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MILITARY SPECIFICATION

ELECTRIC LOAD AND POWER SOURCE CAPACITY, AIRCRAFT, ANALYSIS OF

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the methods and requirements for preparing alternating current (at) and direct current (dc) electric load and power source capacity analyses for aircraft.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-W-5088 - Wiring, Aerospace Vehicle

Beneficial comments (recommedations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC MISC

STANDARDS

MILITARY

MIL-STD-704 - Electric Power, Aircraft, Characteristics and Utilization of

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Definitions. For definitions and sample calculations applicable to this specification, see section 6.

3.2 Report. The electric load requirements and power source capacity shall be determined for each electric system under all operating conditions of the aircraft, and an Electric Load and Power Source Capacity Report shall be prepared in accordance with the methods outlined herein. Analyses shall be made for special-purpose electric systems such as independent engine ignition and control generator systems as well as for general-purpose electric systems.

3.3 Form. The report shall be printed entirely on 8-1/2 x 11-inch sheets or entirely on 8 x 10-1/2-inch sheets. All letters and numbers shall be at least 0.075 inch tall. All marking on each page shall be included in a 7-1/2 x 10-inch area. The report may be printed on one or both sides of each sheet. The report shall be printed with all marking on all pages in the normal attitude for reading with the long side of each sheet vertical, or with all marking on all pages in the normal attitude for reading with the long side of each sheet horizontal (not like this specification). The report shall be assembled, and shall be bound on the side which is on the left with the assembled report closed and in the normal attitude for reading with the front cover on top, and all pages shall be in the normal attitude for reading when the report is opened to them with the bound edge in this orientation.

3.4 Charts.

3.4.1 Arrangement. The charts shall be presented on a number of sheets as shown in the sample analyses. These sheets shall be arranged to facilitate cross-referencing from the load equipment chart to the load analysis charts.

3.4.2 Sample analyses. The sample analyses (Figures 1 through 19) illustrate a typical method for presenting data. The information entered consists of excerpts from a typical analysis and is not a complete study of the electric power configuration of any particular aircraft.

3.4.3 Numbering of pages. The pages of each complete report shall be numbered consecutively and each shall contain a revision number in the form of a dash number after the page number to indicate the applicability to a particular revision of the report.

3.4.4 Columns and entries. The columns and entries of each chart shall conform to the following:

3.4.4.1 Alphabetical column headings. For referencing, the column headings of the charts are designated alphabetically, and this designation is continued in sequence from sheet to sheet of each complete analysis.

3.4.4.2 columns without alphabetical designations. Columns shall be provided where indicated in the sample charts for the following types of entries:

a. Item numbers: Consecutive numbers for each item of equipment which shall appear on both sides of the chart when space permits.

b. Notes: For entry of explanations, data, calculations, or other miscellaneous information.

3.4.4.3 Multi-system analyses. When space permits, load analyses for two or more individual systems may be reported on the same group of charts, provided that the individual system analyses are clearly separated and identified.

3.4.4.4 Order of charts. Charts shall be arranged in the order given in the outline of 3.5 for each source. Where several sheets are required for a given charts all sheets for each chart shall be grouped together in consecutive order.

3.4.4.5 Chart entries.

3.4.4.5.1 Multiple entries. When multiple entries are recorded in the electric power system analysis, the purpose and applicability of each entry shall be clearly established. In general, multiple entries are required under the following conditions:

a. Operation at various power levels: When an equipment operates at two or more distinct power levels, the maximum power requirements shall be entered first, followed by entries covering the lesser power requirements.

b. Special power requirements: When special power requirements cannot be supplied to equipment terminals by the sources in the aircraft, these special requirements shall be

fully explained in notes. For example, calibration power requirements might require closer voltage tolerance than that required for normal operation.

c. Multiple_power_sources: When an equipment requires, or is served by multiple power sources at the same time, its requirements shall be entered in the load analysis is of each power source. such multiple entries shall not be compounded in system power totals. POW

3.4.4.5.2 "Operating conditions" entries. All entries shall be accurate within 5% maximum error.

3.5 Contents. The report shall consist of applicable items from the following outline, with ac and dc analyses repeated as required for each electric ppwer system in the aircraft:

Item	
I	Title Page (see 3.5.1)
II	Table of Contents (see 3.5.2)
III	Introduction (see 3.5.3) A. Statement of mission (optional see 3.5.3) B. Operating Conditions (see 3.5.3.2) C. Electric Bus Wiring Diagram (see 3.5.3.3) D. Description of Electric System Operation (see 3.5.3.4) E. Generator Mounting and Drive Data (see 3.5.3.5) F. Power Source Output Data (see 3.5.3.6)
IV	AC Load Analyses (see 3.5.4) A. Connected Load Chart (see 3.5.4.1) B. Load Analysis Chart (see 3.5.4.2) C. Transient Analyses (see 3. 5.4.3) D. Power Source Utilization Analysis Chart (see 3.5.4.4) E. Power Source Utilization Graph (see 3.5.4.5) F. Adjusted Power Source Graph (see 3.5.4.6)
V	DC Analyses (see 3.5.4 and 3.5.5) A. Connected Load Chart (see 3.5.4.1) B. Load Analysis Chart (see 3. 5.4.2) C. Transient Analyses (see 3.5.4.3) D. Power Source Utilization Analysis Chart (see 3.5.4.4)

E. Power Source Utilization Graph (see 3.5.4.5)
F. Adjusted Power Source Graph (see 3.5.4.6)
G. Battery Analysis (see 3.5.5.1)

VI Starting Load Data (see 3.5.6)
A. Engine Starting Requirements Data (see 3.5.6.1)
B. Starting Power Source Data (3.5.6.2)

VII Ground Power Analysis (see 3.5.7)

VIII Summmary and Conclusion (see 3.5.8)
A. Summary of System Analysis (see 3.5.8.1)
B. Conclusions (see 3.5.8.2)

IX Notes (see 3.5.9)

3.5.1 Title Page. The title page shall include the following information:

* _____ Electric Load and Power Source Capacity Report for Model ** _____ Aircraft
Date of Report ***
Contract Number
Prepared in accordance with MIL-E-7016F ****
Number of pages with revision data
Serial numbers of aircraft
Name and address of aircraft manufacturer
Security Classification

*Insert any applicable term such as "Preliminary", "Intermediate", or "Final" which is specified inthe contract.
**Insert the model number of the aircraft.
***If the report is a revision, the date of the report shall be the date of the revision, not the date of the original report.
*** *If any amendment to this spec. is applicable, add:
with amendment _____(Insert the number of the amendment.)

Additional information may be presented on the title page at the option of the contractor.

3.5.2 Table of contents. A table contents shall be included listing the various parts of the report with the page numbers.

3.5.3 Introduction.

3.5.3.1 Statement of aircraft mission. The statement of aircraft mission shall consist of a brief statement of the mission, with general explanations which will serve to clarify the function of the electric system with respect to the mission (Optional).

3.5.3.2 Operating conditions. A list of the operating conditions represented by the G numbers shall be given, similar to the following:

G1	Ground maintenance
G2	Calibration
G3	Loading and preparation
G4	Start and warm up
G5	Taxi
G6	Take off & climb
G7	Cruise
G8	Cruise combat
G9	Landing
G10	Emergency

3.5.3.3 Bus wiring diagram. The bus wiring diagram shall consist of a functional single-line diagram of the bus arrangement, with buses, power sources and interconnections identified as illustrated in Figure 1.

3.5.3.4 Electric system operation. Power distribution from the source output terminals to the buses shall be described briefly for both normal and abnormal operation.

3.5.3.5 Generator Mounting and Drive Data. For a sample of Generator Mounting and Drive Data, see Figure 2.

3.5.3.6 Power Source Output Data. For a sample of Power Source Output Data, see Figure 3.

3.5.4 AC and DC analyses.

3.5.4.1 Connected load chart. The connected load chart is a listing of equipment for each bus grouped by its functional category (see 3.5.4.1.1), along with power requirements per unit, applicable notes, and number of units. Entries on this chart are used to identify entries on all succeeding sheets of the analysis of a given source. If equipment requires multiple power sources, this fact should be stated in the notes. Typical connected load charts are shown on Figures 4 and 10.

3.5.4.1.1 Functional category - column A. Each item of equipment shall be assigned a functional category code letter identifying the function of the equipment

The selection of the code letter and grouping of equipments by category shall be in accordance with the circuit function letters specified in MIL-W-5088 wherever applicable. Functional category code letters shall be listed alphabetically (see Figure 4 and 10).

3.5.4.1.2 Connected load - column B. All equipment requiring electric power from the system analyzed shall be listed in this column.

Exception: When the power source supplies its rated capacity plus the requirements of its associated control devices, these control devices shall not be included in the listings.

3.5.4.1.2.1 Order of entry. The equipments listed shall be grouped by functional category (see 3.5.4.1.1) for each bus. Examples are shown in Figures 4 and 10.

3.5.4.1.2.2 Dummy loads. This type of load, identified as such, shall be entered as a separate item immediately following the load corrected. If used for ac system power factor correction, The entry shall be made under "x - ac power". Similarly, dummy loads used on a dc system shall be listed under “P - dc power”.

3.5.4.1.2.3 Transformers. The type, configuration, and rating of transformers considered as part of the power system shall be listed on the load identification charts or given in a note. A separate analysis is not required. The equipment connected to the secondaries of such transformers shall be grouped, together with the transformer losses, under the proper phases of the primary into which the phase loads are reflected. See example On Figure 4.

3.5.4.1.3 Total number of units - column C. The total number of installed units supplied simultaneously by the source being analyzed shall be entered in this column.

3.5.4.1.4 Ac electrical requirements per unit - column D.

3.5.4.1.4.1 Units. The electric power requirements for each load shall be stated in watts, vars, and voltamperes, measured at the equipment terminals, with the nominal system voltage maintained at these terminals. Loads having a leading power factor shall be identified by an asterisk, with a footnote stating that the asterisk means leading power factor.

3.5.4.1.4.2 Averaging of requirements. The load requirements for each unit shall be the average value required by the equipment during the operating time. Rated load shall be entered for equipments, such as hoists, whose power requirements depend on the manner in which they are used.

3.5.4.1.4.3 Ac phase identification. Loads supplied from wye-connected sources shall be entered under phases A-N, B-N and C-N. Loads supplied from delta-connected sources shall be entered under phases A-B, B-C and C-A. Loads supplied from single-phase sources shall be entered under the phase to which it is reflected, with an appropriate note.

3.5.4.1.5 Dc amperes per unit - Column E. Dc power requirements shall be stated in amperes, measured at nominal system voltage, Entries shall be the average current drawn by the equipment over the operating time. Transient and in-rush currents shall be analyzed in accordance with 3.5.4.3.

3.5.4.1.6 Load operating time - column F. The load operating time is the time in minutes for which each item of equipment draws electric power in each operating condition. If the operating time varies in a manner which cannot be defined satisfactorily with a simple unit of time, an explanation shall be included in the notes. Operating times of O. 005 minute or less shall be entered as “O”. Operating times greater than 0.005 but less than 5 minutes shall be entered to the nearest 0.01 minute. Periods longer than 5 minutes are considered continuous; enter “C" as on Figures 4 and 10.

Exception: No entry shall be made for equipment used only during engine starting.

3.5.4.2 Load analysis charts- column G. The load analysis charts are used to determine the total load requirements for each condition under which the aircraft operates. The operating conditions listd in the following paragraphs are considered typical for most military aircraft. The conditions shall be reported and analyzed in the order corresponding to a typical operation of the particular aircraft. Special conditions applicable shall be reported in additional operating condition columns. The charts for each operating condition shall be designated G1, G2, G3 . . . consecutively for a normal operating sequence. See Figures 5 and 11 for sample load analysis charts.

3.5.4.2.1 Ground maintenance. Ground maintenance is that operating condition existing when electric components are being repaired, checked or tested, and electric power is supplied by internal or external power source(s). The electric loads reported shall include the maximum power requirements of all loads or groups of loads which may be operated simultaneously during maintenance operations.

3.5.4.2.2 Calibration. Calibration is that period when equipment is be checked for accuracy or recalibrated.

Exception: The condition of calibration may be omitted when each electric equipment in the aircraft can be calibrated with (1) power having the characteristics specified in MIL-STD-704, and (2) the ground power source required for the ground maintenance

condition is also adequate for calibration power In lieu of the "Calibration" entries, a statement that both of the above requirements have been fulfilled shall be included in the notes.

3.5.4.2.3 Loading and preparation. Loading and preparation is that condition between securing and starting. Operations performed during this period may consist of hoisting, fueling, lighting, radio communications, heating, cooking, etc During this period, power is supplied by an auxiliary power unit, internal batteries. or an external power source.

3.5.4.2.4 Start and warmup. Start and warmup is that condition from preparation for starting to taxiing. An example of anengine starting analysis is given Figure 16.

Exceptions: a. Equipment warmup: If certain equipments require extended or otherwise special warmup prior to routine flight operations, the additional condition of "Equipment warmup" shall be reported.

b. Electric-powered start: For aircraft utilizing electric power for engine starting, a separate detailed analysis shall be made to define starter input power requirements. When the main engines are started by external electric power only, the starter load shall not be entered in this column.

3.5.4.2.5 Taxi. Taxi is that condition from the aircraft's first movement under its own power to the start of the takeoff run, and from completion of landing rollout to engine shutdown.

3.5.4.2.6 Takeoff and climb. Takeoff and climb is that condition commencing with the takeoff run and ending with the aircrft leveled-off and set for cruising.

3.5.4.2.7 Cruise. Cruise is that condition during which the aircraft is in level flight but is not in a combat-ready condition.

3.5.4.2.8 Cruise-combat. Cruise-combat is that condition during which the aircraft is performing its combat missiom in a combat-ready or actual combat condition.

3.5.4.2.9 Landing. Landing is that condition between entering into the base leg of a landing approach and completion of rollout.

3.5.4.2.10 Emergency. Emergency is any period of flight during which the normal sources of power are inoperative. During this period, loads essential to safety of flight under any flight condition are transferred to an alternate source of power. These loads are listed in the emergency column, and the total load requirements are analyzed with respect to the alternate power source. Possible categories of essential electric loads are flight instruments, surface controls, engine controls, and fuel boost systems. If the emergency power source is a battery, see 3.5.5.1.

Exception: For rotary wing aircraft having at least two separate primary sources driven by the rotor transmission and at least two secondary sources, where a single primary or secondary source can supply all essential loads, the emergency condition shall be omitted and replaced by analyses of the loads and source capacities remaining after a single failure for each type of power source.

3.5.4.2.11 Mission completion. Mission completion power is defined as minimum electric power required to enable an aircraft to complete its mission The requirement for this power may occur during any period of the flight. For a multi-engine aircraft the load shall be compared to the power source capacity remaining after loss of any one generating or conversion system. For a multi-role aircraft, the mission requiring most electric power shall be chosen for analysis.

3.5.4.2.12 Additional columns. Additional columns may be used as required to report special operating conditions which may materially affect the load analysis by indicating conditions more critical than those specified. These conditions might include any of the following:

Ground Alert
Equipment Warmup
Idle Descent
Hovering
Loiter
Jato or Rocket Ignition
Launch

3.5.4.2.13 Combination of columns. Where load requirements for one operating condition as specified under 3.5.4.2.12 are identical to those of one or more other conditions, they may be combined into a single column with a suitable heading denoting these conditions.

3.5.4.2.14 Average Load - subcolumns. For each analysis other than continuous analyses, the average watts and average vars ac entries, or average amperes dc entry, for each load for which the operating time is less than the time

interval of that column heading, shall equal the product of the number of units operating simultaneously during the operating condition, multiplied by the load requirements per unit, multiplied by the operating time accumulated during the time interval of that column heading, divided by the time interval.

Formula:

$$\text{Watts, Vars or Amperes} = \frac{\text{No. of units x load requirements per unit x operating time}}{\text{Time interval}}$$

For continuous analyses,

$$\text{Watts, Vars or Amperes} = \text{No. of units x load requirements per unit}$$

If the power drawn by a continuous load varies, the greatest average load for any 5-minute period shallbe entered.

Note: The load requirements entries made under the "Average Load" subcolumns concern steady state load requirement only. Differences appear between entries of load requirements for short-time intervals and continuous duty. These differences are the result of single, intermittent or cyclic operation of certin loads, and do not consider starting transients or inrush currents. See 3.5.4.3 for a discussion of transient analyses.

3.5.4.2.15 Time intervals. Three analyses shall be made for each operating condition, as follows (see 6.2.5.2):

a. 5-second analysis: All loads which last longer than 0.005 minute shall be entered in this analysis.

b. 5-minute analysis: All loads which last longer than five seconds shall be entered in this analysis.

c. Continuous analysis: All loads which last longer than five minutes shall be entered in this analysis.

3.5.4.2.15.1 Other time intervals. The time intervals listed above are considered suitable for most aircraft electric power sources, but on occasion the design of a particular power source may dictate other time intervals. In such cases, the correct intervals shall be entered together with justification for any changes. Corresponding power source ratings shall be obtained by test means, or by interpolation among known ratings, for use in the load and power source comparisons.

3.5.4.2.16 Ac load summation. For each time interval, the following shall be calculated.

3.5.4.2.16.1 Phase watts - phase vars. These entries are the sum of the watts and the algebraic sum of the wars in each phase.

3.5.4.2.16.2 Phase VA - phase power factor. Phase VA is the vector sum of phase watts and phase vars. Phase power factor equals the phase watts divided by the phase VA, and shall be compatible with the capabilities of the source.

3.5.4 .2.16.3 Phase unbalance. This entry equals the maximum phase VA minus the minimum phase VA expressed as a percentage of the adjusted source (see 6.3.1.1) phase VA rating.

3.5.4.2.16.4 Total watts - vars. Total watts is the sum of the watts for each phase. Total vars is the algebraic sum of the vars for each phase. Total VA is the vector sum of the total watts and total vars.

3.5.4.2.17 DC load summation. For each time interval, the total amperes dc shall be entered as shown in Figure 11.

3.5.4.3 Transient power requirements. Certain equipments, such as motors, solenoids lamps, etc., require starting power in excess of the steady-state power requirements. For an analysis of transient power requirements, all probable transient and steady-state loads are combined into a curve of load versus time. and this curve is command with the system 5-second adjusted capacity for the

Exceptions: a. In general, transient power requirements may be disregarded for the time interval between the start of transient demand and 0.02 second. This generally excludes transients due to lamp loads. When a peak load transient drawn by any load, or by simultaneously switched loads, is greater than 20 percent of the continuous full load rating of any one generator, then the complete transient load curve shall be shown. The curve shall begin at zero time and continue until steady state is reached.

b. Motor starting transients shall be analyzed as shown in 6.3.6.

c. Possible transients resulting from bus (multiple load) switching during fault or emergency conditions may be disregarded in load and power source capacity analyses,

but such transients shall be reported and justified in separate systems analyses when required by the procuring acitvity.

Note: The transient power requirements when superimposed upon the 5-second average power requirements, shall fall within the 5-second adjusted capacity of the power source.

3.5.4.4 Power source utilization analysis chart. This analysis develops the adjusted source capacities for each interval and for each operating condition and compares these with the load requirements. See examples, Figures 7 and 12.

3.5.4.4.1 Aircraft flight conditions. The maximum true airspeed, maximum altitude and operating time are stated in the detail specification for the aircraft. If entry of this information would raise the security classification of the report, it may be omitted and reference made to the detail specification.

3.5.4.4.2 Power source operating conditions.

a. The generator drive shaft speed in revolutions per minute (rpm) is determined from the engine rpm, the gear pad ratio, and/ or the drive characteristics.

b. For air-cooled generators, the minimum differential pressure across the generator is determined from the airspeed, altitude, blast tube and generator characteristics.

c. The maximum air inlet temperature is determined from the airspeed, altitudes and blast tube characteristics, taking into account the effect of temperature rise due to ram air pressure.

d. Appropriate data for oil-cooled generators, including oil inlet temperature and flow rate.

3.5.4.4.3 Rating factor. A rating factor is a number which, when multiplied by the nominal rating (see 6.2.6.1) of a source, gives the capacity of the source under specific operating conditions. Each rating factor for a specific operating condition must be chosen so that the product of all the rating factors and the nominal rating correctly defines the capacity of the source.

a. Mechanical rating factor. The mechanical rating factor is established by the torque limitations of the generator drive system. This rating factor is defined as the ratio of drive

output torque limitation to torque required at rated load. For systems which are limited by the thermal or electromagnetic rating factor the mechanical rating factor shall be equal to 1.0.

b. Electromagnetic rating factor. The electromagnetic rating factor is established by the generator speed versus output chamacteristics. It shall be equal to the ratio of maximum allowable load at the operating speed to rated load. For systems which are limited by the mechanical or thermal rating factors the electromagnetic rating factor shall be equal to 1.0.

c. Thermal rating factor. The thermal rating factor shall be based on test or calculated data and shall define the effect of the cooling medium (air or oil) on the capacity of the source to deliver power. For systems which are limited by mechanical or electromagnetic factors the thermal rating factor shall be equal to 1.0.

d. The rating factor for paralleling shall be applied whenever power sources are operating in parallel. For generators, the standard paralleling factor of 0.9 shall be used, unless more precise load division capabilities can be demonstrated.

e. The composite factor is the product of the individual rating factors above. The factor multiplied by the interval rating of the source shall correctly define the capacity of the source to deliver power under the operating conditions.

3.5.4.4.4 Analyses. The 5-second analysis is performed as follows:

a. The 5-second composite rating factor shall equal the mechanical factor times electromagnetic factor times the parelling factor times the impedance losses factor. (For this interval only, the thermal rating factor shall be assumed equal to 1.0).

b. The 5-second source interval rating shall equal the 5-second rating of individual units multiplied by the nuder of units operating in parallel.

c. The 5-second adjusted source capacity shall be the product of the 5-second source interval rating and the 5-second composite rating factor.

d. The 5-second load requirements shall be taken from the load analysis charts.

e. The 5-second growth capacity shall be determined in accordance with 6.3.4.

f. The 5-second phase load unbalance, expressed as a percentage shall be taken from the load analysis charts.

Note: The 5-minute and continuous analyses are performed similarity to the 5-second analysis. For these intervals, the thermal rating factor shall correspond to the cooling provided under the operating condition.

3.5.4.5 Power source utilization graph. A visual display shall be provided which will illustrate the power available and the power consumed for all operating conditions at temperatures and altitudes relevant to the operation of the aircraft. See Figures 8 and 13.

3.5.4.6 Source capacity curves. Appropriate rating curves for each power source shall be provided. Factors which may require dislay include speed and temperature, altitude and pressure effects for air cooled generators and oil inlet temperature and flow rate for oil cooled types. See Figures 9 and 14.

3.5.4.7 Fault clearing capacity. In the case where a single load on the system requires a circuit protective device with a rating equal to or greater than 10 percent of a single generator adjusted capacity, an analysis shall be performed to show that the generator is capable of opening the circuit protective device under the following conditions:

a. A low-impedance short circuit applied at the load input terminals.

b. The single generator supplying loads requiring 100 percent of its adjusted capacity prior to the application of the fault.

3.5.5 DC Analyses.

3.5.5.1 Battery analyses. Analyses shall be made for the Loading and Preparation, and Emergency conditions if applicable. The initial state-of-charge assumed for the battery shall not exceed 80 percent of nominal capacity.

3.5.5.1.1 Loading and preparation. An analysis shall be made identifying typical battery loading during the Loading and Preparation condition which shall

determine the available operating time. If the battery may subsequently be used for starting, the above operating time shall be calculate so that sufficent capacity remains for starting. See Figure 15 for example.

3.5.5.1.2 Emergency. An analysis of battery loading during the emergency condition shall be made to determine the time remaining during which electrical power will be available.

3.5.6 Engine starting - electrical requirements. The power requirements for engine starting shall be defined as follows:

3.5.6.1 Engine starting requirements data. The current drawn, minimum potential required, and other pertinent data should be shown in a manner such as the example on Figure 16.

3.5.6.2 Starting power service data. The identification and rating of the recommended source of power for starting should be given in a manner such as the example on Figure 16.

3.5.6.3 Peak starting requirements (common bus). If the loads normally "ON" during start and warmup are connected directly to the starting power source during the engine starting, the analysis shall be continued as follows:

a. Start and Warmup:

5-second average load, _____ amperes/VA
5-minute average load, _____ amperes/VA
Continuous average load, _____ amperes/VA

Note: The above results shall be taken from the "Start and Warmup" operating conditions chart, Figure 11.

b. The possible system peak is the sum of the peak starter load plus the 5-second average load from a. above.

c. The probable system peak is the sum of the peak starter load plus the 5-minute average load from a. above.

3.5.6.4 Self-powered engine starting. If the aircraft is capable Of self-powered engine start, the starting requirements shall be reported under the start and warmup operating conditions for analysis with respect to the internal power source.

3.5.7 Ground power. The following information shall be furnished which pertains to ground operation with an internal auxiliary power unit, with external power or both See Figure 17.

a. A tabulation of the connected loads with each significantly large load (in excess of 10 percent of the source rating) individually listed. The table shall contain the electrical power requirements and the drive horse power required. This can be supplemented by elementary functional diagrams when necessary.

b. Number, type, and location of external power receptacles installed on the S.ire@, and connections thereto.

c. Maximum amount, type, and quality of electric power required to be carried by each receptacle for ground support of the aircraft. The specific electrical equipment to be operated on the ground shall be identified.

d. Any unusual external power receptacle arrangements or special plug-in procedures shall be described and justified. The description shall include a wiring diagram of the receptacle.

3. 5.8 Summary and conclusions.

3.5. 8.1 Summary of system analyses. A summary shall be compiled (see Figure 18) showing the minimum growth capacity of each electric system analyzed and briefly reporting the conditions and loads which create these minimum growth capacities.

3. 5.8.2 Conclusions. The conclusion (see Figure 18) shall consist of statements attesting to the adequacy of the various power sources when operating under the most severe conditions revealed by each analysis, and declaring that the limits specified have not been exceeded.

3.5.9 Notes. Notes shall be entered defining the operating conditions and providing any other explanations necessary as shown in Figure 19.

4. QUALITY ASSURANCE PROVISIONS

4.1 Evaluation of data. The data provided in the aircraft electrical load and power source analysis reports shall show that each power source is adequate for supplying the power requirements of its connected load under all of the required operating conditions and shall state the growth capacity available.

4.2 Approval. Approval of the analysis shall be based upon evaluation by the procuring activity, or acceptance of the contractor's evaluation.

Note: Approval of the analysis cannot be construed to mean approval of any specific electric component or circuitry.

5. PACKAGING

5.1 This section is not applicable to this specification.

6. NOTES

6.1 Intended use. This specification is intended for use in preparing analyses of the electric load and power source capacity for aircraft.

6.2 Definitions. The following definitions are applicable to the terminology used in this specification.

6. 2.1 Analyses.

6.2.1.1 Electric load and power source utilization analysis. An electric load and power source utilization analysis for an aircraft consists of individual analyses of each electric power system, which is used in line maintenance, operation, or both, of the aircraft. Each of these individual analyses is called a system analysis.

6.2.1.2 System analysis. A system analysis is an electric load and power source utilization analysis for an individual electric power system. In this specification, the system analysis is divided into a load analysis and a power source analysis.

6.2.1.3 Load analysis. A load analysis is essentially a summation of the electric loads applied to the particular system during specified operating conditions of the aircraft.

6.2.1.4 Power source analysis. A power source analysis Consists of determining the capacity of the power source for the same operating conditions specified for the load analysis. The power source analysis includes the calculation of percent growth capacity (see 6.2. 6).

6.2.2 Electric system. An electric system consists of an electric power source, its power distribution system, and the electric load connected thereto.

6.2.3 Electric sources.

6.2.3.1 Electric source. An electric source is the electric equipment which produces, converts, or transforms electric power. Common ac sources are ac generators inverters, transformers, and frequency changers. Common dc sources are dc generators, converters and batteries. A source may consist of multiple unit sources operating in parallel.

6.2.3.2 Primary source. A primary source is equipment that generates electric power from energy other than electrical, and is independent of any other electrical source. For example: The primary source of an ac electric system may be the main engine-driven generator(s) or auxiliary power unit-driven generator(s). The primary source of a dc electric system may be a battery, main engine-driven genentor(s) or auxiliary power plant (APP) - driven generator. There may be both an ac and a dc primary system in the same vehicle.

6.2.3.3 Secondary source. A secondary source is equipment that transforms and/or converts primary source power to supply electric power to either ac or dc utilization equipment. A secondary source is entirely dependent upon a primary source and is considered part of the load of its primary source. There may be both an ac and dc secondary source in the same vehicle.

6.2.3.4 Normal source. The normal source is that source which serves an electric power system throughout a routine mission.

6.2.3.5 Alternate source. An alternate source is a second power source which may be used in lieu of the normal source, usually upon failure of the normal source. The use of alternate sources having characteristics differing from those of the normal source creates a new load and power configuration and therefore a new electric system, which may require separate source capacity analysis.

6.2.4 Emergency. For the purpose of this specification, emergency is the condition when the normal source of essential electric power becomes totally inoperative and an alternate power source must be used.

6.2.5 Ratings.

6.2.5.1 Nominal rating. The nominal rating of a unit power source is its nameplate rating. This rating is usually a continuous duty rating for specified operating conditions.

6.2.5.2 Interval rating. The interval rating of a unit power source is its maximum power output capacity for a specified time interval This rating is determined under the operating conditions specified for the nominal rating. 5 seconds and 5 minutes have been adopted as the standard overload intervals for this specification. Specifications and standards for electric power sources should specify overload capacities for these intervals. Among the documents involved are:

MIL-G-6162
MIL-I-7032
MIL-C-7115
MIL-G-21480
MIL-E-23001

6.2.5.3 Source interval rating. The source interval rating is the interval rating of a unit power source multiplied by the number of units operating in parallel.

6.2.5.4 Adjusted source capacity. The adjusted source capacity is the maximum power output capacity of a power source (system) when it is operated under specified conditions. It is the product of the composite rating factor multiplied by the source interval rating factor of the system.

6.2.6 Growth Capacity. Growth capacity is a measure of the power source capacity available in an aircraft electric system to supply future load equipment. This value is expressed in terms of percent of source capacity and shall be no less than the percentages specified in the aircraft detail specification.

6.2.6.1 Growth capacity of a primary system. Growth capacity of a primary system is calculated as indicated in 6.3.4.

6.2.6.2 Growth capacity of a secondary system. Growth capacity of a secondary system is equal to the quotient of the adjusted secondary source capacity minus the existing secondary system load divided by the adjusted source capacity, the quantity multiplied by 100. The result of this calculation shall appear on the summary of the system analysis sheet.

6.3 Sample calculations.

6.3.1 Ac load analysis calculations.

6.3.1.1 Formulas: Volt amperes (VA) = $(\text{watts}^2 + \text{vars}^2)1/2$

Power factor (p.f.) = W/VA, W = watts

$$\text{Percent phase load unbalance} = \frac{(\text{Max phase VA} - \text{Min phase VA}) \times 100}{\text{Adjusted source phase VA rating}}$$

6.3.1.2 Sample load analysis calculation.

	Watts	Vars	volt amperes	Power factor
Phase A	3,930	2,400	4,600	0.855
Phase B	4,130	2,820	5,000	0.826
Phase C	4,050	2,640	4,830	0.838

Adjusted Source Capacity = 30 kVA

Max Phase VA 5000
-Min Phase VA -4600
400

Phase Unbalance Percent = 400 x 100 = 4.0 percent
10000

6.3.2 Battery charging currents. The charging current for any aircraft battery shall be based on the total elapsed time from the beginning of charge, and shall be calculated in accordance with the following formula:

$$I = Ax\ C$$

Where: I = Average charging current in amperes.
A = Ampere-hour capacity of the battery, based on the 1-hour discharge rate.
c = Battery charging factor taken from Figure 20.

Exception: If a battery charger or charge current control device is used, the actual load drawn shall be entered.

6.3.2.1 Sample battery charging current calculations.

Given: a. The capacity of the battery = 31.0 Ampere-hour

b. Operating Condition		Minimum time (t)
Ground Maintenance	G-1	Not charging
Calibration	G 2	Not charging
Loading & Preparation	G-3	Not charging
Start & Warmup	G-4	5 minutes
Taxi	C-5	10 minutes
Takeoff & Climb	G-6	10 minutes
Cruise	G-7	15 minutes
Cruise-Combat	G-8	20 minutes
Landing	G-9	10 minutes
Emergency	G-10	Not charging

(1) At the beginning of the Start and Warmup condition, G-4 is the start of the battery charging. Since previous charging has not taken place, the charging factor C is read directly from Figure 20 for the times indicated in the chart below.

Time (Minutes)	Charging Factor (C)
0.08	3.37
1.00	2.77
5.00	2.10

(2) At the beginning of the Taxi condition, G-5, the battery charging has been progressing for five minutes. Hence, the charging factor for this period is taken from Figure 20 at the times of 5, 6 and 15 minutes, as indicated below.

Time (Minutes)	Charging Factor (C)
5	2.10
6	1.99
15	1.32

(3) At the beginning of the Takeoff and Climb condition, battery charging has been progressing for 15 minutes. Therefore, the charging factor at the beginning of this operation condition is 1.32. Similar calculations will yield the following results for the complete analysis.

Operating Condition	Minimum Duration of Condition t (minutes)	Rating Interval t' (minutes)	Total Elapsed time T' (minutes)	Charging Factor C	Charging Current I Amperes
G-1, G-2, G-3	0.0				
		0.08	0.08	3.37	104.5
G-4	5.0	1.00	1.00	2.77	85.9
		1/ 5.00	5.00	2.10	65.1
		0.08	5.0	2.10	65.1
G-5	10.0	1.00	6.0	1.99	61.7
		1/ 10.0	15.0	1.32	40.9
		0.08	15.0	1.32	40.9
G-6	10.0	1.0	16.0	1.28	39.7
		1/ 10.0	25.0	0.88	27.3
		0.08	25.0	0.88	27.3
G-7	15.0	1.0	26.0	0.83	25.7
		15.0	40.0	0.45	14.0
		0.08	40.0	0.45	14.0
G-8	20.0	1.00	41.0	0.44	13.6
		1/ 20.0	60.0	0.23	7.1
		0.08	60.0	0.23	7.1
G-9	10.0	1.00	61.0	0.23	7.1
		1/ 10.0	70.0	0.18	5.6
G-10					

1/ The actual duration (t) of the operating condition is inserted.

6.3.3 Inverter input calculations. When more exact data concerning inverter input current is not available, the following formula may be used to calculate inverter input current:

6.303.1 Formula: $$I = \frac{VA\ (1 - n) + va\ (1 + n)}{2 \times E \times n}$$

Where: I = Average input current in amperes
VA = Rated VA output of the inverter
n = Efficiency of the inverter in decimal form (See Note)
v a = va load on the inverter
E = Input terminal Voltage

Note: The minimum inverter efficiency noted below shall be used where applicable efficiencies in accordance with the inverter specification are not avaihble:

Inverter Rating	Rotary 3Ø	Rotary 1Ø	Static 3/1Ø
100 VA or less	0.35	0.25	0.60
101 VA to 250 VA	0.40	0.35	0.65
251 VA to 1500 VA	0.50	0.45	0.65
1501 VA to 2500 VA	0.55	0.50	0.65
Greater than 2500 VA	0.60	0.55	0.65

6.3.3.2 Sample inverter input current calculation. The inverter input current at 28 volts for a 100 VA inverter supplying a 50 VA load is calculated as follows:

$$I = \frac{100\ (1 - 0.35) + 50\ (1 + 0.35)}{2 \times 28 \times 0.35} = 6.8 \text{ amperes}$$

6.3.4 Growth capacity calculations.

6.3.4.1 Formula: (1) $$Hp = \frac{(J - L) \times 100}{J}$$

(2) $$Hs = \frac{(K - M) \times 100}{K}$$

where: Hp= Primary source growth capacity
Hs= Secondary source growth capacity
J= Adjusted primary source capacity
K= Adjusted secondary source capacity

L= Primary system load requirement, including the input to the secondary system with the existing load.
M= Secondary system load requirement

6.3.5 Adjusted system capacity calculation. The wide deviations in the characteristics and usage of system components necessitate the development of individual rating procedures for each system configuration with due consideration of the effects of installation and environment. Sample calculations are given in Figures 7 and 12, and below. These are not necessarily typical but illustrate the method used.

a. Electromagnetic rating factor. Lacking more specific information it is reasonably safe to assume that the maximum load capacity of the generator is 100 Percent of the normal rating at minimum rated speed, increases as a straightline function to 200 percent at 1-1/2 times minimum rated speed and remains constant at 200 percent from 1-1/2 times minimum rated speed to 2 times rated speed. For a generator with nominal speed range of 4000-8000 rpm, the maximum rating at 5500 rpm will be: 1. 00 + 1500/2000 = 1.75 x nominal rating. This factor replaces the nominal 5-second rating factor of 2.00; when converted to a direct-multiplying factor the 5-second electromagnetic factor becomes 1.75/2 = 0.87. For the 5-minute and continuous ratings, the electromagnetic rating factor is assumed to remain 1.0.

b. Rating factor for paralleling. This factor is arbitrarily set at 0.9 of the interval system capacity. Deviation from this value requires the approval of the procuring actitity.

C. Thermal rating factor. This rating is based on the rate of flow of cooling medium through the generator. It is assumed that the specific heat capacity of the generator is utilized when the 5-second interval rating is determined, and that environmental effects of temperature altitude, and differential pressure have no appreciable effect over the 5-second interval, Therefore, this factor is 1.0. For the 5-minute and continuous ratings, rating curves shall be used for the specific generators in the particular application.

6.3.6 Analysis of motor and other starting transients. The magnitide of system overloads due to motor and other starting transient power requirements may be determined as follows:

Formula: $A = \frac{1.1(B-C+D)}{E}$

Where:

A = Peak demand factor.

B = The 5-second average system power requirements for the operating condition analyzed.

C = The 5-second average power requirements of the largest equipment or group of equipments started simultaneously during the operating Condition

D = The peak power requirements of the above equipment.

E = The 5-second adjusted capacity of the power source.

Note: The peak demand factor (A) must, in general, be less than 1 to avoid system malfunction.

6.3.6.1 Sample calculation.

		kW	kVAR	kVA
B	(5-second average load from load analysis chart)	35.7	36.4	51
C	(5-second average motor load from Figure 6)	21.0	21.4	30
B-C	(Remainder)	14.7	15.0	
D	(Peak power requirement of Figure 6)	35.2	96.0	102
B-C+D	(Probable peak demand of load)	49.9	111.0	122
1.1	(Multiply by 1.1 to cover line losses)		x 1.1	
1.1(B-C+D)	(Probable peak demand on source)			134
E	(Takeoff and climb 5-second adjusted source capacity)			137
$A = \frac{1.1(B-C+D)}{E}$	(Transient demand factor, condition G6)			0.98

$A = \frac{134}{137} = 0.98$

6.3.7 Contract data requirements Data specified in 3.2 will be listed directly on a DD Form 1423 incorporated into the contract.

Preparing Activity:
Navy - AS
(Project No. MISC-0A88)

custodians:
Arny - AV
Navy - AS
Air Force -11

Review activities:
Army -
Navy -
Air Force -

User activities:
Navy - MC

Review/user information is current as of the date of this document. For future coordination of changes to this document, draft circulation should be based on information in the current DODISS.

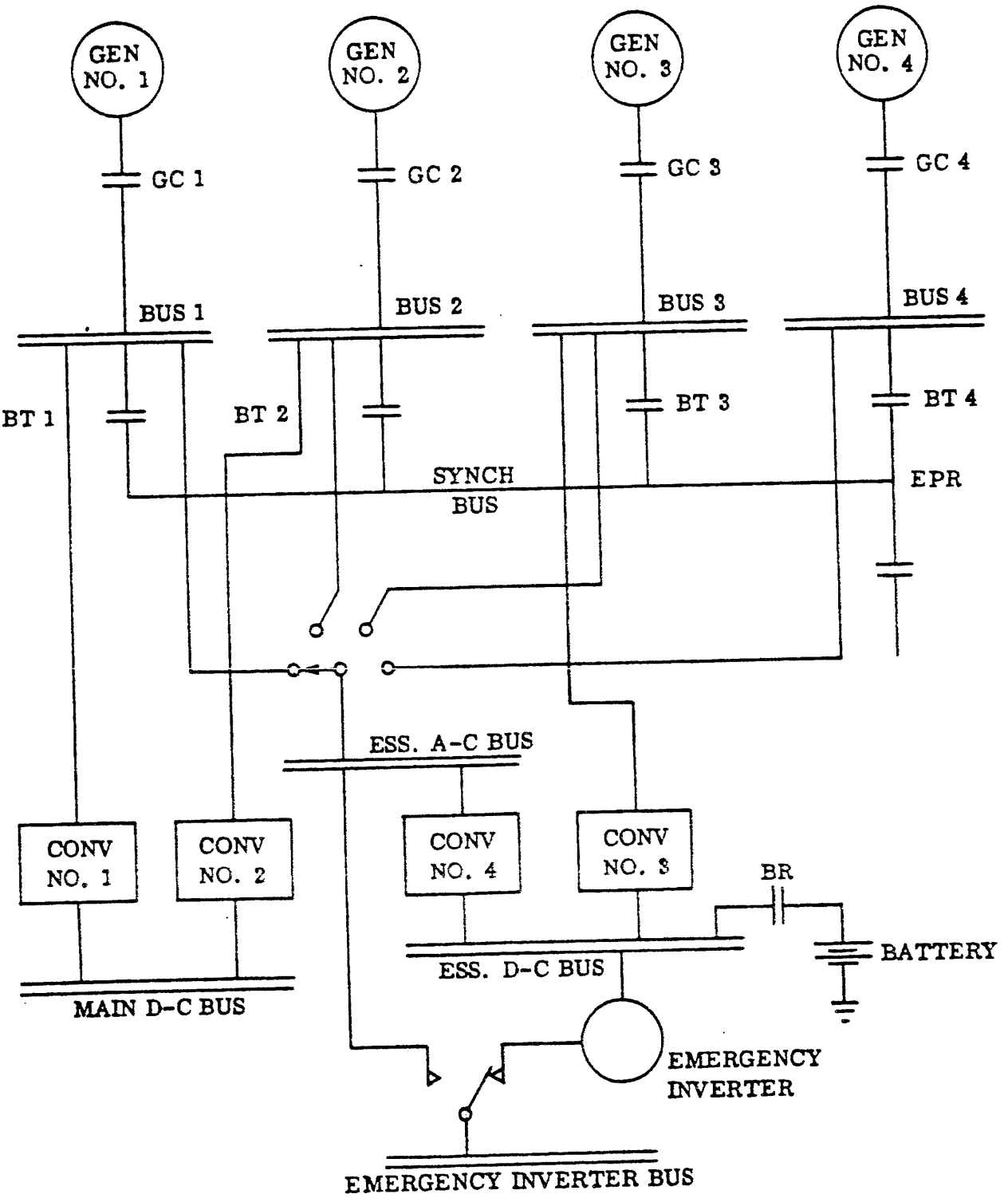

FIGURE 1. Bus wiring diagram

ACCESSORY PAD AND FLANGE COORDINATION

	ENGINE	DRIVE		GENERATOR
		INPUT	OUTPUT	
MANUFACTURER	Jetco	Hydro	xxxx	Genco
TYPE	M-37	x-30407	xxxx	G-40104A
NUMBER OF UNITS	4	4	xxxx	4
WEIGHT (POUNDS)	xxxx	23	xxxx	31
CENTER OF GRAVITY (INCHES)	xxxx	4.0	3.0	3.5
ACCESSORY PAD OR FLANGE	Pad	Flange	Pad	Flange
SPECIFICATION DRAWING NO. *	None	None	MIL-G-1234	MIL-G-1234
SPECIFICATION TYPE *	None	None	4	----
DIAMETER OF BOLT CIRCLE (INCHES)	5"	5"	5"	5"
MIN DRIVE SHAFT RPM	5000	4000	5700	5700
MAX DRIVE SHAFT RPM	11000	12000	6300	6300
TORQUE, RATED (LB. IN.)	4000	3400	3000	2500
MAX ACCESSORY WEIGHT (LBS.)	100	xxxx	100	xxxx
MAX OVERHUNG MOMENT (LB. IN.)	400**	**	400	109

NOTE: * REFER TO ANA DRAWINGS, SERIES 20002-8 AS SAMPLE SPECIFICATIONS

REMARKS: ** CONSTANT SPEED DRIVE IS SUPPORTED AT ITS CENTER OF GRAVITY

FIGURE 2. Generator mounting and drive data

IDENTIFICATION:	GENS 1, 2, 3, 4	CONV. 1 & 2	CONV. 3 & 4
ITEM:	AC GENERATOR	CONVERTER	CONVERTER
NO. UNITS:	4	2	2
RATING: (NAME PLATE)	60 kVA	200 AMPS	20 AMPS
VOLTAGE:	120/208	28 Vdc	28 Vdc
FREQUENCY:	400 Hz	-	-
POWER FACTOR:	0.75-1.00	-	-
CONFIGURATION:	WYE	-	-
MANUFACTURER:	GENCO	DAY	DAY
MODEL NO.:	G-40104A	3XX50	3XX20
INTERVAL RATINGS:	120 kVA-5 Sec.	400-5 Sec.	40A-5 Sec.
	90 kVA-5Min.	300-5 Min.	30A-5 Min.
VOLTAGE REGULATION:	±1%	26-29 Vdc	26-20 Vdc
FREQ. REGULATION:	±2%	-	-
REGULATOR P/N:	G-62	-	-
CONTROL PANEL P/N:	G-48	-	-

IDENTIFICATION:	-	-
ITEM:	BATTERY	EMERGENCY INVERTER
NO. UNIT:	1	1
RATING:	5A-H	250 VA
VOLTAGE:	24 Vdc	115/200 Vdc
FREQUENCY:	-	400 Hz
POWER FACTOR:	-	0.8-1.00
CONFIGURATION:	-	WYE
MANUFACTURER:	SIMPLEX	-
MODEL NO.	7-XXX	MS25093-1
INTERVAL RATINGS:	-	500 VA-5 Sec.
		375 VA-5 Min.
VOLTAGE REGULATION:	20-25V	±2.5V
FREQ. REGULATION:		±10 Hz
REGULATION P/N:	-	-

FIGURE 3. Power source output data

CONNECTED LOAD CHART AC

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A ITEM NO	A FUNC CAT	B LOAD EQUIPMENT	C SEE NOTE	C TOTAL NO OF UNITS	D ELECTRIC LOAD REQUIREMENTS PER UNIT TOTAL VA	TOTAL WATTS	TOTAL VARS	A-N VA	A-N WATTS	A-N VARS	B-N VA	B-N WATTS	B-N VARS	C-N VA	C-N WATTS	C-N VARS	F OPERATING TIME, MINUTES
1		NOT PRI AC BUS	1														
2	D	INSTRUMENT TRANS	2	1										5.0	3.0	4.0	C
3	D	UTIL HYD PRESS IND		1	7.8	1.6	7.6	0.0	0.0	0.0	0.0	0.0	0.0	7.8	1.6	7.6	C
4	D	PRI HYD PRESS IND		1	7.8	1.6	7.6	0.0	0.0	0.0	0.0	0.0	0.0	7.8	1.6	7.6	C
5	E	FUEL FLOW INDICAT		1	10.0	10.0	0.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	C
6	F	YAW INDICATOR		1	5.7	4.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	5.7	4.0	3.1	C
7	F	ATTITUDE GYRO		1	25.1	20.1	15.0	25.1	20.1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	C
8	L	FLIGHT LIGHTS		1	45.0	45.0	0.0	0.0	0.0	0.0	45.0	45.0	0.0	0.0	0.0	0.0	C
9	L	NON FLIGHT LTS		1	25.0	25.0	0.0	0.0	0.0	0.0	25.0	25.0	0.0	0.0	0.0	0.0	C
10	M	CONVERTER		1	6935.0	6935.0	0.0	2311.6	2311.6	0.0	2311.6	2311.6	0.0	2311.6	2311.6	0.0	C
11	M	WINDSHIELD WIPER		1	423.0	225.0	369.9	141.0	75.0	123.0	141.0	75.0	123.0	141.0	75.0	123.0	C
12	R	IFF		1	89.9	80.0	41.0	89.9	80.0	41.0	0.0	0.0	0.0	0.0	0.0	0.0	C
13	R	UHF RECEIVER	3	1	220.0	220.0	0.0	73.3	73.3	0 0	73.3	73.3	0.0	73.3	73.3	0.0	C
14	R	HF		1	600.0	600.0	0.0	200.0	200.0	0.0	200.0	200.0	0.0	200.0	200.0	0.0	C

FIGURE 4 CONNECTED LOAD CHART AC

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LOAD ANALYSIS CHART AC

G-7 CRUISE

ITEM NO	5 SEC AVG						5 MIN AVG						CONT AVG					
	A-N		B-N		C-N		A-N		B-N		C-N		A-N		B-N		C-N	
	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS	WATTS	VARS
1																		
2	0.0	0 0	0 0	0.0	3.0	4.0	0.0	0 0	0 0	0 0	3.0	4 0	0.0	0 0	0 0	0 0	3 0	4 0
3	0.0	0.0	0.0	0.0	1.6	7.6	0 0	0.0	0.0	0 0	1.6	7.6	0 0	0 0	0 0	0 0	1 6	7 6
4	0.0	0.0	0 0	0 0	1.6	7.6	0 0	0 0	0 0	0 0	1 6	7 6	0 0	0 0	0 0	0 0	1 6	7 6
5	0.0	0 0	0.0	0.0	4 0	3 1	0.0	0 0	0 0	0 0	4 0	3.1	0 0	0 0	0 0	0 0	4 0	3 1
6	0 0	0.0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
7	20.1	15.0	0.0	0.0	0.0	0.0	20.1	15.0	0.0	0.0	0.0	0.0	20.1	15.0	0.0	0.0	0.0	0 0
8	0.0	0 0	45.0	0 0	0 0	0 0	0 0	0 0	45 0	0 0	0 0	0 0	0 0	0 0	45 0	0 0	0 0	0 0
9	0.0	0.0	25.0	0.0	0 0	0 0	0 0	0.0	25.0	0 0	0 0	0.0	0 0	0 0	25 0	0 0	0 0	0 0
10	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
11	73.3	0.0	73.3	0.0	73.3	0.0	73.3	0.0	73.3	0.0	73 3	0 0	9 7	0 0	9 7	0 0	9 7	0 0
12	200.0	0.0	200.0	0.0	200 0	0 0	200.0	0.0	200 0	0 0	200.0	0 0	26 6	0 0	26 6	0 0	26 6	0 0
13	2196.	722.	2196.	722.	2196.	722.	2196	722.	2196.	722.	2196.	722.	2196.	722.	2196.	722	2196	722.
14	0.0	0 0	0.0	0.0	0 0	0 0	0 0	0.0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
15																		
A	2489.4	737.	2539.3	722.	2479.5	744	2489.4	737.	2539 3	722	2479 5	744	2252 4	737.	2302 3	722	2242 5	744 3
B	2596.2	.95	2639.9	.96	2588.7	.95	2596.2	.95	2639.9	.96	2588.7	.95	2369.9	.95	2412 8	.95	2362 7	95
C	.128						.167						.250					
D	7824.7	.96					7824.7	.96					7145.4	.95				

KEY TO LAST 5 LINES:
15 NO. 1 PRIMARY AC BUS TOTALS
- A PHASE WATTS VARS
- B PHASE VA POWER FACTOR
- C PHASE UNBALANCE (PCT)
- D TOTAL VA POWER FACTOR

FIGURE 5 LOAD ANALYSIS CHART AC

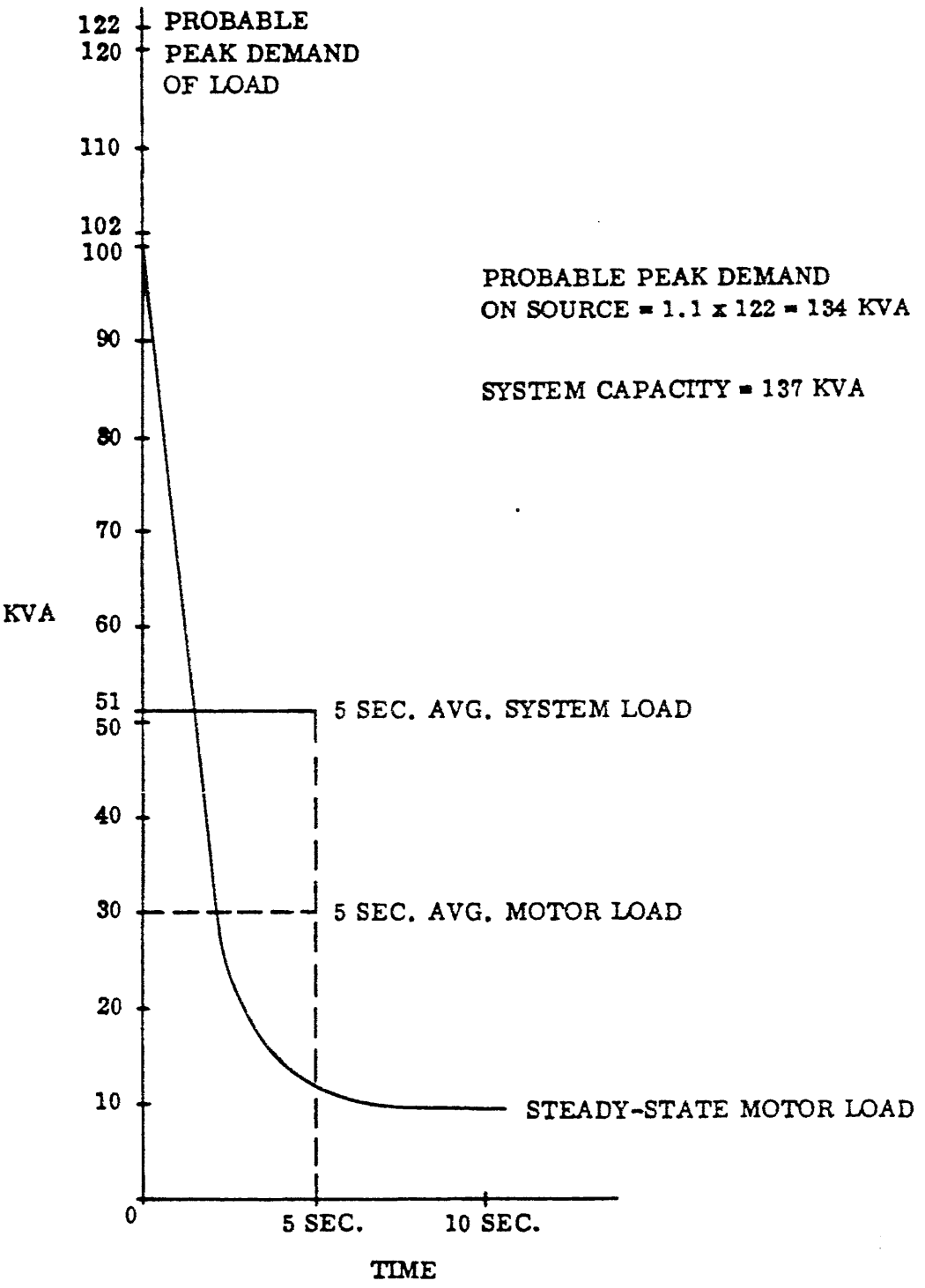

FIGURE 6. Typical AC transient analysis (motor starting characteristic)

PAGE NO.

POWER SOURCE UTILIZATION ANALYSIS CHART AC — AIRCRAFT
NO.1 GENERATOR — PAGE NO.

RATING AND CORRELATION DATA	OPERATING CONDITIONS (G-1)	(G-2)	(G-3)	(G-4)	(G-5)	(G-6)	(G-7)	(G-8)	(G-9)	(G-10)
AIRCRAFT										
MAX. AIRSPEED (KNOTS)										
MAX. ALTITUDE (FEET)	7500.0	7500.0	7500.0	10000.0	30000.0	30000.0	40000 0	40000 0	10000 0	10000 0
MIN. COMPARTMENT PRESS (IN.WATER)	316.7	316.7	316.7	218.	103.8	103.8	67.5	67.5	206.3	218.0
MAX. OPERATING TIME (MINUTES)	60.0	60.0	20.0	10.0	30.0	30.0	30.0	30.0	20.0	20.0
MIN. OPERATING TIME (MINUTES)	5.0	5.0	10.0	5.0	10.0	10.0	15.0	10.0	10.0	10.0
SOURCE										
MIN. DRIVE SHAFT RPM	5700	5700	5700	5700	5700	5700	5700	5700	5700	5700
MAX. CONT. DRIVE SHAFT RPM	6100	6100	6100	6100	6100	6100	6100	6100	6100	6100
MAX. SHORT TIME DRIVE SHAFT RPM	6400	6400	6400	6400	6400	6400	6400	6400	6400	6400
MIN. DIFF. PRESS (IN.WATER)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
MAX. AIR INLET TEMP. (DEG.C)	39.4	39.4	39.4	24.0	-22.2	-22.2	-42.8	42.8	18.9	18.9
RATING FACTORS										
MECHANICAL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ELECTROMAGNETIC	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PARALLELING	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
THERMAL	1.26	1.26	1.26	1.20	1.02	1.02	.95	.95	1.15	1.15
IMPEDANCE LOSSES	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
5-SECOND ANALYSIS										
COMPOSITE RATING FACTOR	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
SOURCE INTERVAL RATING (KVA)	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
ADJUSTED SOURCE CAPACITY (KVA)	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0
LOAD REQUIREMENTS (KVA)	49.4	48.4	47.4	48.8	51.6	52.6	52.6	52.6	47.4	55.7
GROWTH CAPACITY (PCT)	51.0	49.6	50.0	52.2	48.6	46.0	46.7	47.7	50.0	46.2
PHASE LOAD UNBALANCE (PCT)	1.2	1.7	0.9	1.0	2.0	1.9	2.7	1.6	1.3	2.0
POWER FACTOR	.91	.88	.89	.90	.91	.89	.93	.90	.88	.92
PROBABLE PEAK DEMAND (KVA)										
TRANSIENT DEMAND FACTOR										
5-MINUTE ANALYSIS										
COMPOSITE RATING FACTOR	1.21	1.21	1.21	1.15	.98	.98	.91	.91	1.10	1.10
SOURCE INTERVAL RATING (KVA)	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
ADJUSTED SOURCE CAPACITY (KVA)	109.0	109.0	109.0	104.0	88.0	88.0	81.5	81.5	99.0	99.0
LOAD REQUIREMENTS (KVA)	49.4	48.4	47.4	48.4	51.6	52.6	52.6	52.6	47.4	55.7
GROWTH CAPACITY (PCT)	50.5	49.6	50.2	50.6	36.2	33.0	40.6	31.8	45.2	41.0
PHASE LOAD UNBALANCE (PCT)	2.1	2.1	1.9	2.3	2.0	1.7	1.9	1.9	2.1	2.3
POWER FACTOR	.89	.90	.91	.89	.93	.94	.91	.88	.92	.91
CONTINUOUS ANALYSIS										
COMPOSITE RATING FACTOR	1.21	1.21	1.21	1.15	.98	.98	.91	.91	1.10	1.10
SOURCE INTERVAL RATING (KVA)	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
ADJUSTED SOURCE CAPACITY (KVA)	72.5	72.5	72.5	69.0	58.8	58.8	54.6	54.6	66.0	66.0
LOAD REQUIREMENTS (KVA)	45.4	45.2	44.9	45.7	47.4	48.2	48.5	48.5	44.5	52.6
GROWTH CAPACITY (PCT)	33.8	32.7	32.9	31.5	14.5	11.5	5.32	9.7	26.3	19.7
PHASE LOAD UNBALANCE (PCT	1.8	1.8	1.7	1.6	1.9	1.4	1.6	1.7	1.9	2.0
POWER FACTOR	.91	.94	.91	.92	.93	.91	.90	.91	.94	.90

FIGURE 7 POWER SOURCE UTILIZATION ANALYSIS CHART AC

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POWER SOURCE UTILIZATION GRAPH AC
No.1 AC GENERATOR

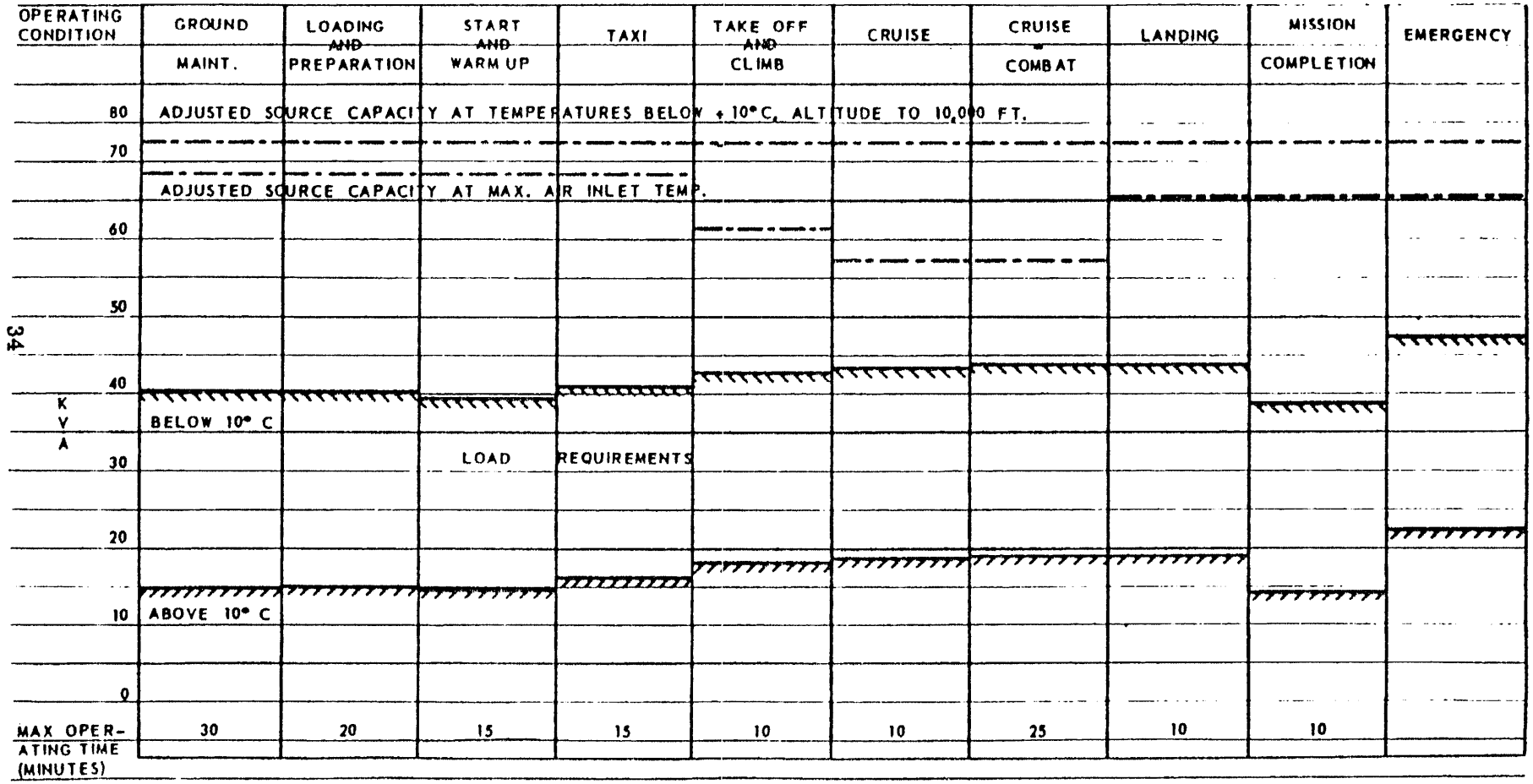

FIGURE 8 POWER SOURCE UTILIZATION GRAPH AC

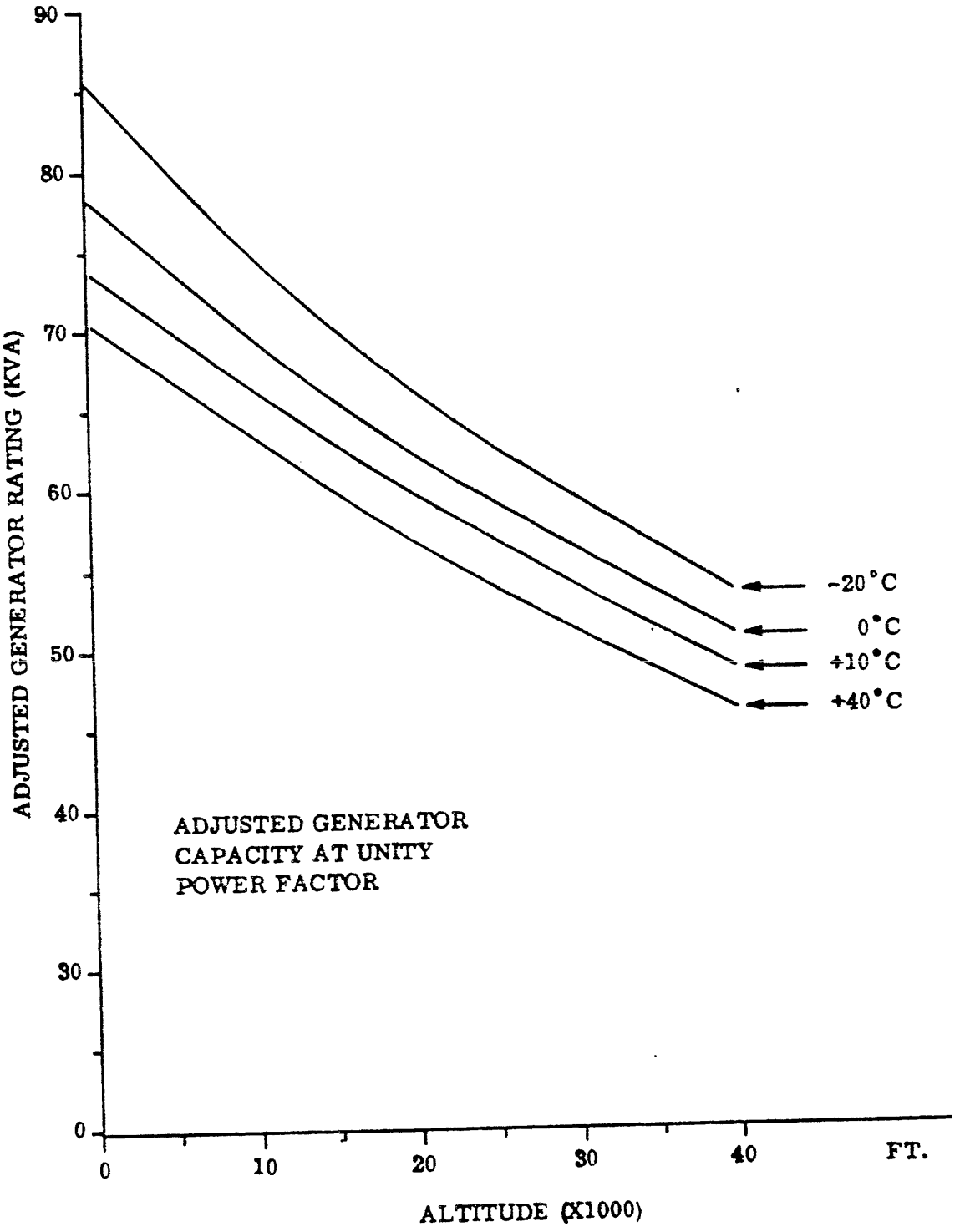

FIGURE 9. Adjusted power source graph AC

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CONNECTED LOAD CHART DC

ITEM NO.	A FUNC CAT	B LOAD EQUIPMENT	SEE NOTE	C TOTAL NO. OF UNITS	E ELECTRICAL LOAD REQUIREMENTS PER UNIT AMPERES	F OPERATING TIME MINUTES
101		NO. 1 PRI DC BUS				
102	E	ENG OIL TEMP		1	0.5	C
103	E	OIL QTY INDIC		1	0.5	C
104	F	PITOT TUBE HEAT		1	6.5	C
105	J	ENG IGNITION		1	5.0	C
106	L	ANTI-COLL LTS		2	2.3	C
107	L	POSITION LTS		3	.95	C
108	L	LANDING LTS		2	16.2	C
109	M	BATTERY CHARGING	4	1		C
110	R	HF SSB		1	3.6	C
111	R	UHF		1	4.65	C

FIGURE 10 CONNECTED LOAD CHART DC

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LOAD ANALYSIS CHART DC

ITEM	G-1 AVERAGE AMPS			G-2 AVERAGE AMPS			G-3 AVERAGE AMPS			G-4 AVERAGE AMPS			G-5 AVERAGE AMPS			ITEM
	5SEC	5MIN	CONT	5SEC	5MIN	CONT	5SEC	5MIN	CONT	5SEC	5MIN	CONT	5SEC	5MIN	CONT	
101																101
102	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	102
103	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0 5	0.5	0.5	0.5	0.5	0.5	0.5	103
104	2.16	2.16	2.16	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	104
105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	0.66	0.0	0.0	0.0	105
106	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	4.6	4.6	4.6	4.6	4.6	4.6	106
107	2.85	1.43	0.2	0.0	0.0	0 0	0.0	0.0	0.0	2.85	2.85	2.85	2.85	2.85	2.85	107
108	32.4	32.4	4.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108
109	3.6	3.6	.48	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.6	.48	3.6	3.6	.48	109
110	4.65	4.65	1.55	4.65	4.65	1.55	4.65	4.65	1.55	4.65	4.65	1.55	4.65	4.65	1.55	110
111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	105.4	86.5	62 2	62.2	58.5	37 4	111
112	46.96	45.55	10.1	12.15	12.15	9.05	12.15	12.15	9.05	133.0	124.9	79.74	85.4	81.7	54.3	113

KEY TO LAST LINE:

112 NO. 1 PRIMARY DC BUS TOTALS

FIGURE 11 LOAD ANALYSIS CHART DC

POWER SOURCE UTILIZATION ANALYSIS CHART DC

PAGE NO.

AIRCRAFT

REPORT NO.

NO.1CONVERTER

OPERATING CONDITION

RATING AND CORRELATION DATA	(G-1)	(G-2)	(G-3)	(G-4)	(G-5)	(G-6)	(G-7)	(G-8)	(G-9)	(G-10)
AIRCRAFT										
MAX. ALTITUDE (FEET)	7500.0	7500.0	7500.0	7500.0	10000.0	30000.0	40000.0	40000.0	10000.0	10000.0
MIN. COMPARTMENT PRESS (IN.WATER)	316.7	316.7	316.7	218.	103.8	103.8	67.5	67.5	206.3	218.0
MAX OPERATING TIME (MIN)										
MIN OPERATING TIME (MIN)										
SOURCE										
MIN DRIVE SHAFT RPM	NOT APPLICABLE TO CONVERTERS									
MAX CONT.DRIVE SHAFT RPM	NOT APPLICABLE TO CONVERTERS									
MAX SHORT TIME DRIVE SHAFT RPM	NOT APPLICABLE TO CONVERTERS									
MIN DIFF.PRESS (IN OF WATER)	NOT APPLICABLE TO CONVERTERS									
MAX AIR INLET TEMP (DEG.C)	39.4	39.4	39.4	24.0	18.9	18.9	18.9	24.0	18.9	18.9
RATING FACTORS										
MECHANICAL	NOT APPLICABLE TO CONVERTERS									
ELECTROMAGNETIC	NOT APPLICABLE TO CONVERTERS									
PARALLELING	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
THERMAL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5-SECOND ANALYSIS										
COMPOSITE RATING FACTOR	.9	.9	.9	.9	.9	.9	.9	.9	9	.9
SOURCE INTERVAL RATING (AMPS)	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
ADJ SOURCE CAPACITY (AMPS)	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0
LOAD REQUIREMENTS	161.1	82.4	67.3	190.7	143.1	82.5	110.8	195.0	72.3	185.0
GROWTH CAPACITY (PCT)	55.2	77.1	81.3	47.0	60.2	78.9	69.2	45.8	79.9	48.6
PROBABLE PEAK DEMAND (AMPS)										
TRANSIENT DEMAND FACTOR										
5-MINUTE ANALYSIS										
COMPOSITE RATING FACTOR	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
SOURCE INTERVAL RATING	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
ADJ SOURCE CAPACITY (AMPS)	270.0	270.0	270.0	270 0	270.0	270.0	270.0	270.0	270.0	270.0
LOAD REQUIREMENTS	135.2	82.4	67.3	182.6	139.4	82.5	100.0	190.0	72.3	185.0
GROWTH CAPACITY (PCT)	49.9	69.4	75.0	32.4	52.0	69.4	62.9	29.6	73.2	31.4
CONTINUOUS ANALYSIS										
COMPOSITE RATING FACTOR	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
SOURCE INTERVAL RATING (AMPS)	200.0	200.0	200.0	200 0	200 0	200.0	200.0	200 0	200.0	200.0
ADJ SOURCE CAPACITY (AMPS	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
LOAD REQUIREMENTS	106.8	77.3	57.7	137 4	102.0	75.5	90.5	160 0	60.6	170 0
GROWTH CAPACITY (PCT)	40.6	57.0	67.9	23.4	43.3	58.0	49.7	11.1	66.3	5.5

FIGURE 12 POWER SOURCE UTILIZATION ANALYSIS CHART DC

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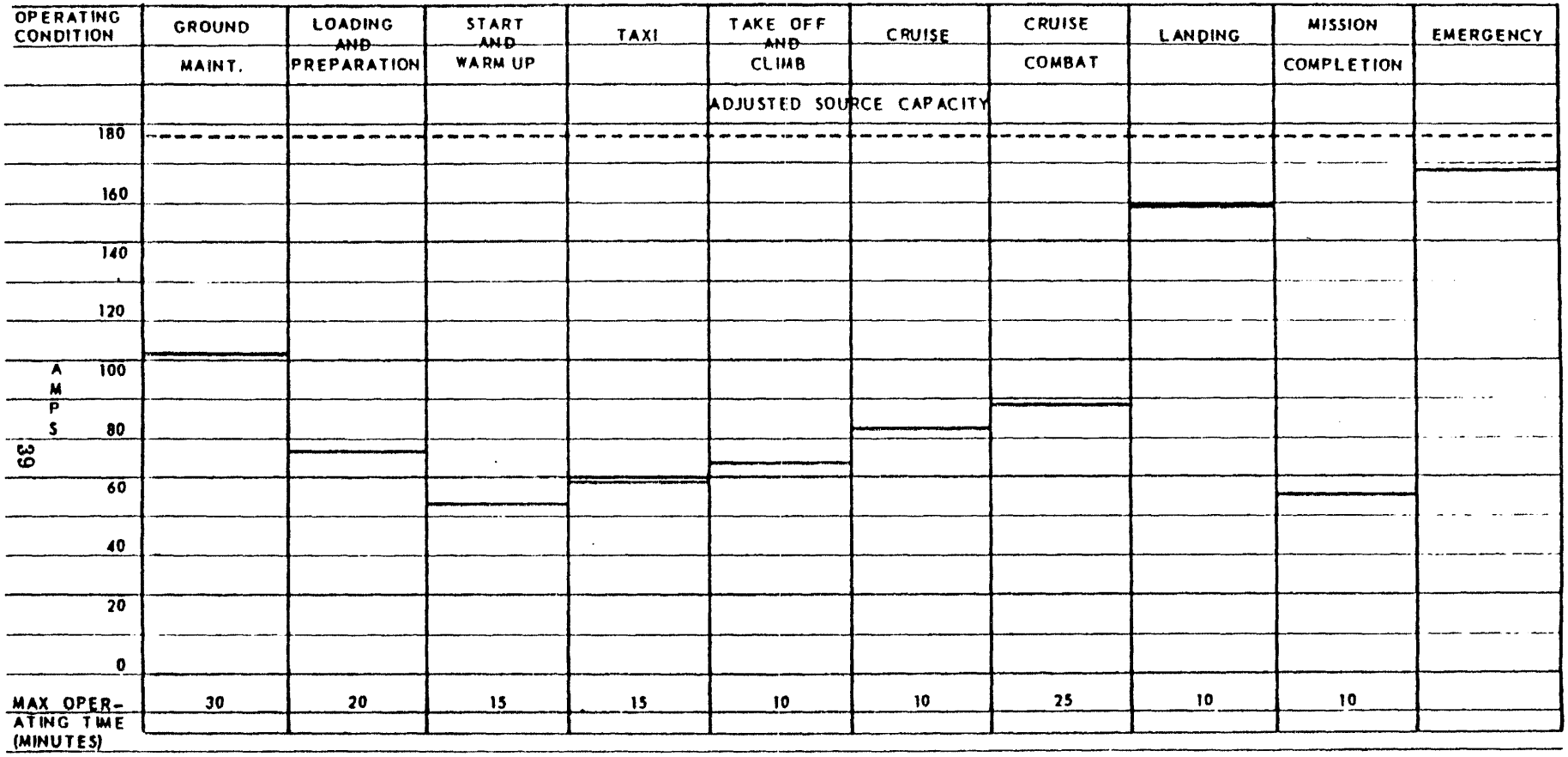
POWER SOURCE UTILIZATION GRAPH DC
NO 1 CONVERTER



LEGEND

---- ADJUSTED SOURCE CAPACITY
—— LOAD REQUIREMENTS

FIGURE 13 POWER SOURCE UTILIZATION GRAPH DC

AIRCRAFT _____

REPORT _____

ADJUSTED POWER SOURCE GRAPH DC

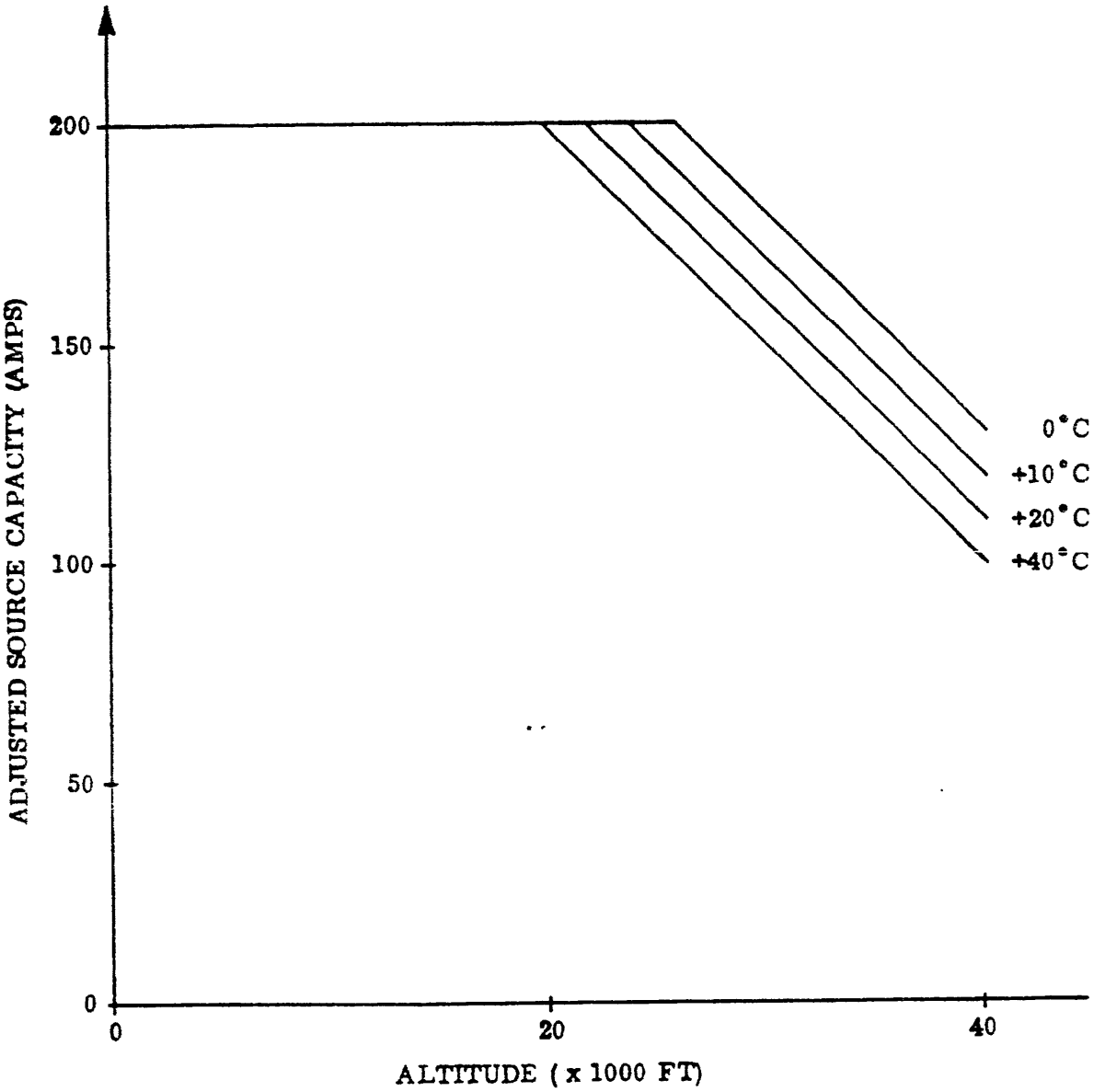


FIGURE 14. Adjusted power source graph DC

PAGE NO.
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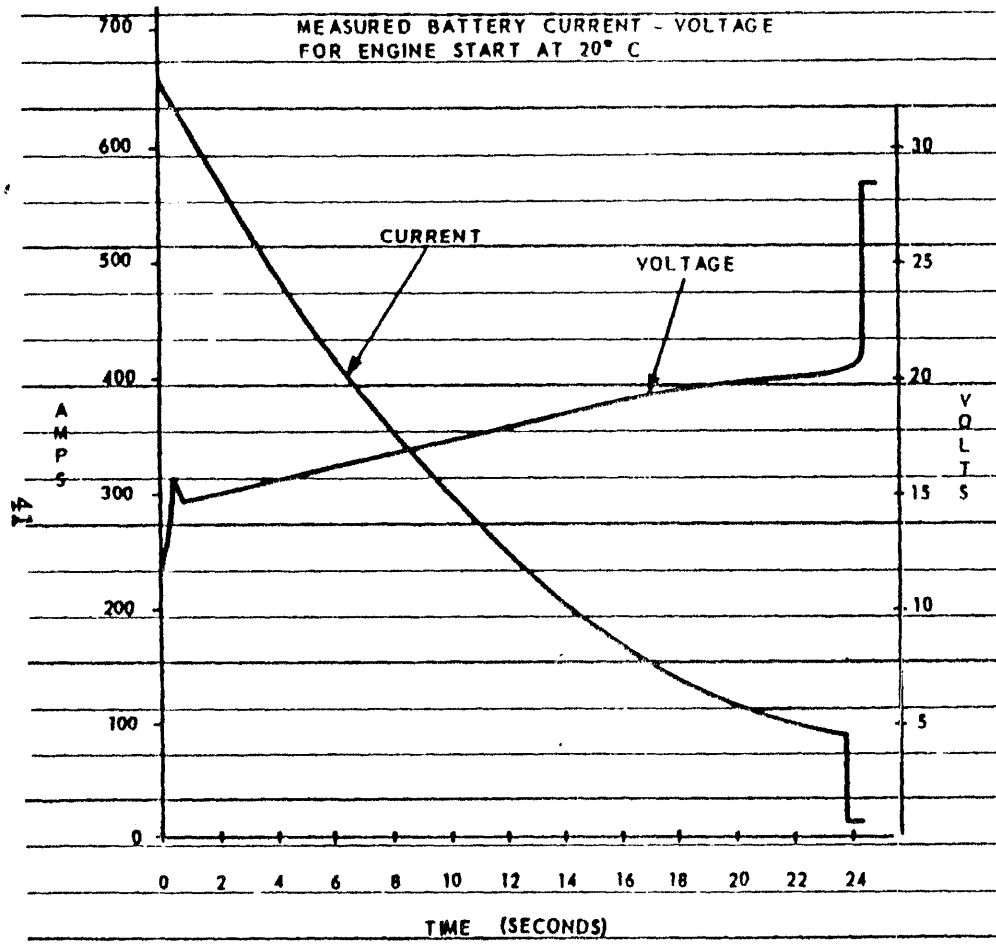
BATTERY ANALYSIS

DATA

MEASURED BATTERY CURRENT - VOLTAGE
FOR ENGINE START AT 20° C



CALCULATIONS

APPROXIMATION OF AMP - HR REQUIREMENTS
FOR ENGINE STARTING

620 X 2 = 1240
550 X 2 = 1100
490 X 2 = 980
425 X 2 = 850
370 X 2 = 740
305 X 2 = 610
205 X 2 = 500
200 X 2 = 400
160 X 2 = 320
125 X 2 = 250
105 X 2 = 210
90 X 2 = 180

TOTAL 7380 AMP-SEC = 2.05 AMP - HR

BATTERY AMP - HRS CAPACITY	22.0 AMP.HRS
AMP - HRS NECESSARY FOR TYP. START	2.05 AMP.HRS
REMAINDER	19.95 AMP.HRS

CONTINUOUS LOAD ON BATTERY DURING
LOADING AND PREPARATION 30. AMPS

MAX. DURATION ON BATTERY 0.66 HRS

FIGURE 15 BATTERY ANALYSIS

ENGINE STARTING, ELECTRIC REQUIREMENTS FOR

PAGE_____
AIRCRAFT_____
REPORT_____

SECURITY CLASSIFICATION

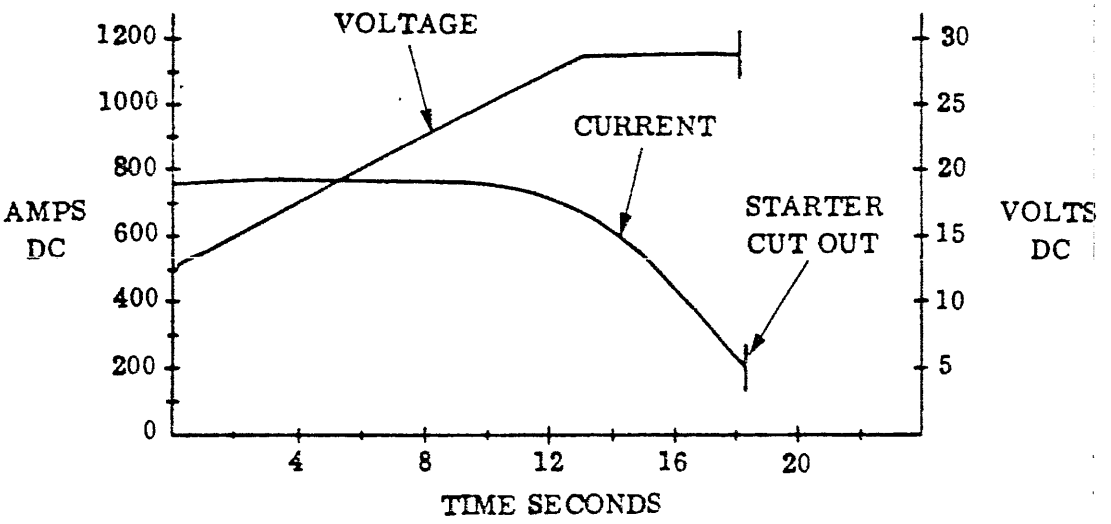
STARTER:

MANUFACTURER	AVCO	POWER INPUT (AMPS)	800 MAX
MODEL NO.	J-314	VOLTS, MAXIMUM	30 VDC
MIL DWG NO.	E-40305	STARTING BUS TYPE: SPLIT	

If the starting bus is common (used simultaneously for load and starting), enter the following data, derived from the 5-second Start and Warmup load analysis:

POSSIBLE SYSTEM PEAK___AMPS PROBABLE SYSTEM PEAK___AMPS

STARTING TRANSIENT CURVE =



RECOMMENDED POWER SUPPLY:	GROUND POWER	AIRBORNE
MANUFACTURER	ELCO	
TYPE	NC-2A	
RATING (AMPS)	750 INT/500 cont.	
VOLTAGE	28 VDC	

REMARKS:

1. The above starting transient curve was obtained with an NC-2A ground power source. This information was supplied by the engine manufacturer.

FIGURE 16. Engine starting requirements data

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GROUND POWER CHART

(EXTERNAL POWER OR AUXILIARY POWER UNIT)

LOAD IDENTIFICATION	5 SEC			5 MIN			CONT		
	KVA	PF	HP	KVA	PF	HP	KVA	PF	HP
NO. 1 PRI AC BUS	7.824	.96	10.1	7.824	.96	10.1	7.145	.95	9.09
NO. 1 ENG. ANTI-ICE									
INLET ANTI-ICE	2.578	.79	2.7	2.578	.79	2.7	2.578	.79	2.7
NOSE GEAR BOX ANTI-ICE	1.000	1.00	1.3	1.000	1.0	1.3	1.000	1.0	1.3
NO. 2 PRI AC BUS	7.510	.95	9.56	7.510	.95	9.56	6.982	.94	8.79
NO. 2 ENG ANTI-ICE									
INLET ANTI-ICE	2.578	.79	2.7	2.578	.79	2.7	2.578	.79	2.7
NOSE GEAR BOX ANTI-ICE	1.000	1.00	1.3	1.000	1.00	1.3	1.000	1.00	1.3
TOTAL	22.080	.93	27.66	22.080	.93	27.66	20.919	.92	25.88

REMARKS

1.

FIGURE 17 GROUND POWER CHART

SUMMARY AND CONCLUSIONS

1. The required and available growth capacities are as follows:

	Required by Specification	Available
a) Primary AC Bus	50%	70%
b) AC System	30%	41%
c) Primary DC Bus	50%	65%
d) DC System	30%	43%
e) Emergency AC System	10%	13%
f) Emergency DC System	10%	11%

2. All of the available growth capacities are based on the most severe conditions disclosed in this analysis.

FIGURE 18. Summary and conclusions.

NOTES

1. load on primary ac bus limited to 26 kVA by contactor rating.

2. Instrument transformer characteristics

   Type: 115 to 26 volts 400 Hz step down

   Configuration: Single phase

   Rating: 100 VA maximum

   Items 2, 3, and 4 connected to secondary of transformer.

3. AN-ARC-51 replaced with AN/ARC-51A, effective on ACFT 3738 and subsequent.

4. The battery charging load is listed only in the operating condition charts.

5. Air particle separator not on below 10°C and when anti-ice is on

6. Cyclic load with period of one second approxiately average value recorded for all intervals of analysis.

Figure 19. Notes

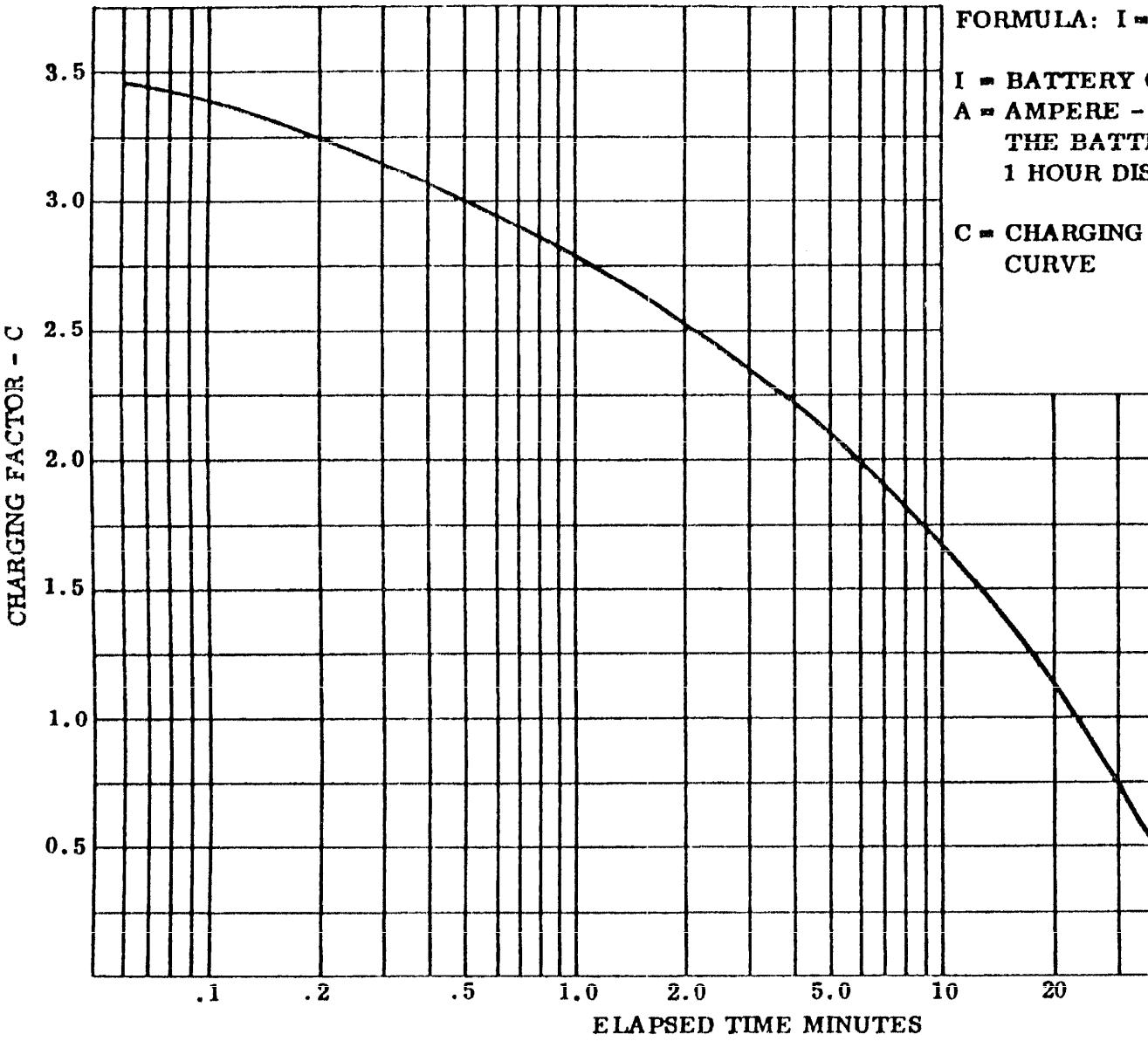

FIGURE 20. Battery charging graph - factor Vs time

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