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MOBILE ELECTRIC POWER PLANT (MEPP) TEST SET DEVELOPMENT.(U)
MAY 77 J A KERSHAW

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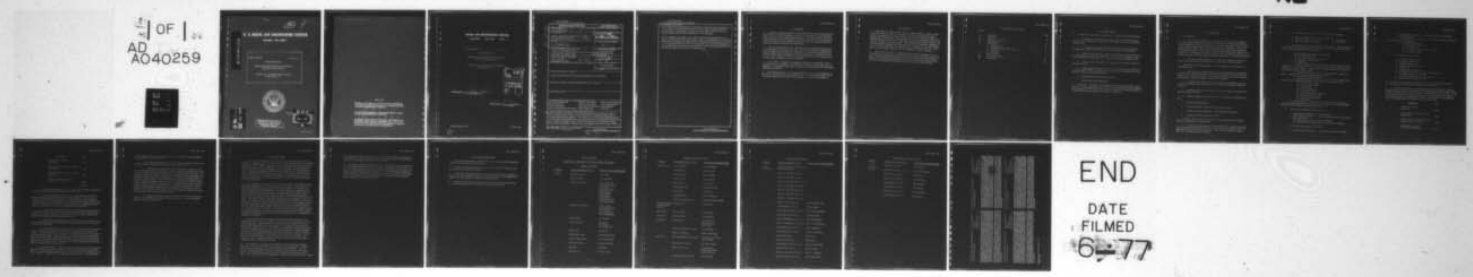

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U. S. NAVAL AIR ENGINEERING CENTER

LAKEHURST, NEW JERSEY

NAEC-GSED-103

19 May 1977

INTERIM REPORT

MOBILE ELECTRIC POWER PLANT (MEPP)
TEST SET DEVELOPMENT

AIRTASK NO. A3400000/051B/7F41461400
WORK UNIT NO. 31

PLATE NO. 11749A

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NAVAL AIR ENGINEERING CENTER

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PREPARED BY J. A. Kershaw Jr.
J. A. KERSHAW JR.

APPROVED BY F E Evans
F. E. EVANS

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Electric generators	Electronic test equipment	Test equipment
Electric measurement instruments	Mobile equipment	Test sets

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Military Standard 704B tightens the parametric tolerances governing the quality of power being generated for the various types of aircraft equipment either in use or currently undergoing development. The objective of the work being performed herein is to determine the configuration and cost of a test set that would be used to ensure the power supplied by Mobile Electric Power Plants (MEPP's) is within the tolerances defined in the specification. Surveys of the test equipment field were made, vendors

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20. ABSTRACT (Continued)

were contacted and demonstrations for equipment evaluations were conducted, and in use assets were considered for MEPP evaluation after consultation with Navy field personnel. Subsequently, a breadboard model of the test set will be constructed and the basic design configuration will be established.

Since the equipment necessary to test MEPP's and aircraft generators for compliance with MIL-STD-704B is not available either in a configuration or in quantities that permit its utilization by organizational and intermediate maintenance personnel, it is recommended that a test set be developed that can be used by other than depot level maintenance personnel to ensure that future operational field equipment can be checked for compliance with the new specification.

I. SUMMARY

A. GENERAL. Military Standard 704B tightens the parametric tolerances governing the quality of power being generated for the various types of avionic equipment either in use or currently undergoing development. The objective of the work being performed herein is to determine the configuration and cost of a test set that would be used to ensure the power supplied by Mobile Electric Power Plants (MEPP's) is within the tolerances specified in the specification.

B. PROCEDURES AND RESULTS. Surveys of the test equipment field for equipment applicable to the test set were made. Vendors were contacted and demonstrations for equipment evaluations were conducted. In use assets were considered for MEPP evaluation after consultation with Navy field personnel. Subsequent to visits with Navy field personnel, a breadboard model of the test set will be constructed and the basic design configuration will be established.

C. CONCLUSION. Presently, the equipment necessary to test MEPP's and aircraft generators for compliance with MIL-STD-704B is not available either in a configuration or in quantities that permit its utilization by organizational and intermediate maintenance personnel.

D. RECOMMENDATIONS. It is recommended that a test set be developed that can be used by other than depot level maintenance personnel to ensure that future operational field equipment can be checked for compliance with the new specification.

II. PREFACE

A. BACKGROUND. There are two types of equipment capable of testing a MEPP to MIL-STD-704B and these are the computerized and non-computerized types. Neither type appears to be suited to testing a MEPP at the organizational and intermediate level of maintenance. The non-computerized type of equipment would occupy approximately two 19 inch wide by 6 feet high equipment racks and take between 8 and 16 hours to complete the required tests. The computerized equipment, although considerably smaller in physical size and much faster in testing time, has the disadvantage of requiring a high degree of training for the personnel who must use it. They must know the computer language of the test equipment in order to operate it.

B. EXPECTED OUTCOME. It is expected that the test set developed as a result of this program will be small, relatively inexpensive when compared to existing units, and provide an operational testing procedure that is both short and simple enough to permit its use by both organizational and intermediate maintenance personnel while completely satisfying the test parameters set forth in the new MIL-STD-704B.

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IV. INTRODUCTION

A. APPROACH. The following methods will be employed as possible solutions.

1. Investigate the equipment requirements and costs involved in using a number of non-computerized "off the shelf" instruments to make the conformance measurements.

2. Investigate the equipment requirements and costs involved in using a transportable computerized system to make the conformance measurements.

3. Determine the feasibility of using a portable unit to sample the power to be checked; then use existing Navy computers to process the data sample in order to verify conformance to MIL-STD-704B. This scheme had been proposed by NRL.

4. Contact various companies on the possibility of developing a dedicated diagnostic test set.

5. Check existing maintenance manuals to determine present requirements for insuring that MEPP's or aircraft electrical power systems supply power in conformance with the required specifications.

6. Determine the needs of Naval personnel.

7. Decide on the best configuration.

B. OBJECTIVE. The objective of this program is to determine the best configuration for a test set to be used to check a MEPP or aircraft electrical system output for conformance to MIL-STD-704B. The test set investigated will be used principally by organizational and intermediate level maintenance personnel.

V. DISCUSSION

A. BACKGROUND.

1. MIL-STD-704B defines the characteristics of electric power supplied to aircraft utilization equipment and dictates requirements so stringent that sophisticated test equipment not currently available in a typical test laboratory will be required to check ground support mobile electric power plants for conformance. Hence, the manufacturers of MEPP's who must perform first article tests and Navy personnel who must check MEPP's will be faced with the problem of obtaining the required test equipment. If a simplified, small sized, readily usable, standard test set were devised and manufactured, it could be made available when required to overcome this problem.

2. The object of this program is to determine the configuration and cost of a test set which can be used to test MEPP's for conformance to MIL-STD-704B.

B. EQUIPMENT AND PROCEDURES. The basic approach to the development of a MEPP test set is to:

1. Make a survey of the test equipment field for equipment that is applicable to the test set. Visit vendors' plants for equipment demonstrations or have vendors come to NAEC for demonstrations. Use the demonstrations as a means of evaluating the equipment. Also have equipment consigned for evaluation.

2. Investigate the possibility of using available Navy computers to process recorded data samples taken from MEPP's as a means for evaluating the MEPP performance.

3. Determine the needs of Naval personnel who are presently responsible for testing MEPP's in the field.

4. Based on findings, determine the best set configuration and approximate cost.

5. Perform simulated testing.

6. Procure hardware to build a prototype breadboard unit.

7. Test the breadboard design on aircraft equipment and MEPP's.

8. Release the breadboard unit to 6.4 R&D.

C. ANALYSIS. The new test set would have to be able to perform the following checkout and maintenance requirements.

1. F-14 Electrical Power System Demonstration Test. An electrical system power demonstration test is performed to verify that the power system can meet the specification (MIL-STD-704A) requirements. This test is performed in a single aircraft to demonstrate system capability.

2. F-14 Organizational Maintenance Requirements (from manual).

a. Check AC voltage for 115±10VAC per phase b. Check DC voltage for 28+3, -2VDC c. Check Frequency for 400±25Hz	Use test set AN/USM-128

3. F-14 Intermediate/Depot Maintenance (from manual). The following tests are performed on the aircraft generator utilizing Aircraft Electrical Power Test Set MA 2 or MA 3 which basically is a drive stand.

a. Perform generator winding resistance tests.
b. Perform rotational tests.
(1) Read line to line voltage at no load.
(2) Make phase sequence check.
c. No load tests.
(1) Apply variable DC to the exciter field. Raise excitation until the voltage from T to T4 is 120 volts with no load. Read and note the three line to neutral and three line to line voltages. Voltage amplitude modulation shall not exceed 1/2%. Field current shall not exceed 1 amp.
(2) Raise field current to 3.85 amps. Read and note voltages as in step 1. Minimum line to neutral voltage shall be 160 volts.
d. Full load and overload beating test.
(1) Operate the generator with a 75KVA, .75PF load at rated voltage until the exciter voltage has stabilized. Read and note at 2 minute intervals.
(a) AC line to line voltage.
(b) DC line to line voltage.
(c) Line currents.
(d) Power in each phase.
(e) Exciter field current.
(f) Oil inlet and outlet temperature.
(g) Oil inlet pressure and flow.
(h) Generator case pressure.
(i) Oil leakage.
e. Phase Balance. From the data noted during the no load and 75KVA, .75PF rated load testing, check that none of the line to line or line to neutral voltages deviates from the average of the three by more than .5%.

4. MMG-1A MEPP Maintenance (from manual).

a. Organizational Maintenance - inspect the unit.
b. Intermediate Maintenance - make an operational check of the controls.
c. Depot Maintenance
(1) Measure stator and rotor winding resistance.
(2) Measure dielectric strength (motor and generator windings).

5. NC-8A MEPP Maintenance (from manual).

a. Organizational Maintenance - output power quality is not checked.

b. Intermediate Maintenance - output power quality is not checked.

c. Depot Maintenance.

(1) Preliminary - Use load bank FSN RX 4920-571-7719515 and check the calibration of the instruments.

(2) DC Output Power System.

(a) DC voltage regulation test.

(b) DC ripple test.

(c) DC voltage transient recovery and load.

(d) DC voltage trip test.

6. AC output power system test.

1. AC voltage regulation test.
2. Frequency regulation test.
3. Voltage modulation test.
4. Voltage waveform (harmonics).
5. Crest factor.
6. AC phase balance voltage test.
7. AC transient voltage recovery and load cycling test.
8. Transient frequency recovery test.
9. AC under voltage and over voltage trip test.
10. Under and over frequency trip test.

D. RESULTS. Several different computerized instruments, composite test sets, and other methods of test set output data analysis were examined.

1. Composite Instrument. It was determined that the following list constitutes one possible set of existing non-computerized instruments which could be used to check a MEPP or aircraft electrical system output for conformance to MIL-STD-704B. Brand names and model numbers are used merely to indicate the characteristics required, not to endorse the use of the specific instruments. It is estimated that this equipment would occupy approximately 2 standard 19 inch electrical racks.

Instrument	Cost
Phase Meter, Dianetz Model 305	$ 2,400
Digital Voltmeter, Hewlett Packard Model 3403C	2,095
Frequency Meter, Hewlett Packard Models 5300A, 5311 and 5302	1,040
Oscillograph, Honeywell Model 906 (with amplifiers)	2,450

Instrument	Cost
Memoryscope, Nickolay Model 1090	$ 5,100
Spectrum Analyzer, Hewlett Packard Model 3580A	4,665
Oscilloscope Camera, Hewlett Packard Model 197A	800
Spectrum Analyzer, Tektronix Model 7L5+C-51 Camera	7,600
	$26,150

2. Computerized Instruments. The following "self contained" computerized instruments were examined and the results of each is noted:

a. A demonstration of the Nicolet Instrument Corporation NIC-1180 series data acquisition and processing system was witnessed. Only a few of the required MIL-STD-704B measurements were demonstrated because the required computer programs were not available. A Nicolet Instruments representative stated that the computer program would be written and the NIC-1180 with these programs would sell for $40,000. The unit was transportable but not portable.

b. A demonstration of the Tektronix WP1210 Digital Processing Oscilloscope was witnessed. Some of the measurements required to show power system conformance to MIL-STD-704B were demonstrated. The company representative stated that he believed the WP1210 system is $48,000.

c. Preliminary arrangements have been made for a demonstration of the Noreland Instruments NI2001 Programmable Calculating Oscilloscope. The cost of the instrument is $17,300.

d. Johnsville NADC was visited to witness a demonstration of the Sostel System. This is an advanced electrical system being developed for future Naval Aircraft. The system contains a memory to record faults which occur in the electrical system during a flight. At the conclusion of a flight the memory is interrogated by maintenance personnel to determine which parts of the electrical system require servicing. Johnsville personnel stated that all the Sostel system would do regarding power quality would be to monitor the voltage level and the frequency and record any faults occurring in those characteristics.

3. Integrated Systems. Checks were made to determine if the 3M computers (see attached list) could be used to process MEPP/aircraft generator data samples taken by a portable digitizer-memory unit. The data would be sent by telephone lines to the computer. This scheme was originally suggested by NRL. It was found that

all the computers in the system could perform the required data processing except the IBM 1401C-6 and the IBM 360-20.

4. Self-contained Computerized Test Sets. Several manufacturers were contacted regarding the possibility of developing a dedicated test set.

a. One electronics company submitted a preliminary concept for a test set. In their concept the set consists of an attache case size unit which could be used to check a MEPP or aircraft power system for conformance to MIL-STD-704B. The unit would basically be a piece of automatic test equipment which would measure and display the voltage and frequency continuously. For all the other characteristics, if and when the power fails to meet MIL-STD-704B, the test set will trigger an alarm (such as a light) and display to the operator not a measured parameter but the identification of the faulty electrical characteristic. This portion of the test set would be used for flight line and other checks where a quick checkout is required. For shop checkout where diagnostic capability would be required, an add-on unit would be attached to the basic test set. The add-on unit would provide the capability of diagnosing the cause of the out of specification condition.

b. Personnel in another electronics specialty firm have been contacted regarding the possibility of developing a dedicated test set. No concrete response has been received as of this time.

VI. CONCLUSIONS

A. The list of non-computerized "off the shelf" instruments (see Section V, paragraph D.1.) required to check aircraft generator/MEPP supplied power for conformance to MIL-STD-704B is lengthy. The main reason for the large number of instruments listed is the variety and the complexity of the measurements to be made and the fact that each instrument is usually designed to make one specific type of measurement only. Making the measurements with these instruments will be a time consuming process also and it is estimated that the process would require 8 to 16 hours (including data reduction time). Because of the complexity of the measurements and the time involved, this type of test set is unacceptable for organizational and intermediate level maintenance.

B. The computerized, transportable "off the shelf" data processing units investigated showed advantages over the non-computerized instruments. For instance, both the Tektronix WP1210 and the Nicolet NIC-1180 were capable of obtaining a Fast Fourier Transform narrow band analysis in a matter of seconds. Obtaining a narrow band analysis (1 or 3Hz filter) with a spectrum analyzer could take a matter of hours. Both the computerized instruments did show some shortcomings however. For instance, the spectral analyses were presented on a linear scale rather than a log scale. A log scale format is required for quick checkout of compliance to MIL-STD-704B. Also as demonstrated, the individual frequency components were read off with a curser arrangement. This was a time consuming process. With additional development both these instruments possibly could be made to overcome these difficulties. The other shortcoming noted in these instruments was the fact that the operator had to be computer oriented. For instance, he had to be familiar with the computer language for successful operation. Because of the shortcomings noted, the two units as demonstrated, did not appear to be good choices for an organizational or intermediate level maintenance instrument.

C. The NRL test set scheme of using a portable unit to sample the power to be checked then use existing Navy computers to process the data was found to have some shortcomings also. The concept was investigated from the standpoint of the availability of the required data links and computers. The system investigated was the 3M computer data link system. It was found that a number of Naval Air Stations were served by computers that did not have the required capabilities. Additional thought on the scheme also indicated that the overall process would be too time consuming to be used as an organizational or intermediate maintenance level procedure. Excessive time would be required to take the data sample, transmit the sample to the computer, wait for computer availability to reduce the data, then have the results transmitted back to the data point of origin.

D. The concept for a dedicated test set made by the first electronics company appeared to be the most acceptable of all the possibilities investigated. The basic unit is a self-contained go, no go, piece of automatic test equipment. The time involved in obtaining results is short and no special operator skills are necessary to use it. The add-on unit which will perform the diagnostics would consume more time in use. The basic unit would adapt itself in general to operational and intermediate

level maintenance while the add-on unit would be utilized in depot level maintenance. At the present time, the development costs for the first company's units are not yet known so a cost effectiveness analysis cannot be made.

E. The quality of the power output of the NC-8A or the MMG-1A are not required to be checked during operational or intermediate level maintenance check outs. On the F-14, at the organizational level, the voltage and frequency level of the aircraft system are checked using test set AN/USM-128. At the intermediate maintenance level the generator is checked as a component in test set MA 2 or MA 3 which essentially is a drive stand. Some power quality characteristics and other operating characteristics are checked during this test.

VII. RECOMMENDATIONS

A. The concept that suggests a dedicated test set in a suitcase should be pursued further with test equipment manufacturers.

B. To obtain cost effective quotes on a test set, more specific information (test parameters) and direction must be given.

C. Consultation with fleet personnel to determine what they desire in a piece of test gear will aid in the physical design and instrument readout of the equipment and supply much of the information required to design a test set.

D. Implement a test scheme (breadboard design) in the laboratory and combine test set development with current generator development programs.

VIII. APPENDIX

AVIATION 3-M SYSTEM LEAD PROGRAMMING ACTIVITIES

MSDO, North Island

SYSTEM	DATA SERVICES FACILITY	SUPPORTED STATIONS/SHIPS
B-3500	AFB Lajes Azores	NAF Lajes
	AFB Lakenheath	NAF Midenhall
	CNET DSC Pensacola	NAS Chase Field NAS Corpus Christi NAS Dallas NAS Ellyson Field NAS Kingsville NAS Memphis NAS Meridan NAS Pensacola NAS Saufley Field NAS Whiting Field
	DPSCPAC North Island	NAF El Centro NAS Imperial Beach NAS Miramar NAS North Island NWEG Albuquerque
	NAS Alameda	NAS Alameda
	NAS Jacksonville	NAS Albany NAS Atlanta NAS Jacksonville
	NAS Norfolk	NAS Norfolk
	NAS Whidbey Island	NAS Whidbey Island
	NATC Patuxent River	NAS Patuxent River
	NSC Pearl Harbor	NAS Barbers Point
	NSD Guam	NAS Agana
	NSD Subic Bay	NAS Cubi Point

MSDO, North Island (Cont'd)

SYSTEM	DATA SERVICES FACILITY	SUPPORTED STATIONS/SHIPS
IBM 1401C-6	NAF Washington	NAF Washington
	NAS Bermuda	NAS Bermuda
	NAS Brunswick	NAS Brunswick
	NAS Key West	NAS Key West
	NAS Lemoore	NAS Lemoore
	NAS Moffett Field	NAS Moffett Field
	NAS Oceana	NAS Oceana
	NAVSTA Keflavik	NAVSTA Keflavik
	NAVSTA Roosevelt Roads	NAVSTA Roosevelt Roads
IBM 360-20(Tape) (Emulating IBM 1401C-6)	NAVSTA Rota	NAVSTA Rota
IBM 360-30	DPI-28, H&MS-17	MCAS Iwakuni
IBM 360-40	MCDEC Quantico	MCAS Quantico
IBM 360-50	MCAS El Toro	MCAS El Toro MCAS Santa Ana MCAS Yuma
	FMPFAC Camp Smith, Hawaii	MCAS Kaneohe
	PMTR, Point Mugu	PMTR, Point Mugu
IBM 360-65	ASC Camp Butler, Okinawa (OS)	COMFLEACTS Okinawa MCAF Futema
	CNAVRES New Orleans	NAS New Orleans
	MCAS Cherry Point	MCAS Beaufort MCAS Cherry Point MCAS New River
	North East Computer Center	NAS Lakehurst

NAVMMACLANT Norfolk

SYSTEM	DATA SERVICES FACILITY	SUPPORTED STATIONS/SHIPS
U-1500 (AN/UYK-5)	COMINEWARFOR, CHARLESTON SOUTH CAROLINA	
	MAG-11, 3rd MAW (El Toro)	
	MAG-13, 3rd MAW (El Toro)	
	MAG-14, 2nd MAW (Cherry Point)	
	MAG-16, 3rd MAW (Santa Ana)	
	MAG-24, 1st MBGD (Kaneohe)	
	MAG-26, 2nd MAW (New River)	
	MWSG-37, 3rd MAW (El Toro)	
	NAVSTA Guantanamo Bay	NAS Guantanamo Bay
	USS AMERICA (CVA-66)	USS AMERICA
	USS CONSTELLATION (CVA-64)	USS CONSTELLATION
	USS CORAL SEA (CVA-43)	USS CORAL SEA
	USS ENTERPRISE (CVAN-65)	USS ENTERPRISE
	USS F.D. ROOSEVELT (CVA-42)	USS F.D. ROOSEVELT
	USS FORRESTAL (CVA-59)	USS FORRESTAL
	USS GUADACANAL (LPH-7)	USS GUADALCANAL
	USS GUAM (LPH-9)	USS GUAM
	USS INCHON (LPH-12)	USS INCHON
	USS INDEPENDENCE (CVA-62)	USS INDEPENDENCE
	USS IWO JIMA (LPH-2)	USS IWO JIMA
	USS J.F. KENNEDY (CVA-67)	USS J.F. KENNEDY
	USS KITTY HAWK (CVA-63)	USS KITTY HAWK

NAVMMACLANT Norfolk (Cont'd)

SYSTEM	DATA SERVICES FACILITY	SUPPORTED STATIONS/SHIPS
U-1500 (AN/UYK-5) (Cont'd)	USS MIDWAY (CVA-41)	USS MIDWAY
	USS NEW ORLEANS (LPH-11)	USS NEW ORLEANS
	USS NIMITZ (CVAN-68)	USS NIMITZ
	USS OKINAWA (LPH-3)	USS OKINAWA
	USS ORISKANY (CVA-34)	USS ORISKANY
	USS RANGER (CVA-61)	USS RANGER
	USS SARATOGA (CVA-60)	USS SARATOGA
	USS TRIPOLI (LPH-10)	USS TRIPOLI

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Since the equipment necessary to test MEPP's and aircraft generators for compliance with MIL-STD-704B is not available either in a configuration or in quantities that permit its utilization by organizational and intermediate maintenance personnel, it is recommended that a test set be developed that can be used by other than depot level maintenance personnel to ensure that future operational field equipment can be checked for compliance with the new specification.

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