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ENERGY CONSERVATION OPTIONS AT THE NAVAL AIR STATION, MOFFETT F--ETC(U)
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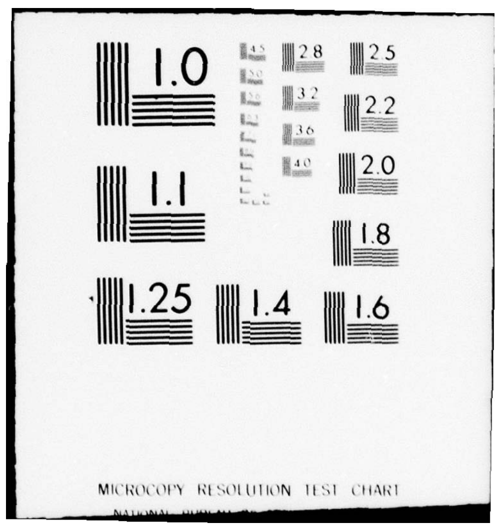
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Technical Note TN-81

January 1979

ENERGY CONSERVATION OPTIONS AT THE NAVAL AIR STATION, MOFFETT FIELD

By: MANCHI S. COLAH WILLIAM SCHUBERT

Prepared for:

WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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(10) By: MANCHI S./COLAH WILLIAM/SCHUBERT

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I INTRODUCTION

Defense support installations, such as shipyards, air stations, training centers, and communications stations, provide support to the combat units of the United States that is essential to the maintenance of the operational readiness of those units. As a result of recent events, these installations are highly vulnerable to the rapidly increasing costs of energy forms, to possible decreases in the general quality of available energy forms, and to any politically-motivated manipulation of energy production, deliveries, and prices.

The need for carefully planned and decisively executed action by the military services to reduce this vulnerability is clearly evident. Improvements are needed both in systems and facility design and in operational and training doctrine to conserve the use of energy and to adapt to the use of more plentiful energy forms, while at the same time being careful not to produce unacceptable impacts on the combat readiness of our military forces and their costs.

The Navy's energy program is structured around five strategies to meet this need: energy conservation, adaptation to the use of synthetic fuels or the more plentiful natural fuels, utilization of alternate energy sources (such as solar) to enhance energy self-sufficiency, improvements in energy distribution and allocation for optimal effect on fleet readiness, and energy management planning.

To help conserve energy in the Naval shore establishment, the Naval Facilities Engineering Command (NAVFAC) issued NAVFACINST 4100.6 of 29 March 1974, "Shore Facilities Energy Conservation Survey Program," which called for the regional NAVFAC Engineering Field Division (EFDs) "to provide the required technical expertise to assist Naval activities

(1) to meet the immediate energy consumption reduction goals of the federal energy conservation program, and (2) to limit the adverse effects which specific energy shortages would have on fleet support." This instruction was amplified by NAVFAC letter 102/JLD of 7 January 1976, "Energy Conservation Surveys," to extend the surveys to include investigation of more basic ways to reduce the requirements for energy-intensive operations, provide better energy control, save waste energy, and introduce alternative energy systems, (for example, solar), where appropriate.

In keeping with these broader objectives, SRI International suggested to Navy officials that more in-depth surveys/studies should be undertaken to answer the following questions relating to the basic functional design of the Navy shore activities:

- What is the current relationship between energy consumption and end-product output at typical shore activities?
- To what extent can energy use be reduced without interfering with output?
- In a period of serious energy shortage, what reduction of output would result from a range of substantial constraints on energy use below this threshold?
- Which kinds of shore activities and which locations are most vulnerable in this respect?
- What effects would such output reductions have on the combat readiness of the Fleet?
- Which shore activities are associated with the most critical of these effects?
- To what extent are energy-intensive automated processes appropriate when energy is scarce and expensive?
- How much energy could be saved if currently dispersed shore activities were combined or relocated?
- Could energy be saved by contracting to industry some of the work now performed in-house?
- How will future trends in technical development and energy prices affect the answers to the above questions over the long term?

It was suggested that answers to these and other related questions would be useful to Navy decision makers in (1) making short- and long-term plans for an optimal energy-conserving configuration of the shore establishment in an era of energy scarcity, and (2) formulating optimal energy allocation strategies for use when energy supplies become critical.

As a first step toward answering some of the large questions posed above, SRI was engaged to assist the Western Division of NAVFAC and the Civil Engineering Laboratory in an energy conservation survey of the Puget Sound Naval Shipyard (PSNS) at Bremerton, Washington, during the period 1-4 March, 1977. As its part of the survey, SRI undertook a limited exploratory effort to examine (1) the effects that energy constraints would have on the shipyard's output of ship repair services, based on the yard's current functional configuration, (2) how the yard's functional configuration might be modified to conserve energy over the long term, and (3) how the findings at Puget Sound might be applied elsewhere in the shore establishment. The results were reported in an SRI Special Report, "Energy Conservation Options at the Puget Sound Naval Shipyard," dated August 1977.

As a further step in this program, in September 1978, the Western Division of NAVFAC again contracted SRI to perform a limited (3 man-weeks) study at the Naval Air Station, Moffett Field, California. The contract scope of work is quoted below:

"1. The scope of work is to provide investigation and study of Energy Conservation through functional readjustment in the shore establishment. An industrial engineering/operations research approach shall be emphasized and shall address the energy related aspects of the basic functional design of the activity.

All engineering services shall be accomplished in accordance with this scope.

2. The geographic scope of the study is limited to NAS, Moffet Field with the primary focus of the survey and report to be concentrated on activities in Hangars 1, 2, and 3.

3. A written report addressing but not limited to the following questions:

a. To what extent can energy use be reduced without interference with output?

b. How will future trends in technological development and energy prices affect the answers to the above questions over the long term?

c. The report shall include specific actions or renovation projects that will result in energy savings. These projects must be technically proven and economically justifiable.

d. The study shall identify and analyze the consumption history and costs for:

(1) Heating fuels
(2) Electricity

e. The analysis shall include but not be limited to the effectiveness of the functional/operational uses of the following systems:

(1) Lighting
(2) Air conditioning
(3) Compressed air
(4) Heating
(5) Ventilating
(6) Battery, chargers
(7) Hoists and cranes."

The results of that study are reported herein.

II RECOMMENDATIONS

It is recommended that Moffett Field:

1) Establish an Energy Conservation Organization (ECO) headed by an officer who will be responsible directly to the base Commanding Officer, thus giving energy a degree of attention commensurate with its increasing importance at the national level. This organization would concentrate on energy related problems and would from time to time appoint energy monitors responsible for major organizational units. Among the prime duties of the ECO would be to:

- Develop a long-range master plan for energy use and conservation, which would serve to add cohesion and planning to energy-related activities and projects at the Air Station
- Develop a Load Shedding Plan
- Develop a plan for metering energy
- Work closely with NAVFAC (Western Division) to take advantage of existing documented research in energy conservation
- Coordinate with other air stations and installations so as to increase the pool of knowledge in this area.

2) Develop a comprehensive Load Shedding Plan to cover various emergencies, organize "exercise" days during which such a plan can be implemented, and evaluate the plan's usefulness.

3) Investigate various means of reducing the electrical power consumption of the FASOTRAGRUPAC flight simulators including their lighting for displays and associated air conditioning systems (see Section IV-D). Since this consumption accounts for 10-20% of the "ceiling" demand figure of 6000kw (beyond which the tariff rises very steeply), significant savings could be achieved in this area.

4) Explore the possibility of turning off the air conditioning in the Avionics Facility during the third shift.

5) Repair the diesel air compressor metering unit at the Engine Test Facility.

6) Explore the cost-effectiveness of installing a built-in compressed air system to start all P3C aircraft engines, thus saving much of the fuel currently used in the GTC and APU systems for this purpose.

7) Investigate the possibilities of a centralized 400 Hz generating and distribution system.

III APPROACH

SRI's study team consisted of William Schubert, Energy Program Manager at SRI's Naval Warfare Research Center, and Manchi S. Colah, Senior Research Engineer in the Engineering Sciences Laboratory. Dennis Dickerson, Utilities Division, WESTDIVNAVFAC, coordinated SRI's efforts for WESTDIV.

After an initial orientation meeting in company with Mr. Dickerson at the Air Station on 25 September 1978, chaired by Ensign R. M. Torigoe, USNR, Moffett Field's Energy Conservation Officer, the SRI team gathered data in the form of documents and notes taken from direct observation of operations and from interviews with the following Moffett personnel in their workspaces during the period of 16-19 October 1978.

ENS R. M. Torigoe, Energy Conservation Officer, Public Works Dept.
Robert Pesavento, Budget Analyst, Public Works Dept.
Enrique Pedraza, Facilities Planner, Public Works Dept.
Mark McGlynn, Administration Director, Public Works Dept.
Ted Olson, Facilities Engineer, COMPATWINGSPAC staff
LT (jg) G. W. Brinkley, Avionics Div., Aircraft Intermediate Maintenance Dept.(AIMD), NAS
Chief Walsh, Production Control, AIMD
Senior Chief Braden, Ground Support Equipment Maintenance Division, AIMD
LCDR Gerald Smelik, Aviation Training Devices (ATD) Officer, FASOTRAGRUPAC, Moffett Detachment
John Hood, Videotape Production Unit, FASOTRAGRUPAC
LCDR Ken Kirkwood, Training Dept. Head, FASOTRAGRUPAC
ENS Hough, Power Plants Division, AIMD
Chief Sheffield, Airframes Division, AIMD
AD1 Fred Inman, Engine Test Area, Power Plans Division, AIMD
ENS T. P. Shepersky, First Lieutenant, VP-47
ABH3 Brown, aircraft handler, VP-47

A map of the Naval Air Station, Moffett Field is provided in Figure 1.

Moffett Field serves as the base for land-based anti-submarine warfare aircraft in the Pacific region. The principle tenant is the Commander, Patrol Wings, Pacific (COMPATWINGSPAC) who commands a headquarters staff and seven patrol squadrons (at Moffett), each using nine P3C Orion aircraft and twelve flightcrews. Each squadron has about 380 men. The aircraft are provided with organizational level maintenance at each squadron. More complicated maintenance tasks are performed by the Aircraft Intermediate Maintenance Department of the Naval Air Station. Depot maintenance of the P3Cs is conducted at the Naval Air Rework Facility (NARF), at NAS, Alameda, California.

An important support unit for COMPATWINGSPAC is the Fleet Aviation Specialized Operational Training Group, Pacific Fleet (FASOTRAGRUPAC, Moffet Detachment) which provides ground training for P3 crews including classroom instruction and instruction in flight simulators located in Hangar 1.

In our brief survey, we attempted to pursue energy conservation possibilities in the hangar area to a depth beyond obvious solutions such as turning down thermostats and turning off unneeded lights. The approach was to focus observation on the energy-related activities in the shops and training areas of the air station where the direct application of energy to aircraft operations support occurs.

Because of the lack of adequate metering it is difficult to estimate precisely the electrical, steam, or gas energy used by the activities we investigated, expressed as a percentage of the total energy used at the Air Station. However, we estimate that Hangars 1, 2, and 3, together with the Aircraft Intermediate Maintenance Department account for about 15-25% of the total electrical demand

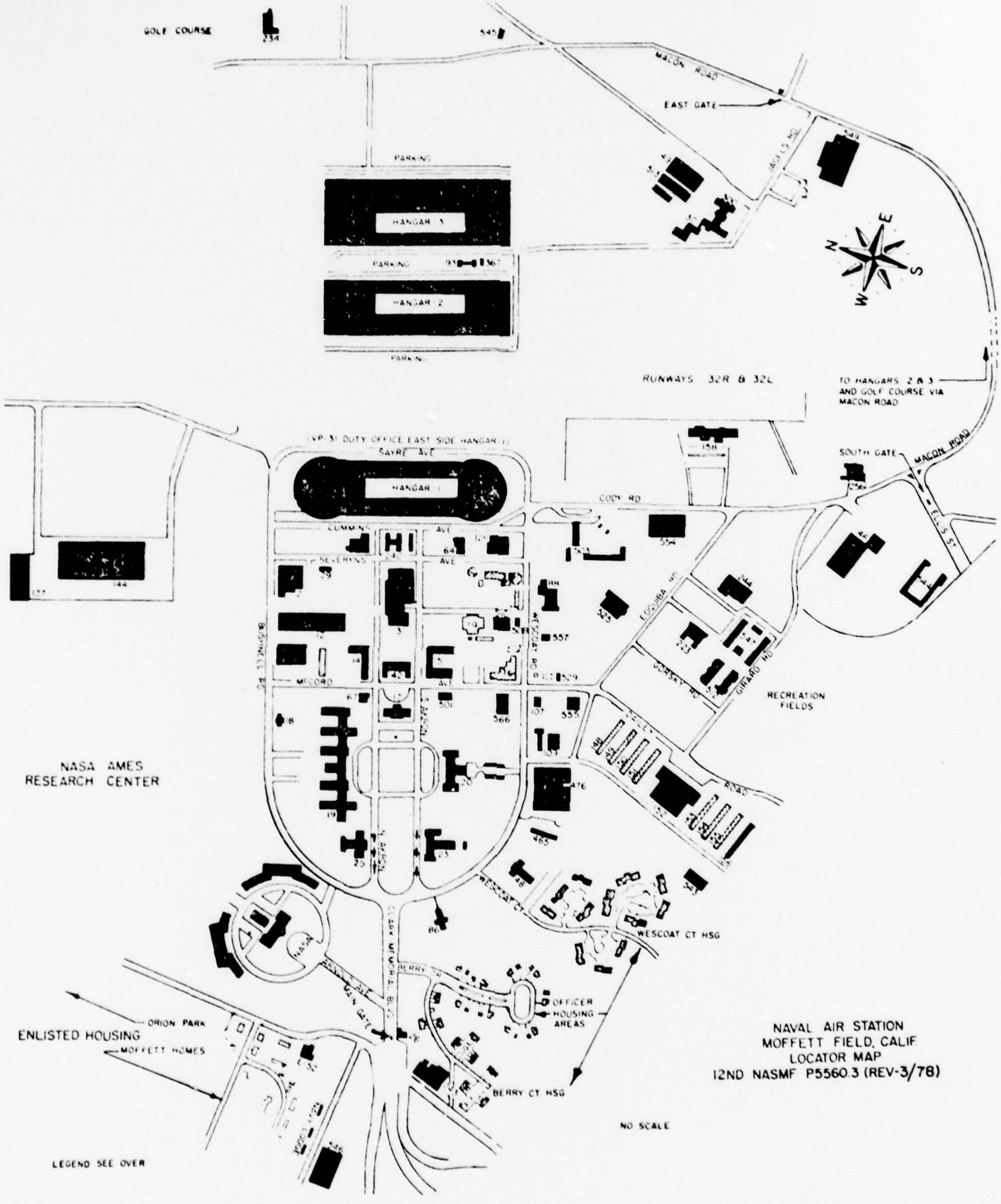
GOLF COURSE
MACON ROAD
EAST GATE
PARKING
HANGAR 3
PARKING
HANGAR 2
PARKING
RUNWAYS 32R & 32L
TO HANGARS 2 & 3 AND GOLF COURSE VIA MACON ROAD
VP-31 DUTY OFFICE EAST SIDE HANGAR 1
SAYRE AVE
HANGAR 1
SOUTH GATE
MACON ROAD
CODY RD
CUMMINS AVE
SEVERYNS AVE
McCORD AVE
RECREATION FIELDS
NASA AMES RESEARCH CENTER
WESCOAT CT HSG
OFFICER HOUSING AREAS
ORION PARK
ENLISTED HOUSING
MOFFETT HOMES
NAVAL AIR STATION
MOFFETT FIELD, CALIF
LOCATOR MAP
12ND NASMF P5560.3 (REV-3/78)
BERRY CT HSG
NO SCALE
LEGEND SEE OVER

Figure 1A

	BUILDING NO.
ADMINISTRATION DEPARTMENT (NAS)	23
AIRCRAFT MAINTENANCE DEPARTMENT	549, HGR 3
ARPA	301
BACHELOR OFFICERS" QUARTERS	20
BANK OF AMERICA	555
BARBER SHOPS	20, 476, HGR 3
BEAUTY SHOP	25
BEVERAGE & CONVENIENCE SHOP	554
BOWLING ALLEY "Moffett Lanes"	525
CAAC	25
CAFETERIA/SNACK BAR	476, HGR 3
CAMPING GEAR ISSUE	64
CAREER COUNSEL SCHOOL	23
CHAPLAIN/CHAPEL	48, 86
CHIEF PETTY OFFICERS' CLUB	243
CHIEF PETTY OFFICERS' QUARTERS	19
CHILD CARE CENTER	223
CIVILIAN PERSONNEL	23
COMPATWINGSPAC	17
COMRESWINGSPAC	HGR 2
COMMANDING OFFICER (NAS)	23
COMMISSARY STORE	12
COMMISSIONED OFFICERS' MESS (Closed)	20
COMMISSIONED OFFICERS' MESS (Open)	3
COMMUNICATIONS	300
COMPTROLLER DEPARTMENT	12
CREDIT UNION	107
DATA PROCESSING	12
DENTAL	546
DISBURSING	23
DISPATCHER/DRIVER LICENSING	146
DISPENSARY	546
DUPLICATING SERVICES	14
EDUCATIONAL SERVICES	23
ENLISTED CLUB	244
ENLISTED QUARTERS	19, 148-156, 512, 547
ENLISTED PERSONNEL OFFICE (NAS)	23
EOD UNIT	125
EXECUTIVE OFFICER (NAS)	23
FASOTRAGRUPAC DET MOFFETT	HGR 1
FILM LIBRARY	HGR 1
FIRE DIVISION	15
FIRE SAFETY	501
FLOWER SHOP	554
GOLF COURSE	234
GYMNASIUM	2
HOBBY SHOP (CRAFTS)	543
HOUSEHOLD GOODS	126
HOUSING OFFICE (NAVY HOUSING/HOUSING REF)	E-52
LAUNDRY, COBBLER, TAILOR	88
LEGAL OFFICE (NAS)	23
LIBRARY	14
MAIL DIRECTORY	23
MARINE BARRACKS	155/156
MEDICAL/DISPENSARY	546
MESSAGE CENTER	300
MESS HALL	152

	BUILDING NO.
MILITARY PERSONNEL (NAS)	23
MOFFETT NEWS (PAO)	23
NAESUDET	HGR 3
NAMTRADET 1012	49, 513
NARDET	HGR 2
NAVY EXCHANGE:	
MAIN RETAIL STORE/CAFETERIA	476
UNIFORM SHOP	510
HANGAR RETAIL FACILITY	367
RETAIL ANNEX/GARDEN SHOP	554
LAUNDRY/COBBLER SHOP	88
MOFFETT STATION CAFE	557
NAVY LODGE OFFICE	114
OFFICES	240
SERVICE STATION	503
TOYLAND	126
TV REPAIR/RENTALS	529
WAREHOUSE/CUSTOMER PICKUP	144
NAVY RELIEF	48
NIS (NAVAL INVESTIGATIVE SERVICE)	14
OFFICE MACHINE REPAIR	29
OFFICER PERSONNEL (NAS)	23
OOD (NAS)	158
OPERATIONS DEPARTMENT (NAS)	158
PASS OFFICE	23
PHOTOGRAPHIC LAB & STUDIO	19
POST OFFICE	67, 93
PROPERTY DISPOSAL	127
PUBLIC AFFAIRS	23
PUBLIC WORKS DEPARTMENT	566/16
PUBLIC WORKS TRANSPORTATION	146
RADIO/TV REPAIR, FOOD SERVICE OFFICE	529
RECREATION DIVISION	25
RECREATION TICKETS	25
RED CROSS	48
SAFETY/AVIATION SAFETY	158
SECURITY	23
SERVICE STATION	503
SUPPLY DEPARTMENT	12
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TECHNICAL LIBRARY	HGR 3
TELEPHONE EXCHANGE	17
THEATRE	25
THE NEARLY NEW SHOP (FORMER THRIFT SHOP)	509
TOYLAND	126
TRANSPORTATION	146
TRAVEL	23
VP-31	HGR 1
VP-91	HGR 2
WAVE QUARTERS	547
WEAPONS DEPARTMENT	HGR 2
WEATHER DETACHMENT	158

Figure 1B--Key to Figure 1A

in terms of KW. There are undoubtedly other organizations at the Naval Air Station which individually account for equally substantial quantities of electrical demand (KW), electrical energy (KWHR), steam, and other types of energy. These must be investigated at some point in time in order to produce meaningful numbers for the Air Station as a whole. However, our study effort was confined to the areas mentioned.

We saw no significant opportunities for using solar energy or cogeneration at Moffet Field in our limited study, though a more detailed examination may uncover some possibilities, especially since climatic conditions are extremely favorable toward solar energy for low-grade energy such as domestic hot water. Continuing advances in solar engineering and cogeneration technology may make future applications more economically practical.

IV FINDINGS AND COMMENTS

A. Energy Conservation Organization

The energy conservation organization at Moffett Field is limited to the Energy Conservation Officer in the Public Works Department. Energy conservation is only one of many duties borne by this officer and therefore suffers from lack of adquate attention. Because of the increased emphasis being given to energy conservation at the national level, energy conservation over the whole Air Station should be given more management emphasis and should be a frequent topic of discussion at the Commanding Officer's management meetings. To encourage an awareness of the need for energy conservation at the Air Station, an energy monitor should be appointed for each major organizational unit (including tenant squadrons). It would be each monitor's duty to observe instances of energy waste in his assigned area and to report these to local authority and suggest corrective action. The need for energy monitors was recognized in Appendix A, but was apparently not implemented.

B. Energy Quantification

It became quickly apparent in our brief survey that there is a pressing need to be able to quantify energy usage; for example, there is widespread concern that the 6000KW electrical demand ceiling (beyond which costs quickly escalate) may soon be exceeded on a regular basis. In order to attend to this problem, one must be able to identify all the sizeable components that go towards making up the total demand. In the course of our study, we have identified (by indirect means) only a few large users of electrical power*, for example, the flight simulators in Hangar 1, which we believe account for about 10-20% of the total electrical load. This figure must be verified by on-site metering, to measure both electrical demand (KW) and energy usage (KWHR); metering is now provided only for reimbursible tenants.

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*The scope of our study precluded investigation of other areas (see Section I).

We suggest that a program aimed at energy quantification be immediately initiated; this could be accomplished at first by the use of portable meters to identify the large users, followed by permanent meter installations later. The cost of installing meters is generally a small percentage of the high cost of electrical power, and would greatly aid the Energy Conservation Officer in his duties.

C. Load Shedding Plan

There is a strong need for a comprehensive load shedding plan at Moffett to cope with possible future energy supply interruptions. This need is further borne out by instructions from COMTWELVE (see Appendix B). The preliminary plan developed in 1977 was not officially implemented (see Appendix A). This plan is much too abbreviated to be of much use; for example, a detailed listing of the "key locations" of paragraph V should be provided.

A comprehensive load shedding plan should include such items as:

- A description of the categories of emergencies covered by the plan and of the various options available under each type of emergency, depending on systems load level, time of year, probable duration of emergency, available advance notice, and so forth.

- The delineation of authority for selecting a given emergency curtailment plan and for ordering its implementation. A detailed list of personnel (together with alternates) within each organization that must be contacted during the emergency.

- Methods for coping with possible local emergencies caused by load dumping, such as bringing local generators in line, disruption of vital repair facilities (such as the Avionics Maintenance Facility), and so forth. The Plan should also provide some analysis of the magnitude of the effect of various emergency curtailment plans on essential operations carried out by the P3C squadrons, on training and educational programs, on residential and social activity, etc.

D. FASOTRAGRUPAC Energy Consumption

The FASOTRAGRUPAC unit in Hangar 1 is a major user of energy within the area surveyed by the SRI team. The unit's operational flight simulators are heavy users of electric power. These simulate (on the ground) the P3 crews' flight environment, so that crew training may be carried out without the dangers and heavy expense of actual training flights in the aircraft itself. The fact that these units are heavy consumers of electrical power must, of course, be weighed in the proper perspective against the even heavier aircraft fuel and maintenance savings that they make possible. FASOTRAGRUPAC officials estimate that P3C flight costs $325 per hour, whereas an OFT simulator operates at only $60 per hour. Further, three hours of operational practice against a submarine require seven flight hours versus three hours in the simulator.

Figure 2 is a layout of the FASOTRAGRUPAC ground trainer complex, showing the location of the principle training devices. In addition to these trainers, the unit also operates trainers in mobile trailers located on the opposite (west) side of Hangar 1.

Table 1 shows the nominal power requirements of these devices as indicated by the manufacturer's performance specifications. According to these figures, the total electrical power requirement, if all systems were operating, would be 1366KW, or about 23% of the current total electrical power demand of the Naval Air Station (approximately 6000KW).

The survey team discussed the utilization of the trainers with cognizant officers and could find no indication of significant energy waste. All the trainers that were observed to be in the "on" condition were in use by students. Appendix C is the FASOTRAGRUPAC simulator training schedule for October 1978, showing the heavy utilization (2 shifts/day) by students (the third shift is reserved for maintenance). Of those which are only relatively lightly utilized, the 2C45 is a P3B trainer and has less call for its use since the Moffett squadrons are all comprised of P3C aircraft, and the 15Z1 radar trainer is a 1940s vintage machine that is an inefficient training tool. In Appendix C, the

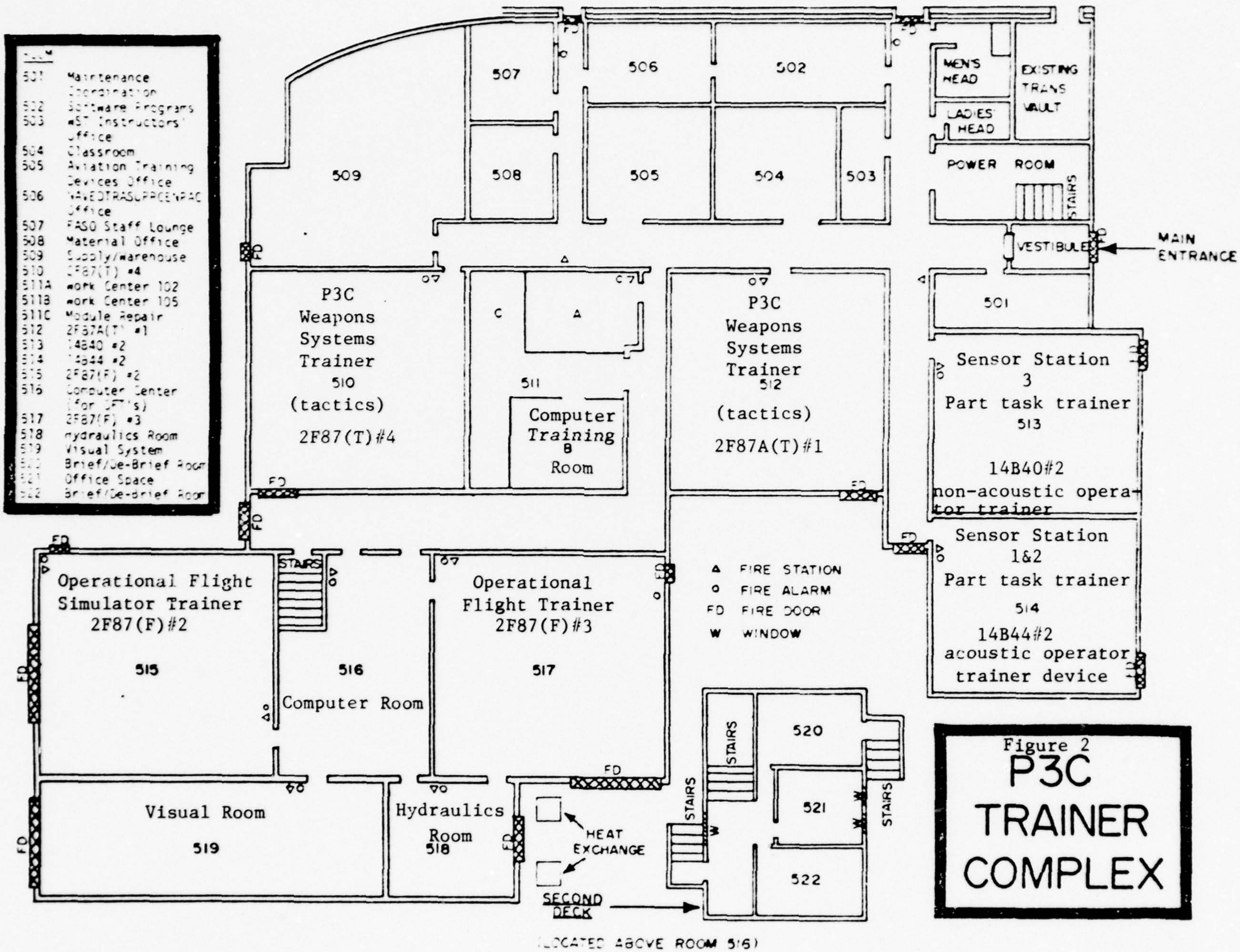

Figure 2
P3C TRAINER COMPLEX

TABLE 1

FASOTRAGRUPAC Trainer Power Requirements

EQUIPMENT		POWER, KW
Weapon systems trainer 2F87(T) #3		72
Weapon systems trainer 2F87(T) #4		72
Non-acoustic operator trainer 14B40		90
Acoustic operator trainer 14B44		92
Operational flight trainer 2F87(F) #1		79.5
Hydraulic pump	(60)	
Booster pump	(3.5)	
Control loading pump	(8)	
Recirculating pump	(3.5)	
Heat exchanger	(4.5)	
Operational flight trainer 2F87(F) #2		79.5
Visual system (illuminated terrain simulation)		108
130 KVA transformer		96
Room lighting		23
Facility air conditioning panel		328
Operational flight training trailer and computer, 2F69A		74
Air conditioning trailer, 2F69A		92
Operational flight trainer, 2F69D(F)		60
Operational flight trainer, 2F69D(T)		67
Shelter, 2F69D(T)		20
ESM trainer, 15E16		13
TOTAL		1,366 KW

Note: The following additional trainers are being used but their power ratings were not available to the survey team: P3B flight trainer, 2C45; Radar trainer, 15Z1; 14B13 trainer (Room 106) numbers appearing in the schedule refer to the squadron number from which the student came: "FA" means FASOTRAGRUPAC, and "CPW" means COMPATWINGSPAC staff. The energy conservation monitoring organization suggested by SRI would serve to insure that these high power machines are turned off or left to idle when not occupied by students.

As the technology of flight simulators advances, it is reasonable to expect some reduction in the power consumption of these machines. For example, a recent development called GCI (for Computer Generated Image) can be used as a substitute for a picture of the terrain, such as that currently provided by the "visual system," which uses about 108KW for illumination of a large 3-dimensional relief map. Since the conversion to GCI may be a long term process, an interim measure might be to install more efficient lighting (in terms of lumens/watt) in order to lower electrical consumption. Thus, while mercury-fluorescent and metal halide lamps are capable of about 57 and 63 lumens per watt, respectively, high-pressure and low-pressure sodium lamps are capable of from 130-180 lumens/watt (see Reference 1). An economic analysis to determine the payback period of such a project would need to include the very high cost of electrical power incurred once the BUREC threshold of 6000 KW is exceeded (see Section IV-E). It is quite likely that this threshold will be exceeded in the near future, since we were informed that:

- FASOTRAGRUPAC is expecting to install 40 advanced teaching units using CAI (Computer Assisted Instruction) techniques, which will add to the overall energy requirements.
- An Air National Guard Unit composed of 600 men flying C-130 aircraft is scheduled to be relocated to Moffett in April-May 1979, and this will also add to training requirements and therefore to energy consumption.

A notable fact connected with these simulators is the large amount of air conditioning power used for the computers, data processors, and other electronic equipment; the magnitude of this air conditioning load should be determined and an attempt made to significantly lower this load. Owing to time and budget constraints, we were unable to pursue this avenue in depth; however, a number of suggestions for improving air conditioning efficiency follow:

- Investigate means for reducing the inlet air temperature to the air conditioning systems, such as looking for locations where the air temperature is a minimum, especially in summer. Such a location might be inside the hangar, or it could even conceivably be outside on the roof of the hangar, 200 ft above ground level.
- Discourage smoking in air conditioned areas so that ventilation rates can be kept to a minimum.
- Utilize the waste heat from the air conditioning condensers in order to provide a boost for domestic hot water systems, to provide warm air for the reheat process during air conditioning or to supplement the space heating within Hangar 1.

E. Overall Electricity Costs

Figure 3 shows monthly electrical demand delivered during FYs 1975, 1976, and 1977. Figure 4 shows average daily metered kilowatt demand delivered by hour of the day. Tables 2 and 3 show the Moffett utilities summaries, by month, for FYs 1977 and 1978 respectively.* These figures indicate an appropriate trend to reduce demand power level and electrical power consumption at the Air Station. However, the Air Station's current power contract with the Central Valley Power Project, a unit of the Bureau of Reclamation (BUREC), permits Moffett to demand a maximum of 6000KW at Central Valley's traditionally low rates, and even these low rates are on the increase (see Table 4). Whenever Moffett's demand

*Note that total electricity costs include mainly electricity purchased from the Bureau of Reclamation as well as smaller purchases of electrical power from PG&E.

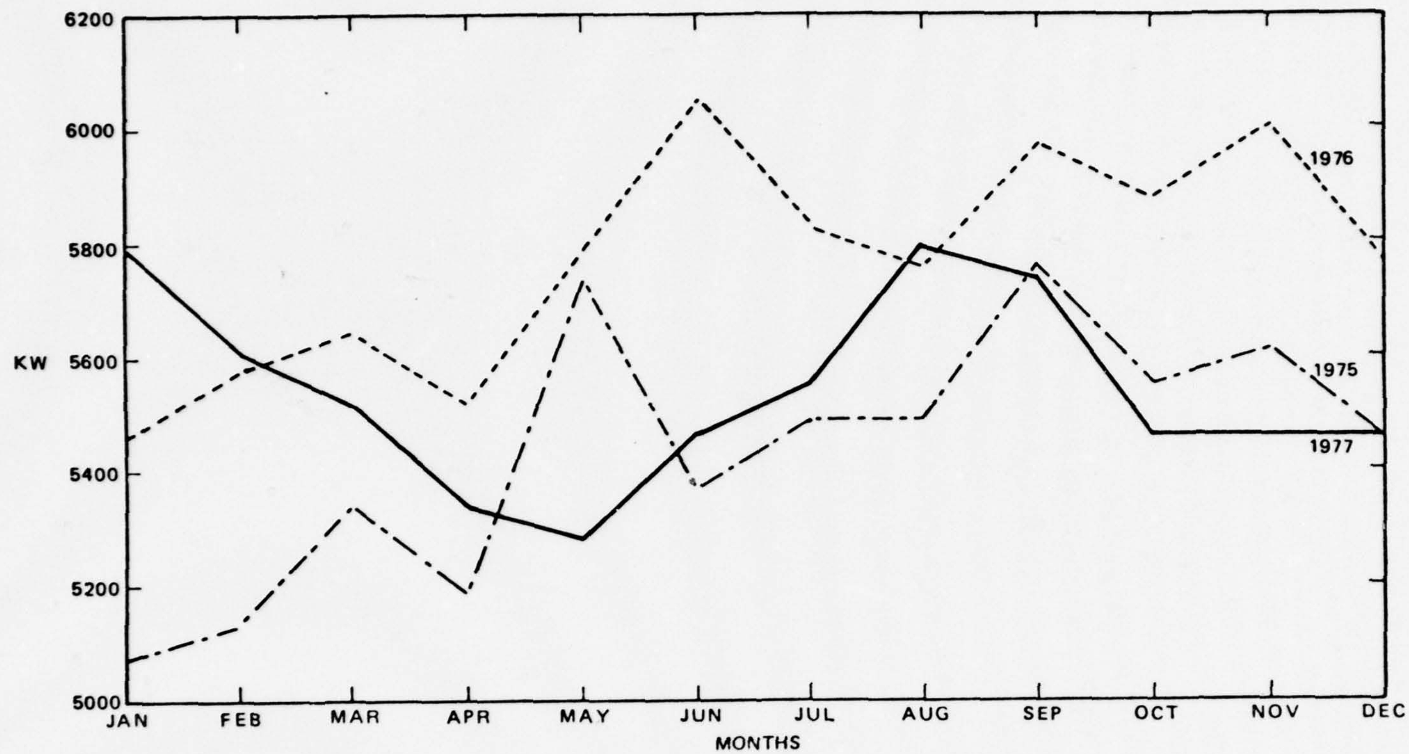

FIGURE 3. MONTHLY ELECTRICAL DEMAND

Source: Public Works Department, Moffett Field, CA

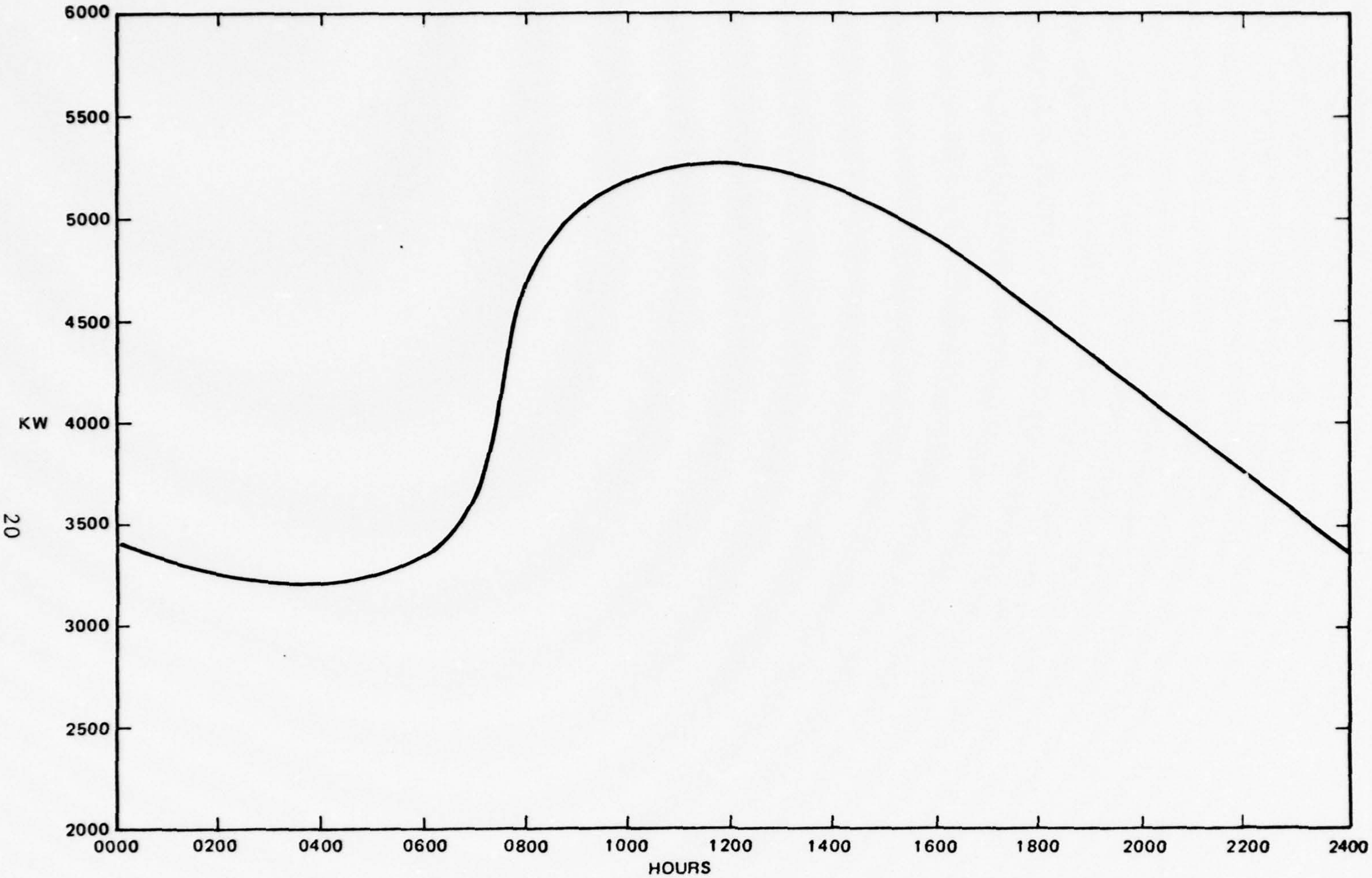

FIGURE 4. AVERAGE ELECTRICAL HOURLY DEMAND

Source: Public Works Department, Moffett Field, CA

TABLE 2

Gross Summary Utilities, FY77

	GAS		STEAM		ELECTRICITY	
	Mil BTU	Cost, $	Mil BTU	Cost, $	KWH	Cost, $
Oct 76	5775	10645.66	9103	18326.96	2913731	16902.37
Nov 76	9942	19000.50	16949	30533.16	2841515	13814.90
Dec 76	15473	29684.02	23673	45747.93	2850996	13510.38
1st qt	31190	59330.18	49725	94608.05	8606242	44227.65
Jan 77	17469	35006.71	27305	54737.63	2948285	13819.87
Feb 77	11615	23572.80	17973	36477.80	2573819	12786.12
Mar 77	11124	22557.26	15464	31385.53	2804400	13188.34
2nd qt	40208	81136.77	60742	122600.96	8346504	39714.33
Cumulative	71398	140466.95	110467	217209.01	16952746	84021.98
Apr 77	9222	19645.28	16520	33839.34	2689249	12602.69
May 77	7528	16136.17	11971	25715.59	2653899	12428.91
Jun 77	5905	12661.05	9926	21324.46	2663483	12974.69
Cumulative	94053	188909.45	148884	298088.40	24959377	122018.27
Jul 77	4831	10412.34	8966	19707.72	2683404	14267.76
Aug 77	4187	9172.80	7754	17757.12	2862550	14141.20
Sep 77	4265	9343.62	8756	21195.32	2704035	13437.38
4th qt	13283	28928.76	25476	58660.16	8249989	41846.34
Cumulative	107336	217838.21	174360	356748.56	33209366	163864.61

Source: Public Works Department, Moffett Field, CA

TABLE 3

Gross Summary Utilities, FY78

	GAS		STEAM		ELECTRICITY	
	Mil BTU	Cost, $	Mil BTU	Cost, $	KWH	Cost, $
Oct 77	4989	10929.84	8179	19869.50	2656779	12764.97
Nov 77	9813	21492.53	18003	38944.89	2610039	12564.56
Dec 77	10677	23343.74	18797	43044.67	2674761	12755.81
1st qt cumulation	25479	55766.11	44979	101858.06	7941579	38085.34
Jan 78	13668	29935.21	18704	42833.31	2717524	12567.04
Feb 78	9650	21138.63	20865	47780.62	2488205	12806.36
Mar 78	8655	18955.20	15970	36561.30	2886596	13185.39
2nd qt cumulation	31973	70029.04	55539	229033.29	16033904	76644.13
Year to date	57452	125795.15	100518	229033.29	16033904	12926.77
Apr 78	8772	19173.76	16254	37449.98	2695165	12926.77
May 78	6080	13319.78	11770	26952.38	2872207	16300.57
Jun 78	4554	9978.94	8046	18424.88	2868961	25544.95
3rd qt cumulation	19406	42472.48	36070	82827.24	8436333	54772.29
Year to date	76858	168267.63	136588	311860.53	24470237	131416.42
Jul 78	4173	9143.89	8140	18640.83	2888923	25860.69
Aug 78	3551	7781.05	7070	16189.61	3082259	26387.01

Source: Public Works Department, Moffett Field, CA

TABLE 4

ELECTRIC RATES FOR THE CENTRAL VALLEY
PROJECT FOR NONLOAD GROWTH CUSTOMERS

FORMER RATE: (prior to 1 May 1978)

Demand:	$0.75 per kilowatt	
Energy:	First 130 KWHR per KW	4 MILLS/KWHR
	Next 130 KWHR per KW	3 MILLS/KWHR
	All additional KWHR	2 MILLS/KWHR

INTERIM RATES:

Demand:	$2.00 per kilowatt	
Energy:	For period 1 May 78 to 31 March 79	4.20 MILLS/KWHR
	For period 1 April 79 and thereafter	5.75 MILLS/KWHR

exceeds approximately 6000KW, the additional load is to be provided by Pacific Gas and Electric Co. at relatively high unit costs, according to the latest PG&E contract for supplemental electric service for Moffett, dated 1 October 1977. The rate schedule for PG&E supplemental service is shown in Table 5.

It is clear that the costs for instantaneous power level demand and electrical energy use are rapidly increasing, and the need for close local control of consumption by Moffett officials is obvious. Up to the present time, the unusually low BUREC rates have made it difficult to economically justify energy conservation projects. During the SRI visit, the electrical power demand monitoring device was indicating a current demand of 5900KW. With the addition of the new 600-man Air National Guard unit flying C-130 aircraft, scheduled to be relocated to Moffett in April-May 1979, the 6000KW BUREC limit will most probably be exceeded, unless stringent conservation measures are applied.

F. Energy Consumption in the Aircraft Intermediate Maintenance Department, NAS

1. Avionics Maintenance Facility

The Avionics Maintenance Facility provides intermediate level maintenance on all avionics equipment used by the P3C squadrons of PATWINGSPAC. Its chief use of energy is in maintaining around-the-clock air conditioning of the large work spaces.

The SRI survey team toured the facility and discussed with officials the degree of utilization of the test-and-repair positions. This was done with a view toward suggesting work-shift adjustments that might permit savings in energy use for air conditioning.

TABLE 5

PG&E SUPPLEMENTAL SERVICE RATES

	Per Month Per Meter
Demand Charge:	
First 1,000 KW of billing demand	\$2,465.00
Over 1,000 KW of billing demand, per KW	1.75
Energy Charge: (in addition to the demand charge)	
First 100 KWHR per KW of billing demand, per KWHR	.01188
Next 200 KWHR per KW of billing demand, per KWHR	.00728
All excess, per KWHR	.00528

Minimum Charge:

The Demand Charge constitutes the Minimum Charge.

It was determined that the current two shifts per day work schedule (with the third shift being used for maintenance of the facility and its test equipment) is probably a minimum schedule to maintain the required output. As shown in Figure 5, there is a substantial backlog of work at the facility, indicating a full utilization of two-shift resources*. However, the backlog is gradually decreasing and this may eventually afford an opportunity to cut back to one shift. Even now, it would be possible to turn off the air conditioning equipment during the third or maintenance shift if fewer test sets were left in power-on condition during that shift, thus heating the workspaces. It was explained by AIMD personnel that these equipments are left "on" because (1) it would take one to two hours of warm-up time to put them into stabilized operating condition for use on the next regular operational shift, and (2) the equipments would require excessive maintenance (if they were turned off during the third shift) due to increased sub-system deterioration associated with on-off cycling. The problem of warm-up time could, of course, be handled by arranging for the third-shift maintenance crew to turn the equipments on about two hours before the end of that shift. Among the equipment that are currently left "on" 24 hours per day, five days per week, are:

a) 18 USM-207 frequency converters

b) 1 APM-314 simulator radar test set

c) 3 UPM-137 IFF test benches

d) 1 USM-449 automated test set (10KW average power rating).

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*Assuming, of course, that the available resources are being effectively applied to the work. Such a determination was outside the scope of this study.

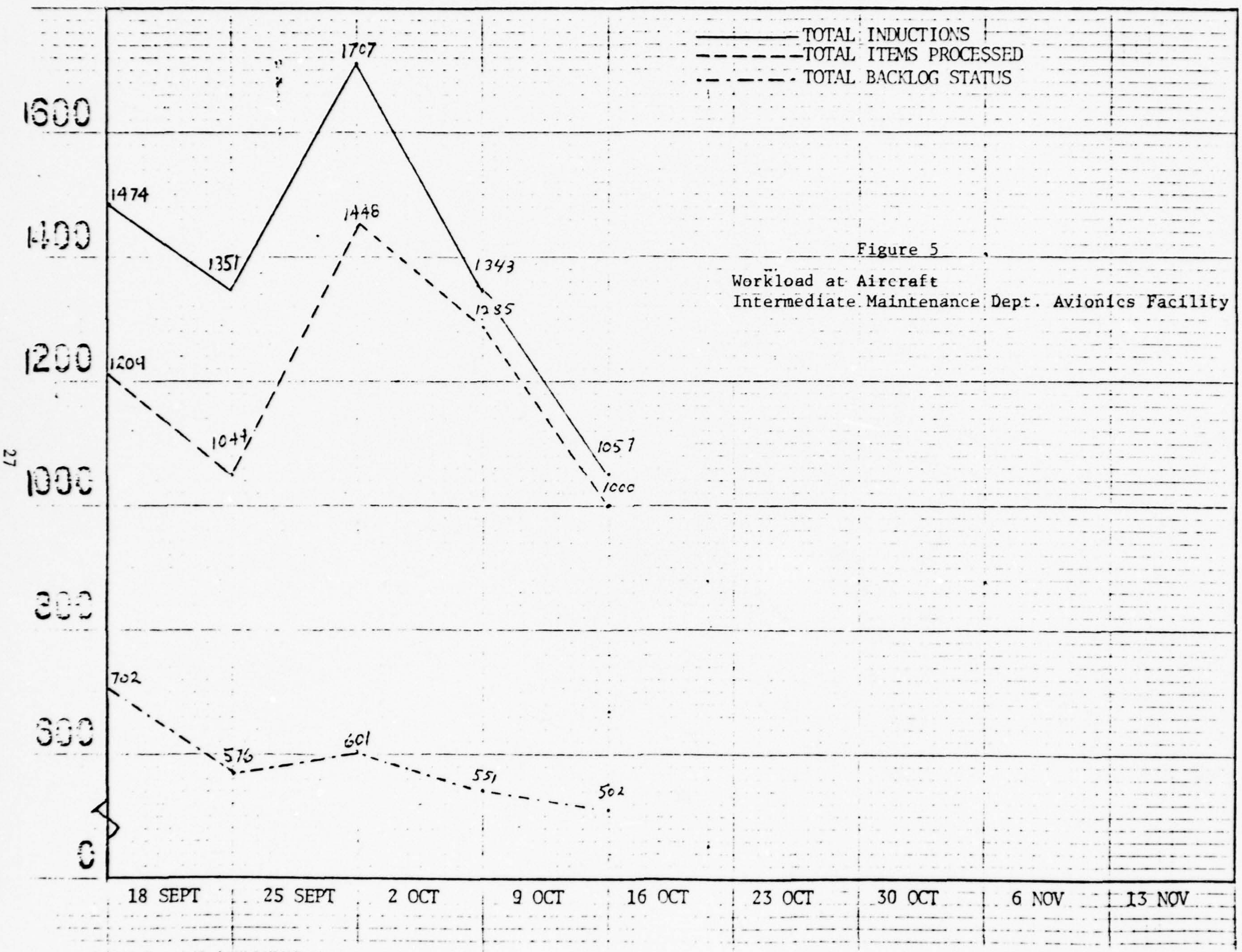

Figure 5

Workload at Aircraft Intermediate Maintenance Dept. Avionics Facility

2. Ground Support Equipment Pool

This unit maintains all the ground support equipment used by the operating squadrons. Energy consumers include:

a) A 5 hp tow bar tester
b) A 20KW arc welder, used about 3 hrs per week
c) A 1KW rod drying oven.

The metal buildings housing this unit will be replaced by a new GSE complex planned for occupancy in 1981 or 1982.

3. Power Plants (Aircraft Engines) Division

This unit performs intermediate maintenance on about 50 of the P3C engines* per year. At this activity, they do not disassemble the engine compressor (power section, torque meter, gear box); such repairs are reserved for depot maintenance at NARF, Alameda. Energy users in this unit include a 30 hp propellor control test stand which operates about 4 hrs per day.

4. Airframes Division

This unit performs metal-bending, welding, and machining operations on a 1-shift per day basis. Energy users include:

a) A 7KW metal shear used about 0.5 hrs per day
b) A 46KW arc welder used about 4 hrs per day
c) A 25 hp milling machine and two 9KW lathes, all used a total of 8 hrs per day
d) Two 5KW ovens used about 8 oven hours per day.

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*T56 turbo-prop engines, 4600 shaft horsepower, manufactured by Allison Division, General Motors Corp.

5. Engine Test Facility

This unit, consisting of an open-air T56 engine test stand in a remote area of the Station, is currently using a GTC-85 gas turbine compressor unit to start the T56 engines (with compressed air) because its normal diesel-powered compressed air unit is temporarily disabled. About three engines per week are tested here. Test personnel explained that the GTC-85 unit uses about 320 gallons of JP-5 fuel per month versus the 30 gallons per month normally required by the diesel unit. Until the diesel unit is repaired, this constitutes an unnecessary net expenditure of 290 gallons of JP-5 fuel per month.

In addition, the GTC-85 gas turbine compressor produces hot compressed air, so that the test start must be limited to about one minute, for safety reasons. This means that if a successful start is not achieved within a minute, the compressor must be allowed to cool and the procedure repeated. (The diesel unit pumps compressed air into large tanks and therefore produces cold air for engine starts.) A minor repair of the diesel compressor metering unit could solve this problem.

G. Energy Consumption in Squadron Ground Operations

The SRI team visited P3C squadron VP-47 (located in Hangar 3) which was taken to be representative of the seven VP squadrons operating out of Moffett Field. Typical energy users in VP-47 include:

a) Two MMG-1A mobile electric power plants, each rated at 7KW, used about 2 hours per day.

b) Floodlights on the outside wall of Hangar 3 are turned "on" all night seven nights per week to illuminate the outside apron area.

c) One NC-10-B diesel powered ground power unit, rated at 6KW, uses about 10 gallons of fuel per hour of operation.

d) One GTC-85 gas turbine compressor supplies compressed air for engine starting on the flight line. This unit is used only as a backup when the P3C's own auxiliary power unit (APU) is inoperable. VP-47 uses the GTC for engine starting about once a day. A GTC unit consumes about 40 gallons of JP-5 per hour of operation. At an estimated 30 minutes of operation per start, this unit comsumes 20 gallons of JP-5 per day. (We understand that NAS, Miramar has a built-in compressed air system for starting aircraft.)

e) One T180F aircraft tow tractor, uses 5 gallons of MOGAS per day.

f) One TA-75 aircraft tow tractor uses about 5 gallons of MOGAS per day.

g) The APU in each P3C aircraft uses 50 gallons per hour of operation, (and operates about 3 hours per day when the plane is on the flight line), or some 150 gallons of JP-5 per day.

h) One NC-12 diesel powered ground power unit, uses about 8 gallons per hour of operation.

H. Other Potentially Beneficial Projects

The Naval Air Station has proposed a number of other projects including the following items which offer opportunities for energy savings in the hangar area:

"1. Existing Projects

a. Programmed--ECIP MCON Projects

(1) P-126 "Hangar 1 Heating Impovements." This FY78 project will reduce the amount of energy necessary to heat various areas of Hangar 1 by providing individual automatic control valves, set back controls, suspended ceilings and insulation. It will reduce the base energy consumption approximately 0.7 percent from the FY73 baseline consumption and represents a savings of $11,551 in FY78 energy costs.

b. Unprogrammed--ECIP MCON Projects

(1) P-180 "Insulate Ceilings/Attics, 16 Bldgs." This project was submitted for FY80 funding but has not been programmed yet. It will

install R-19 insulation in the ceilings/attic spaces of 16 buildings, including the heated spaces of Hangars 1, 2, and 3. The project is expected to reduce the base energy consumption approximately 1.7 percent from the base energy consumption and will represent a savings of approximately $46,600 in FY80 energy costs.

2. Proposed Projects

a. ECIP--MCON Projects

P-185 Reflective Deck Finish for Aircraft Maintenance, Hangars 1, 2, and 3 — $130,000

P-188 Hangar 1 heating system improvements — $172,000

b. Energy Conservation Items for Local Funding and/or Implementation

(1) Metering of Tenant Activities. There is no incentive to practice energy conservation when an estimate is used for utility billing. When a manager or comptroller of a tenant can see the change in utility billing based upon conservation efforts, there will be more attention to the conservation effort. For this reason, metering should be considered when applicable.

(2) Hangar Lighting Controls. It was noted during the various inspections that the hangars had their lights on during the day. There is sufficient daylight during much of the day to permit these lights to be turned off. Human failings being what they are, they require automatic control devices to do the work that the occupant will not. A photo cell, magnetic contactor, momentary contact push button and timer switch may cost $500 per hangar bay. The power required to light each hangar bay may approximate 50 KW. If the lighting conditions, door positions, work locations and weather were such that they permitted the automatic control devices to function for 83 ten-hour days, the energy saved would pay for the cost of the installation.

50 KW X 10 hours/day X 83.3 days X $0.012/KWH = $500 installed cost

(3) Reflective Roof Coatings. A suggestion was made that the application of a reflective roof coating would provide both energy and cost savings. Independent laboratory test results have indicated that reductions of 15 F or more in maximum temperatures when exposed to solar heating, were obtained by treating a black, bituminous surface with a suitable reflective coating. This indicates that both cooling and heating energy can be saved by this application.

(4) Use of Skylights. The use of artificial lighting can be eliminated in many areas of buildings, hangars and warehouses by the increased use of skylights."

c. Other Proposals

A private contractor has performed a preliminary economic analysis aimed at replacing existing 400 Hz motor generator sets with a centralized 400 Hz 4160 V generating system, with distribution to aircraft operation, maintenance and repair facilities throughout the Station. The study, prepared in April 1978, concludes that this arrangement would result in a substantial yearly dollar and energy savings (see Appendix D). While time and budget constraints precluded a detailed analysis of this study, we offer the following comments:

- The study was not exhaustive enough to warrant a firm basis for a course of action; the author has not considered or attempted to quantify the respective benefits and disadvantages of the two alternatives. For example, a breakdown of the centralized distribution system would completely disrupt maintenance operations, whereas breakdowns in the present equipment are spread randomly over several units and over an extended time period.
- The cost figures should be supported by data reflecting industry-wide average costs for comparable equipment.

- "Discounted annual costs" is a confusing misnomer; it should be called "discounted 15-year O&M costs."
- Total currently installed motor/generating capacity is 438 KVA, not 383 KVA, pg. D-4.
- No operating personnel costs are considered in the analysis.
- There is no consideration of equipment replacement for the centralized system.
- The problem of interference (for example, with communications equipment) arising from the use of a centralized 400 Hz system has not been considered.
- The study did not consider the inflation rate for electricity.

To conclude, more exhaustive engineering analysis must be performed; frequency conversion devices using modern solid-state circuitry with higher efficiencies and reliability are viable alternatives to the present motor-generator sets.

REFERENCES

1. "Lighting Handbook," January 1974, Westinghouse Electric Corporation, Lamp Division, Bloomfield, New Jersey.

SUGGESTED READING

1. U.S. Navy Energy Plan and Program 1978, OPNAV 41P4.

APPENDIX A

187:CFW:cl
5 Jul 1977

MEMORANDUM

From: ENS Winsor
To: Public Works Officer

Subj: Load Shedding Plan

Ref: (a) COMTWELVE message R132313Z Jun 77

Encl: (1) Electrical Load Shedding Contingency Plan

1. In accordance with reference (a), each command in Northern California has been tasked with developing a Load Shedding Contingency Plan for electrical usage during the summer, 1977. I believe that the implementation of any load shedding plan should be accompanied with the appointment of a departmental or tenant command unit conservation monitor with alternate for each building on station in order to provide adequate monitoring and accountability for subject plan. NAS Miramar has already successfully done this on a station-wide level.

2. Enclosure (1) outlines some specific procedures in order of increased emergency conditions to be implemented progressively as the crisis for energy increases according to PG&E supply capability.

C. F. WINSOR

ELECTRICAL LOAD SHEDDING CONTINGENCY PLAN

In the event of a threatened or actual energy shortage, NAS Moffett Field will progressively implement the following measures in order to meet the crisis or help reduce the potential for a more serious crisis (note, Step II will only be implemented if Step I action does not produce desired results, etc.):

I. Operate all working spaces on a minimal level of energy usage.

a. Reduce all lighting by 50% (Secure appropriate circuit breakers).
b. Eliminate all unauthorized convenience appliances.
c. Secure all energy using machines when not actually in use where possible.
d. Monitor all spaces periodically during the day to eliminate energy waste where possible (this should be done by a departmental or building energy monitor who is specifically appointed by the command).

II. Secure all personnel comfort-type air conditioning! (Where possible, separate compressor pump circuits from ventilation fan circuit to allow necessary ventilation for some types of buildings.) The following buildings are the most likely candidates on station but this list in not necessarily all inclusive: Building number - 3 ("O" Club); 14 (NIS); 17 (COMPATWINGSPAC); 25 (Beauty Salon); 144 (NEX Warehouse); 240 and 241 (NEX Personnel); 243 (CPO Club); 244 (EM Club); 476 (NEX - Main Store); 503 (NEX Gas Station); 525 (Bowling Alley); 529 (TV Repair Shop); 546 (Dispensary)

III. Completely secure the following buildings or sections of buildings: Building number - 3 ("O" Club); 25 (Station theater and beauty shop); 243 (CPO Club); 244 (EM Club); 476 (NEX Cafeteria); 544 (NEX II Delicatessen); 525 (Bowling Alley); 543 (Craft Hobby Shop); 554 (Auto Hobby Shop); 2 (Gymnasium); 557 (Moffett Station - Chick Inn); Hangar III Cafeteria.

IV. For severely critical energy crises, only those functions vitally necessary for mission of the station would operate. Those functions which would be secured are as follows:

a. All clubs as before
b. All recreational facilities
c. All special services facilities including laundry
d. All NEX and Commissary facilities
e. Others as required!

V. IN THE EVENT OF A TOTAL BLACKOUT, AUXILIARY GENERATORS SHOULD BE BROUGHT IN TO KEY LOCATIONS.

APPENDIX B

ROUTINE * U N C L A S S I F I E D *

PT 04545 165 CC4255

EVE//SW

RTTUZYUW RUWDSGG4409 1650023-UUUU--RUWMHEA RUWMHED.
ZNR UUUUU
RUVMBEA T NAVMARCORESCEN FRESNO CA
RUVMBIA T NAVMARCORESCEN RENO NV
RUWJAJA T MOTU NINE/NAVCRUITDIST SAN FRANCISCO OAKLAND CA
RUWMEKA T COMSERVGRU ONE
RUWMHEA T NAVMARCORESCEN SAN JOSE CA
RUWMHOA T COMCOSRIVDIV ELEVEN/COMSERVRON THREE
R 132313Z JUN 77
FM COMTWELVE SAN DIEGO CA
TO ALTWELVE
INFO RUWNSAA/WESTNAVFACENGCOM SAN BRUNO CA
BT
UNCLAS //N11300//
ALTWELVE 016/77
ELECTRIC LOAD SHEDDING CONTINGENCY PLANS
A. NAVFACINST 4100.6 OF 29 MAR 74 ENCL (6)
1. THIS MSG DISCUSSES THE POSSIBILITY OF ELECTRICAL BROWNOUT/ BLACKOUT SITUATIONS OCCURRING THIS SUMMER IN NORTHERN CALIFORNIA AND URGES THE RAPID UPDATING OF SUBJECT PLANS.
2. THIS YEAR, DUE TO THE EXTENDED DROUGHT CONDITION IN NORTHERN CALIFORNIA, LIMITED HYDROELECTRIC POWER WILL BE AVAILABLE TO NORTHERN CALIFORNIA UTILITIES RESULTING IN THE INCREASED LOCAL USE OF FOSSIL FUELS. IN THE PAST, PACIFIC GAS AND ELECTRIC CO. (PG&E) GENERATED 40 OF ITS ELECTRICITY FROM HYDROPOWER; TODAY, ONLY 25 OF ITS GENERATION COMES FROM HYDROPOWER. PG&E HAD RECENTLY REQUESTED ITS CUSTOMERS TO IDENTIFY LOADS THAT CAN BE VOLUNTARILY REDUCED. THEIR ACTION PORTENDS THE POSSIBILITY OF A SUMMER BROWNOUT OR

BLACKOUT SITUATION IF VOLUNTARY LOAD REDUCTION HAS NOT BEEN ACHIEVED. ADDITIONALLY, AN INFORMAL SURVEY INDICATES THAT A MAJORITY OF COMMANDS IN THE DISTRICT THAT MAY BE SEVERELY AFFECTED BY AN ELECTRICAL ENERGY SHORTAGE DO NOT HAVE A CURRENT LOAD SHEDDING CONTINGENCY PLAN ENABLING ALL MISSION REQUIREMENTS TO BE MET IN A REDUCED ENERGY ENVIRONMENT ON A CONTINUING BASIS.
3. ALL COMMANDS LOCATED IN NORTHERN CALIFORNIA ARE ENJOINED TO DEVELOP OR UPDATE ELECTRICAL LOAD SHEDDING CONTINGENCY PLANS IN ACCORDANCE WITH REF A. ALL OTHER COMMANDS IN THE DISTRICT ARE URGED TO REVIEW THEIR RESPECTIVE ENERGY SUPPLY CONDITIONS AND PROCEED ACCORDINGLY WITH THE DEVELOPMENT OF SUCH PLANS.
BT
#4409

00 01 10 20 30 31 40 50 60 70 71 80 MF CF SDO (23)
A/PUBWKS CO XO ADMIN AIMD SUPO COS GMF (19)
MARBKS, NAVPRO, N&MCRC, OPTEVFORDET, RESPAC (7)

49 COPIES

ROUTINE * U N C L A S S I F I E D *

FASOTRAGRUPACDETMFT FORM 1541/9 (REV 8/77)

APPENDIX C

SIMULATOR UTILIZATION PERIOD <u>01-31 October, 1978</u>

2C45 OCT

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0630-0930								31	31		31	31	31	31	31		31			31	31				
B	0945-1245								31	31	31	31	31	31	31	31		31			31	31				
C	1300-1600								31	31		31	31	31	31	31		31			31	31				
D	1615-1915														31			31			31					
E	1930-2230																				31					

OCT

2F69D (CFT)

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0630-0930								31	31		31	31	31	31	31	31	31			31	31				
B	0945-1245								31	31		31	31	31	31	31	31	31	31		31	31				
C	1300-1600								31	31		31	31	31	31	31	31	31			31	31				
D	1615-1915														31		31	31								
E	1930-2230																	31								
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

<u>NOTES</u>:
a. Crews will brief 30 minutes prior to trainer periods.
b. Brief/debrief room is located topside in trainer complex. Contact trainer maintenance control office for assistance if room is occupied. Brief/debrief rooms scheduled thru Faso ext 5191.
c. No food or drink allowed in trainers.
d. Cancellations or changes to be made at least four (4) working hours in advance of assigned times.
e. Trainer information 0700-1600 Ext 5191 (Trainer Schedules Office)
1600-2400 Ext 5183 (Trainer Maintenance Control)
f. 2F69E (WST) for P3B MOD will be available approximately October 1978.

OCT

2F87(F) OFT #3

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0645-1045	31	31	31	19	46	31	31	CPW	31	31	31	31	CPW	31	31	ITV	ITV	31	31	19	19				
B	1100-1500	31	31	31	CPW	CPW	31	31	31	31	31	31	31	31	31	31	ITV	ITV	31	31	CPW	31				
C	1515-1915	31	31	31	9	9	31	31	9	31	31	31	31	46	31	31	19	19	31	31	9	46				
D	1930-2330	31	31	31			31				31	31	31		31		50		31							
E	X X X X																									
F	X X X X																									

NOTE: a. Trainer instructor must have completed FASO 2F87 OFT operator course.
b. OFT #3 reserved for VP-31 as required for pipeline training. Unassigned periods are available to the fleet.
c. OFT #3/Tactics #1 Link is not available until further notice.

2F87A(T) TACTICS #5

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0530-0830	FA	44	44	19	19	46	31	31	9	19	44	44	19	19	19	19	44	46	9	19	19				
B	0830-1130	FA	44	FA	9	FA	FA	FA	FA	FA	FA	FA	44	46	31	31	31	31	31	31	FA	31				
C	1130-1430	FA	44	FA	FA	31	46	46	19	FA	46	FA	46	FA	FA	9	FA	44	19	19	FA	FA				
D	1430-1730	31	31			9	9	44	44	19	31	FA	FA	FA	FA	19	FA	46	9	31	31	FA				
E	1730-2030	19	31	31	19	19	9	31	31	19	31	31	19	19	46	46	44	9	19	31	19	31				
F	2030-2330		31	31	46	46		44	44	9	9	44	19				44			31	9	19				
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

OCT
2F87(F) OFT #2

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0545-0945	31	31	31		50	31	47	50	19	31	31	31	47	31	31	50	19	31	ITV	47	47				
B	1000-1400	31	31	31	CFW	47	31	31	31	31	31	31	31	31	31	FA	FA	FA	31	31	9	CPW				
C	1400-1700	50	47	50	47	47	47	50	50	47	47	50	19	47	50	ITV	FA	FA	46	ITV	19	47				
D	1715-2015	50	19	46		19	46	46	50	50	9	19	47				9	47	19	19	47	50				
*E	2030-2330							47																		
F	X X X X																									

NOTE: a. Trainer instructor must have completed FASO 2F87 OFT operator course.
b. OFT #2/Tactics #4 Link is available in period indicated by asterisk (*).

2F87(T) TACTICS #4

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0530-0830	FA			47	50	50	47	47	31	50	47	47	47	50	50	50	50	TTT	TTT	31	47				
B	0830-1130	FA			47	47	FA	31	31	FA	50	31	31	47	31	31	31	FA	TTT	31	FA	FA				
C	1130-1430	FA			47	31	50	31	31	FA	31	47	50	FA	FA	50	FA	31	31	FA	50	FA				
D	1430-1730		31		50	FA	50	47	50	47	47	FA	FA	FA	FA	50	FA		47	FA	31	50				
E	1730-2030	31	31	31	50	50	50	47	50	31	47				FA	50				TTT	31					
*F	2030-2330		31	31	50	47	50	47	47	47											31					
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

FASOTRAGRUPACDETMFT FORM 1541/9 (REV 8/77)

14B44 OCT

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31
A	0600-0700	19	50	50	CPW	CPW	47	31	47	47	19	CPW	CPW	CPW	CPW	19	31	TTT	19	CPW	46	47
B	0700-0800	19	50	50	CPW	CPW	47	31	47	47	19	CPW	CPW	CPW	CPW	19	31	TTT	19	CPW	46	47
C	0800-0900	31	CPW	FA	FA	FA	FA	31	FA	47	FA	FA	FA	FA	FA	CPW	31	FA	FA	CPW	FA	19
D	0900-1000	31	CPW	FA	FA	FA	FA	31	FA	47	FA	FA	FA	FA	FA	CPW	31	FA	FA	CPW	FA	19
E	1000-1100	31	CPW	FA	FA	FA	FA	31	FA	47	FA	FA	FA	FA	FA	CPW	31	FA	FA	CPW	FA	FA
F	1100-1200	31	CPW	FA	FA	FA	FA	31	FA	47	FA	FA	FA	FA	FA	CPW	31	FA	FA	CPW	47	FA
G	1200-1300	9	47	FA	FA	FA	FA	31	FA	47	FA	FA	FA	FA	46	FA	FA	FA	FA	9	47	47
H	1300-1400	31	47	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	9	FA	47
I	1400-1500	31	46	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	50
J	1500-1600	31	46	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	50
K	1600-1700	9	46	46	FA	FA	46	46	19	47	19	19	9	9	19	50	9	FA	FA	19	31	50
L	1700-1800	9	31	FA	FA / FA	FA	FA	FA	FA	47	FA	FA	FA	FA	19	50	9	FA	FA	FA	31	50
M	1800-1900	50	31	FA	FA	FA	FA	FA	FA	50	FA	FA	FA	FA	50	50	19	FA	FA	FA	31	50
N	1900-2000	50	31	FA		FA	FA	FA	FA	50	FA	FA	FA	FA	50	50	19	FA	FA	FA	31	50

14B40

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31
A	0800-0900	FA	FA	FA	FA	FA	FA	46	FA	FA	FA	FA	FA	19	9	47	19			9	50	FA
B	0900-1000	FA	FA	FA	FA	FA	FA	46	FA	FA	FA	FA	FA	19	9	47	19			9	50	FA
C	1000-1100	FA	FA	FA	FA	FA	FA	47	FA	FA	FA	FA	FA	47	19						47	FA
D	1100-1200	FA	FA	50	46	FA	FA	47	50	47	19	46	FA	47	19						47	47
E	1200-1300		19	50	FA	FA	19	47	50	47	19	46	FA	50				9			50	47
F	1300-1400	50	19		FA	FA	19	47	9	50	FA	19	FA	50				9			[illegible]	
G	1400-1500	50	FA	FA	FA	FA		50	9	50	FA	19	47									
H	1500-1600		FA	FA	FA	FA		50			FA		47									
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

FASOTRAGRUPACDETMFT FORM 1541/9 (REV 8/77)
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OCT
15F16 ESM TRAINER

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0600-0700																									
B	0700-0800																									
C	0800-0900										FA				FA						31					
D	0900-1000										FA	FA			FA						31					
E	1000-1100										FA	FA	FA	FA	FA						31					
F	1100-1200											FA	FA	FA							31					
G	1200-1300																									
H	1300-1400									FA		FA	FA	FA												
I	1400-1500										FA	FA	FA	FA												
J	1500-1600										FA	FA	FA	FA												
K	1600-1700																									
L	1700-1800																									
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

FASOTRAGRUPACDETMFT FORM 1541/9 (REV 8/77)

OCT
15Z1 RADAR TRAINER

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0600-0700																									
B	0700-0800																									
C	0800-0900					FA	FA		FA																	
D	0900-1000				FA	FA	FA	FA	FA																	
E	1000-1100				FA	FA	FA	FA	FA			FA														
F	1100-1200				FA	FA	FA	FA	FA			FA														
G	1200-1300																									
H	1300-1400						FA	FA																		
I	1400-1500						FA	FA																		
J	1500-1600						FA	FA																		
K	1600-1700																									
L	1700-1800																									
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

FASOTRAGRUPACDETMFT FORM 1541/9 (REV 8/77)
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14B13 RM 108

PER	TIME/DATE	2	3	4	5	6	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	31				
A	0800-0900														FA											
B	0900-1000														FA											
C	1000-1100														FA											
D	1100-1200														FA											
E	1200-1300														FA											
F	1300-1400														FA											
G	1400-1500														FA											
H	1500-1600														FA											
	MTS	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

APPENDIX D

ECONOMIC ANALYSIS
COMPARISON OF
EXISTING OPERATING METHODS
versus
CENTRALIZED 400 Hz GENERATING SYSTEM
at
NAVAL AIR STATION MOFFETT FIELD, CALIFORN

1. Design Alternatives

   A. Continue Existing Operating Methods

   B. Centralized 400 Hz Generation and Distribution System

2. Analysis Summary

	ALTERNATIVES "A"	ALTERNATIVES "B"
Initial Investment	$352,979	$1,400,000*
Discounted Annual Costs	$1,685,011	503,753
Total Present Value	$2,037,990	$1,903,753

* See Cost Estimating Forms - Worksheet NAVDOCKS 2417A

3. Conclusion.

Alternative "B" is selected. Not only is the present-Value of "B" less, its yearly cost savings are impressive.

Discounted Annual Savings are	$1,181,258
Undiscounted Annual Savings are	117,405

4. Recommendation.

Alternative "B" be considered for a military construction project to install a Central 400 Hz - 4160 Volt Generation and Distribution System. Not only is a potential for savings in operating funds, but, aircraft servicing will be much improved.

5. Initial Investment - Alternative "A" - Continue Present Method

Annual replacement cost of existing installed motor generators and mobile electric power plants (MEPP) is based on the assumption that 10% will be replaced annually, and is

10% of 554 KVA = 55.4 KVA @ $250*= $13,850 installed MGs
10% of 360 KVA = 36.0 KVA @ $560*= $20,160 mobile MEPPs
$34,010

* Per "Feasibility Study Of A 400 Hz - 4160 Volt - Three Phase Electrical Power Generation and Distribution System" Jaros, Baum & Bolles Consulting Engineers, February 1977 Contract No. 00025-76-C-001

APUs (Auxiliary Power Units) of the type used in P-3 aircraft are the same type used in some commerical aircraft. Airline information indicates that APUs depreciate at a value of $2.334 per operating hour. The replacement cost per year for the APUs in the 12 aircraft involved in this analysis is

12 aircraft X 1 hour a day X 365 days X $2.334 = $10,223

The total annual replacement cost of 400 Hz power generating equipment is

$13,850 installed + $20,160 MEPPs + $10,223 APUs = $44,233

5.1 Discounted Annual Cost

The discounted annual cost for annual equipment replacement is

$44,233 X 7.98 = $352,979

6. Initial investment - Alternative "B" Central System

The budgetary cost of a military construction program to install a Central 400 Hz - 4160 Volt Generation and Distribution System is shown in detail on cost estimating worksheet, and is

$1,400,000

7. Energy Costs

Alternative "A"	$106,752
Alternative "B"	50,142

8. Maintenance Costs

Alternative "A"	$73,406
Alternative "B"	12,985

9. Discounted Annual Cost (Present Worth of O and M Costs)

9.1 The discounted annual cost procedures are as presented in "Feasibility Study Of A 400 Hz - $160 Volt - Three Phase Electrical Power Generation And Distribution System" Jaros, Baum & Bolles Consulting Engineers, February 1977, Contrat No. 00025-76-C-001.

Electricity and Maintenance. From Table B - Present-Value Tables of Appendix D, NAVFAC P-442, the "Cummulative Uniform Series" the factor 7.980 is selected. (Inflation rate is not considered; Discount rate 10% annually for 15 years)

Fossile Fuel. From Table 7 of Appendix E, NAVFAC P-442, the "Cummulative Uniform Series" the factor 12.278 is selected. (Inflation rate of 7%; Discount rate of 10% annually for 15 years)

9.2 The discounted annual costs are

ALTERNATIVE "A"	ALTERNATIVE "B"
Electricity	
7.98 X $49,202 = $392,632	7.98 X $50,142 = $400,133
Savings 7,501	
Fossile Fuel	
12,278 X $57,550 = $706,599	None
	Savings $706,599
Maintenance	
7.98 X $73,406 = $585,780	7.98 X $12,985 = $103,620
	Savings $482,160
Discounted Annual Cost	
$1,685,011	$503,753

9.3 Discounted annual savings are $1,181,258

9.4 Undiscounted annual savings are 117,405

10. Comments. The proposed system will provide a quantative improvement in aircraft service and reduce the reliance on mobile equipment.

Prepared by
M.T. Hurst
April 1978

The purpose of this economic analysis is to establish the economic feasibility of generating 400 Hz electrical power at a central location and distributing that power at 4160 volts to aircraft operation, maintenance and training facilities throughout the station. It has been proposed to replace existing motor generators with 4160 - 208Y/120 volt stepdown transformers and where possible to continue to utilize existing 120/208 volt distribution systems. 400 Hz power will be provided at the existing aircraft service stantions in hangars to eliminate the use of MEPPs. (Mobile Electric Power Plants) The aircraft parking ramp East of Hangar 3 will be provided with 400 Hz power which will eliminate the need for MEPPs in that area as well as to reduce the use of aircraft on-board APUs. (Auxiliary Power Units)

The analysis will address two alternatives:

1. Plan "A" - Continue Present Method
2. Plan "B" - Central System

- -

1.0 Plan "A" - Continue Present Method - Energy Cost

1.1 The total available capacity of installed motor generators at NAS Moffett Field is assigned as follows:

Location	Qty & Cap Operating MG in KVA	Op Hrs Per Mo	Qty & Cap Standby MG in KVA	Qty & Cap Spare MG in KVA
Hangar 1	2 - 30.00	80		
1	1 - 18.75	730		
1	2 - 25.00	1460		
3	1 - 30.00	730		
3	1 - 30.00	100		
Bldg. 49	1 - 60.00	280		
49	1 - 30.00	280		
Bldg 300	1 - 12.50	730		
300	1 - 37.50	4		
515	1 - 50.00	280	1 - 50.00	
549	1 - 60.00	730	1 - 60.00	
PWD				1 - 60.00
	13 383.75	5404	2 110.00	1 60.00

None of the above motor generators are used to supply 400 Hz power to aircraft.

An MG set running 100% of the time will be in operation 730 hours per month. (8760 hours per year)

The average operating time for each INSTALLED motor generator is
5404 hours ÷ 13 units = 415.7 hours per month

Percent operating time is
415.7 hours ÷ 730 hours = 56.9%

Percent operating time is
5404 hours ÷ (730 hours X 13 units) = 56.9%

NOTE: Operating time is the time the unit is running whether or not it's 400 Hz power is being utilized.

Average KVA spinning and connected to utilization systems is
383.75 KVA X .569 = 218.75 KVA

The total available KVA is the sum of all INSTALLED motor generator sets, and is
383.75 KVA + 110 KVA + 60 KVA = 553.75 KVA

NOTE: Peak and average loads supported by INSTALLED motor generators that must be supported by the central system are derived from Naval Weapons Engineering Support Activity Report 3-73 "AIRCRAFT GROUND SUPPORT 400 Hz ELECTRICAL POWER REQUIREMENTS EVALUATION"

1.2 The peak demand that will be placed on the central system to support the systems now supported by installed motor generators is calculated at 114 KVA

1.2.1 The average load (24 hours a day-365 days a year) has been estimated to be 10% of the peak load
114 KVA X .1 = 11.4 KVA

1.3 Motor generator losses, for the types in use, average at least 20% of their output ratings at no load. Note that the power factor at no load may be as low as 0.2 and no load current may be as high as 40% of the full load operating current.

1.4 Motor generator losses are additionally proportional to load, providing approximately 15% additional losses at full load.

1.5 Total motor generator losses are the no load losses in 1.3 plus the porportional losses in 1.4.

Based on 1.1 and 1.3, the no load losses are
218.75 KVA spinning X .2 = 43.75 KVA no load losses

Based on 1.2.1 and 1.4, the proportional additional losses are
11.4 KVA average load X .15 = 1.71 KVA

Continuous power losses are then
43.75 KVA + 1.71 KVA = 45.46 KVA

1.6 Total 60 Hz power consumption is based on the summation of 400 Hz power used plus 60 Hz power lost, and is
45.46 KVA power lost + 11.4 KVA = 56.86 "KW"

1.7 Total yearly 60 Hz power consumption is
56.86 "KW" X 24 hours X 365 days = 498,094 "KWH"

1.8 Based on the expected power cost in 1982 of $.06 per KWH the yearly cost of 60 Hz power to operate the installed motor generators is
498,094 "KWH" X $.06 = $29,886

1.9 The cost of useful 400 Hz power is
$29,886 ÷ (11.4 KVA X 8760 hours) = $.299 per "KVAH"

1.10 System effeciency is
11.4 KVA ÷ 56.86 = 20%

1.11 MEPPs (Mobile Electric Power Plants) are assigned to NAS Moffett Field as follows:

Type	Qty & Cap		Average Utilization* Per Month	Total Util.*
NC-10 (Diesel)	13	90 KVA	30.7 Hr/Mo	400 Hr/Mo
NC-12 (Diesel)	8	125 KVA	22.6 Hr/Mo	181 Hr/Mo
MMG-1 (Elect.)	16	60	77.3 Hr/Mo	1242 Hr/Mo
Diesels	21			581 Hr/Mo
Electrics	16			1242 Hr/Mo
Total	37			1823 Hr/Mo

* Data from 3-M records

It is intended to replace all MMG-1 MEPPs with hangar 400 Hz distribution systems supported by the central generators. Four NC-10 MEPPS will be eliminated by a 400 Hz distribution system on the East aircraft parking ramp.

1.12 A review of aircraft power requirements presented in NAVWPNENGSUPPACT Report 3-73 reveals that a P-3 aircraft positioned in a hangar for maintenance will require on an average 10 KVA of 400 Hz power. It will be assumed that an operating MEPP connected to an aircraft will be supplying 10 KVA 80% of the time. Therefor the average power supplied is
10 KVA X .8 = 8 KVA

1.13 3-M data reveals that 16 MMG-1 MEPPs operate a total of 1242 hours a month. The average daily use per MMG-1 assigned to a squadron is then
(1242 hours ÷ 16) ÷ 30 days = 2.6 hours per day

1.14 It can be deduced that each MMG-1 assigned to a squadron supplied an average of 8 KVA for 2.6 hours each day

1.15 The total power supplied by MMG-1s each day was
8 KVA X 16 units = 128 KVA for a period of 2.6 hours.

1.16 The average power supplied during the 2.6 hours operating period was 128 KVA from equipment with a capacity of
16 units X 60 KVA = 960 KVA

1.17 If the average power supplied during the 2.6 hours were spread out over a 24 hour day-365 day year, the average power output would be
128 KVA X (2.6 hours ÷ 24) = 13.87 KVA total from the summation of the outputs of all 16 MMG-1s.

1.18 Motor generator losses for an MMG-1 is about 20% of its rated output at no load

1.19 Motor generator losses are also additionally proportional to load, providing an additional 15% power loss at full load.

1.20 Total MMG-1 losses are the no load losses in 1.18 plus the proportional losses of 1.19.

Based on 1.16 and 1.18, the no load losses are
960 KVA X (2.6 hours ÷ 24 hours) X .2 = 20.8 KVA

Based on 1.17 and 1.19, the proportional losses are
13.87 KVA X .15 = 2.08 KVA

Continuous power losses are then
20.8 KVA + 2.08 KVA = 22.88 KVA average each 24 hours

1.21 Total 60 Hz power consumption is based on the summation of 400 Hz power used and 60 Hz power lost, and is
13.87 KVA used + 22.88 KVA = 36.75 "KW"

1.22 Total yearly 60 Hz power consumption is
36.75 "KW X 24 hours X 365 days = 321,934 "KWH"

1.23 Based on the expected power cost in 1982 of $.06 per KWH the yearly cost of 60 Hz power to operate the MMG-1 MEPPs is
321,934 "KWH" X $.06 = $19,316

1.24 The cost of useful 400 Hz power is
$19,136 ÷ (13.87 KVA X 8760 hours) = $.159 per "KVAH"

1.25 System effeciency is
13.87 KVA ÷ 36.75 "KW" = 37.7%

1.26 The combined 400 Hz power output from all electric power motor generator sets is
11.4 KVA installed MGs + 13.87 KVA MEPPs = 25.27 KVA

1.27 The combined average input power is
56.86 "KW" + 36.75 "KW" = 93.61 "KW"

1.28 The combined total yearly 60 Hz power consumption for installed and MEPP units is
498,094 "KWH" installed + 321,934 "KWH" MEPP = 820,028 "KWH"

1.29 Based on an expected power cost of $.06 per KWH, the combined yearly cost of 60 Hz power to operate installed and MEPPs is
820,028 "KWH" x $.06 = $49,202

1.30 The cost of useful 400 Hz power is
$49,202 ÷ (25.27 KVA X 8760 hours) = $.222 per "KVAH"

1.31 Systems effeciency is
25.27 KVA ÷ 93.61 "KW" = 27%

1.32 It is estimated that the fuel used in the diesel MEPPs will cost $.40 a gallon.

1.33 Fuel consumption test on an NC-10 revealed the following:

60 KVA load for 1 hour = 60 KVAH
Fuel used = 5.5 gallons
Specific fuel consumption = 5.5 gal. ÷ 60 KVAH = .092 gal/KVAH
Cost per KVAH =$.092 X $.40 = $.0368

17.5 KVA load for 1 hour = 17.5 KVAH
Fuel used 4 gallons
Specific fuel consumption= 4 gal ÷ 17.5 KVAH = $.229 gal/KVAH
Cost per KVAH = $.229 X $.40 = $.0916

1.34 Appendix "G" of "Feasibility Study For A 400 Hz - 4160 Volt Three Phase Electrical Power Generation and Distribution System" Jaros Baum & Bolles gives the average load for starting and servicing a P-3C aircraft as 17.5 KVA. It will be assumed that when the NC-10 is operating that 17.5 KVA of 400 Hz power is being used.

1.35 3-M records indicate that each NC-10 is operated 30.7 hours per month. Four NC-10s are presently used to supplement the use of on-board APU (Auxiliary Power Unit) for aircraft system check out on the ramp East of Hangar 3. This area will be supported by the central system.

1.36 The average daily use per NC-10 assigned to the two squadrons is

30.7 hours per month ÷ 30 days = 1.02 hours per day

1.37 It can be deduced that each NC-10 assigned to a squadron supplied an average of 17.5 KVA for 1.02 hours each day.

1.38 The total power supplied by NC-10 each day is

17.5 KVA X 4 units = 70 KVA for a period of 2.6 hours daily

1.39 The average power supplied during the 1.02 hours operating period was 70 KVA from equipment with a capacity of

90 KVA X 4 units = 360 KVA

1.40 If the average power supplied during the 1.02 hours were spread out over a 24 hour day - 365 day year, the average power output would be

70 KVA X (1.02 hours ÷ 24) = 2.98 KVA

1.41 The yearly cost for diesel fuel to operate the four NC-10 is

4 units X 30.7 hours X 12 months X 17.5 KVA X $.0916 = $2362

1.42 The on-board APU is used extensively for ramp maintenance and system check out. Airline records for on-board APU of the same type used in the P-3 indicate that the APU fuel cost per hour is

35gph X $.36 per gal = $12.60

1.43 It is estimated that the APU of each aircraft on the ramp will operate an average of 1 hour per day to provide 400 Hz power exclusive of air conditioning. The yearly fuel cost for the 12 aircraft that are expected to occupy the ramp is

1 hour X 12 aircraft X 365 days X $12.60 = $55,188

1.44 If the average power supplied during the 1 hour period (17.5 KVA) were spread out over a 24 hour day - 365 day year, the average power output would be

(17.5 X12) X (1 ÷ 24) = 8.75 KVA

1.45 The total yearly cost of fossile fuel is

$2362 for NC-10 + $55,188 for APU = $57,550

1.46 Energy cost for plan "A" is

Electrical $49,202 + $57,550 Fossile fuel = $106,752

2.0 Plan "B" - Central System - Energy Cost

2.1 The 4160-208Y/120 volt utilization transformers associated with the central 400 Hz distribution system must be rated to provide adequate power for their areas of support. Transformer requirements will be as follows:

Location	Qty	Output Voltage	KVA Each	KVA Total
Hangar 1	2	208/120	30	60
1	5	208/120	60	300
2	11	208/120	60	660
3	1	208/120	30	30
3	9	208/120	60	540
Park Ramp	14	208/120	60	840
Bldg 49	1	208/120	60	60
300	1	208/120	60	60
513	1	208/120	60	60
548	1	208/120	60	60
	46			2640

2.2 Plan "B" will be required to support the loads now supported in Plan "A".

Installed motor generators	11.40 KVA
MMG-1 MEPPs in hangars	13.87 KVA
NC-10 MEPPs on ramp	2.98 KVA
Aircraft APUs	8.75 KVA
	37.00 KVA

2.2.1 Peak power requirements are considered to be 10 times the average power requirements, and are

37 KVA X 10 = 370 KVA

2.3 It is planned to use two 250 KW / 312.5 KVA, 4160 volt, 400 Hz power generating modules. Each module will be capable of continuous operation at 110% of rated capacity. The units will parallel when one unit reaches 80% of its capacity and deparallel when the load on the combination drops to 20% of their conbined capacities. It could be expected that the second power module will come on line about 1% of the time. If base loading in the future should require it, additional parallelable units may be added.

2.4 The step down transformer assembly network will be designed to have power lossesnot to exceed 0.2% of total rated capacities in supporting the average load.

2640 KVA XFMR cap. X .002 = 5.28 KVA

2.5 The 312.5 KVA power modules will be designed to have no load losses not greater 15% of their rated capacities.

312.5 KVA X .15 = 47 KVA

2.6 The power module losses are proportional to load, providing additional 15% losses at full load. The proportional losses are

37 KVA average load X .15 = 5.55 KVA

2.7 Continuous power losses are the losses of paragraphs 2.4, 2.5 and 2.6. and are

5.28 KVA + 47 KVA + 5.55 KVA = 57.83 KVA

2.8 To allow for additional losses when the second module is on the line for 1% of the time

57.83 KVA X 1.01 = 58.4 KVA

2.9 Total 60 Hz power consumption is based on the summation of 400 Hz power used plus 60 Hz power lost, and is

37 KVA of 400 Hz + 58.4 "KW" of 60 Hz = 95.4 "KW"

2.10 The yearly consumption of 60 Hz power to provide 400 Hz power is

95.4 "KW" X 24 hours X 365 days = 835,704 "KWH"

2.11 Based on the expected power cost of $.06 per KWH, the yearly cost of 60 Hz power to operate the central 400 Hz system is

835,704 "KWH" X $.06 = $50,142

2.12 The cost of useful 400 Hz power is

$50,142 ÷ (37 KVA X 8760 hours) = $.155 per "KVAH"

2.13 System effeciency is

37 KVA ÷ 95.4 "KW" = 38.8%

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3.0 <u>Energy Cost Comparison</u>

3.1	Plan "A"	Plan "B"
Average 400 Hz generated	37 KVA	37 KVA
Yearly 60 Hz consumed	820,028"KWH"	835,704"KWH"
60 Hz power cost	$49,202	$50,142
Fossile Fuel Cost	$57,550	--------
Total Energy Cost	$106,752	$50,142
Cost of useful 400 Hz	$.329 "KVAH"	$.155 "KVAH"
System Effeciency	18.3%	38.8%

4.0 Plan "A" - Continue Present Method - Maintenance Cost

4.1 Maintenance costs for fixed motor generators. including spare parts and overhaul, are based on the assumption that the average cost will be $100 per unit per month.*

* See Paragraph 3.1.8, Page 53 of "Feasibility Study--------"

4.2 NAS Moffett Field has 17 fixed installed motor generators involved in this analysis. The yearly maintenance cost is
17 units X $100 X 12 = $20,400

4.3 Yearly maintenance costs for spare parts replacement, major rework and loabor to maintain MEPPs was obtained from NAEC (Naval Air Engineering Center). The yearly maintenance costs are

MMG-1	16 units X $1,116 =	$17,856
NC-10	4 units X $5,393 =	$21,572
	Total	$39,428

4.4 Airline data indicates that it costs about $3.10 per operating hour to maintain on-board APUs. The maintenance cost is
12 aircraft X 1 hour X 365 days X $3.10 = $13,578

4.5 The total yearly cost to maintain 400 Hz generating equipment is the summation of the cost to maintain installed, mobile and on-board equipment, and is
$20,400 + $39,428 + $13,578 = $73,406

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5.0 Plan "B" - Central System - Maintenance Cost

5.1 Maintenance cost for components of the central system are estimated to be

2 -	250 KW, 400 Hz power modules @ $2,4500	$4,900
46 -	Step down transformer assemblies @ $10	460
5 -	5KV 400 Hz switchgear @ $125	625
	5KV distribution system	2,000
	120/208 volt distribution system	5,000
		$12,985

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6.0 Maintenance Cost Comparison

Plan "A"	$73,406	
Plan "B"	12,985	
	$60,421	Savings for plan "B"

7.0 Discounted Annual Cost

7.1 The discounted annual cost procedures are as presented in "Feasibility Study for A 400 Hz – 4160 Volt – Three Phase Electrical Power Generation and Distribution System" Jaros, Baum & Bolles, Consulting Engineers, February 1977, Contract No. 00025-76-C-001.

Electricity and Maintenance. From Table B – Present-Value Tables of Appendix D, NAVFAC P-442, the "Cummulative Uniform Series" the factor 7.980 is selected. (Inflation rate is not considered; Discount rate 10% annually for 15 years)

Fossile Fuel. From Table 7 of Appendix E, NAVFAC P-442, the "Cummulative Uniform Series" the factor is 12.278 is selected. (Inflation rate of 7%; Discount rate 10% annually for 15 years)

7.2 The discounted annual cost are

ALTERNATIVE "A"		ALTERNATIVE "B"
	Electricity	
7.98 X $49,202 = $392,632		7.98 X $50,142 = $400,133
Savings $7,501		
	Fossile Fuel	
12.278 X $57,550 = $706,599		None
		Savings $706,599
	Maintenance	
7.98 X $73,406 = $585,780		7.98 X $12,985 = $103,620
		Savings $482,160
	Discounted Annual Cost	
$1,685,011		$503,753

7.3 Discounted annual savings are
$1,685,011 - $503,753 = $1,181,258

7.4 Undiscounted annual savings are
($49,202 + $57,550 + $73,780 - ($50,142 + $12,985) = $117,405

Prepared by
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