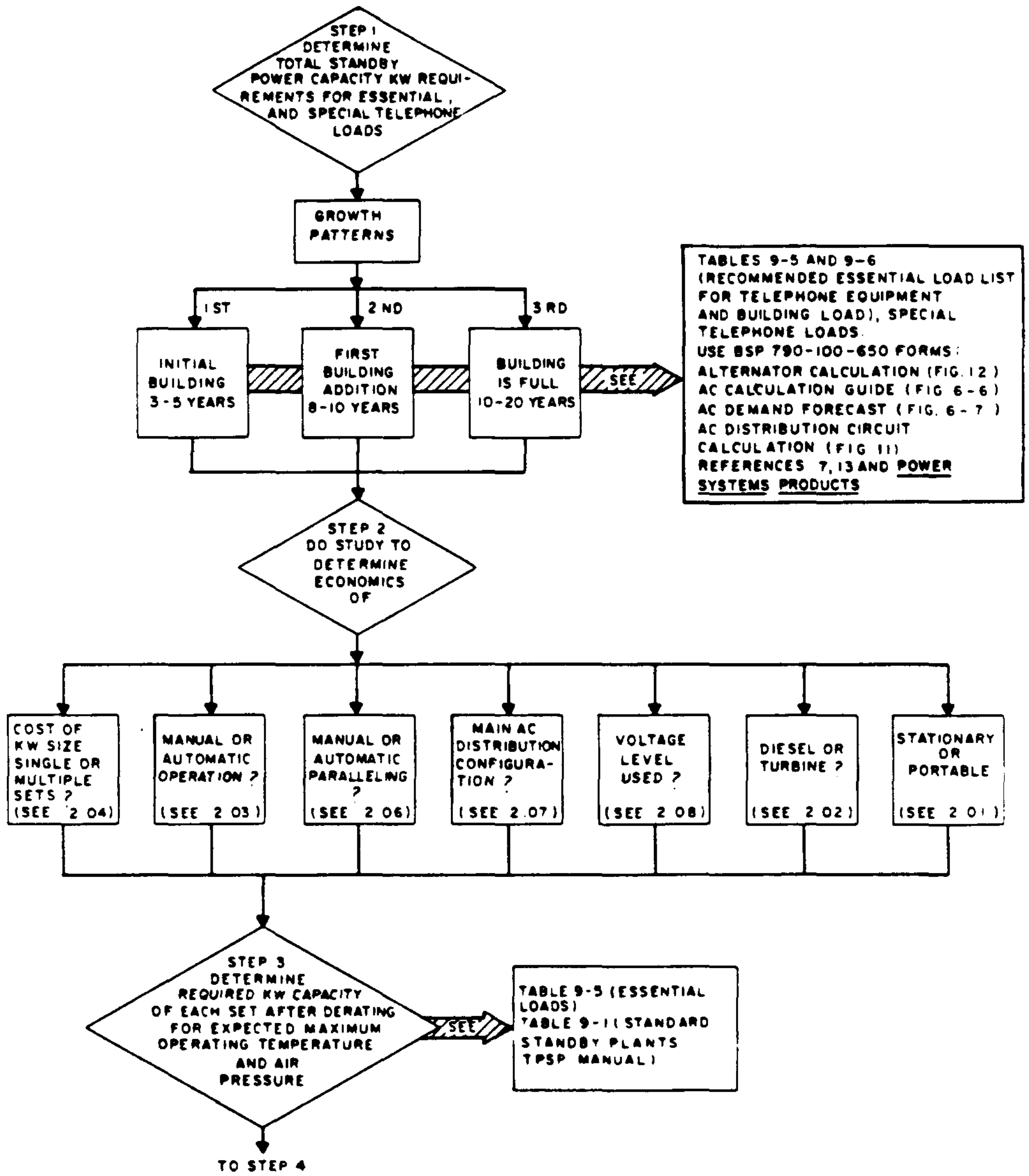

TABLE L (Cont'd)

(SHEET 2)

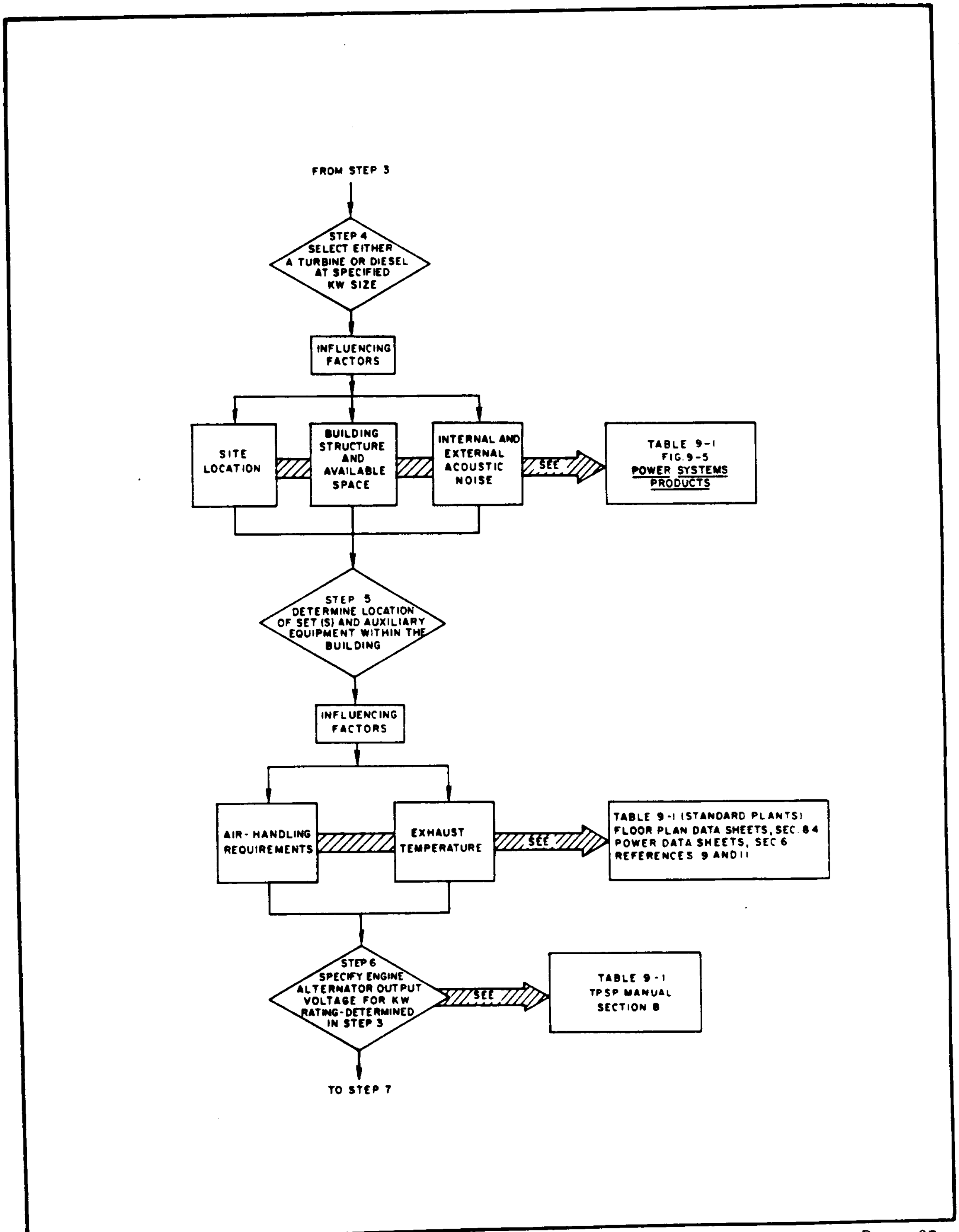

TABLE L (Cont'd)

(SHEET 3)

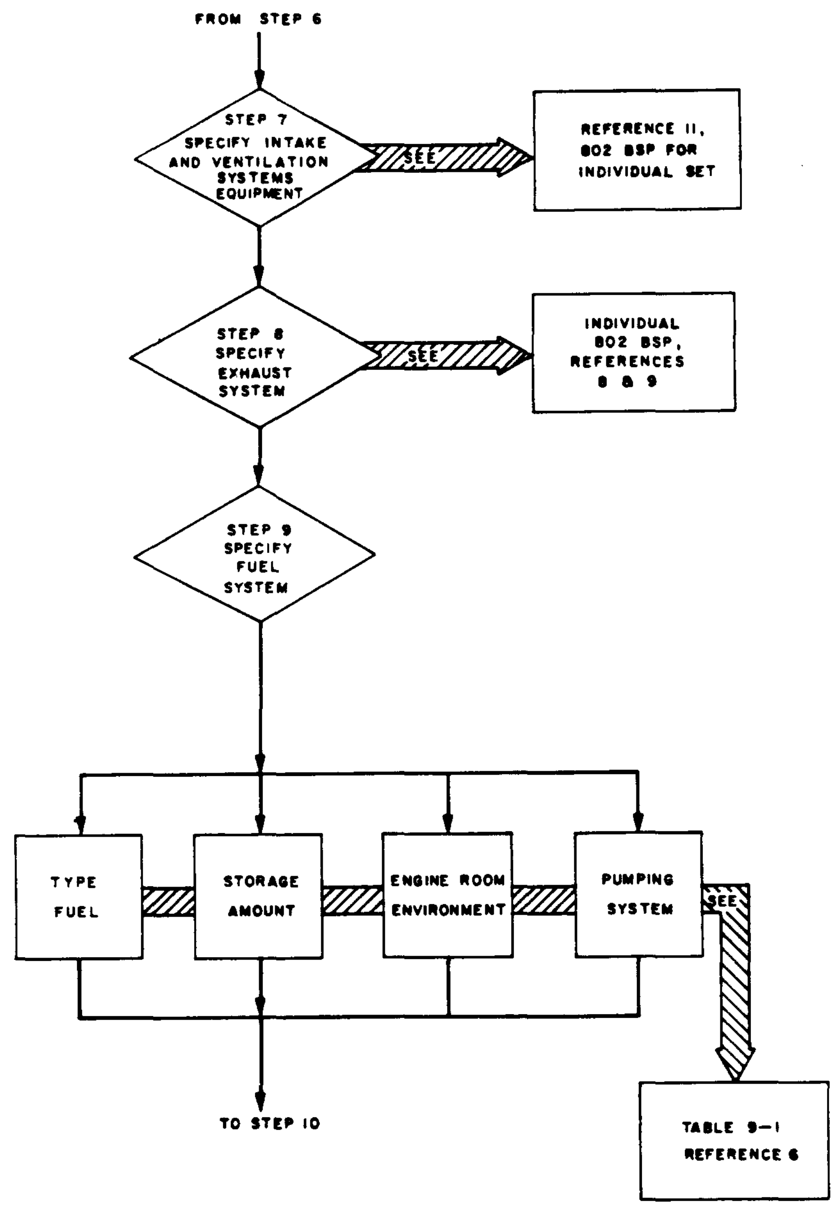

TABLE L (Cont'd)

(SHEET 4)