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HQ AFESC/RDX

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		Rapid Runway Repair

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

This TOD describes the three Technical Planning Objectives developed to guide the conduct of research and development in passive defense techniques for the ~~threater~~ airbase, pavement studies, environmental pollution abatement and control, air mobility concepts, fire fighting equipment, and resource/energy conservation. Facilities aspects of Airbase Recovery and Rapid Runway Repair are also addressed.

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INTRODUCTION

The Air Force Technical Objective Document (TOD) program is an integral part of the process by which the Air Force plans and formulates a detailed technology program to support the development and acquisition of Air Force weapon systems. Each Air Force laboratory annually prepares a Research and Technology (R&T) Plan in response to available guidance based on USAF requirements, the identification of scientific and technological opportunities, and the needs of present and projected systems. These plans include proposed efforts to achieve desired capabilities, to resolve known technical problems, and to capitalize on new technical opportunities. The proposed efforts undergo a lengthy program formulation and review process. Generally, the criteria applied during the formulation and review are responsiveness to stated objectives and known requirements, scientific content and merit, program balance, developmental and life cycle costs, and consideration of payoff versus risk.

It is fully recognized that the development and accomplishment of the Air Force technical program is a product of the teamwork on the part of the Air Force laboratories and the industrial and academic research and development community. The TOD program is designed to provide to industry and the academic community, necessary information on the Air Force laboratories' planned technology programs. Each laboratory's TOD is extracted from its R&T Plan.

Specific objectives are:

a. To provide planning information for independent research and development programs.

b. To improve the quality of the unsolicited proposals and R&D procurements.

c. To encourage face-to-face discussions between non-Government scientists and engineers and their Air Force counterparts.

One or more TODs have been prepared by each Air Force laboratory that has responsibility for a portion of the Air Force Technical Programs. Classified TODs are available from the Defense Technical Information Center (DTIC) and unclassified/unlimited TODs are available from the National Technical Information Service (NTIS).

As you read through the pages that follow, you may see a field of endeavor where your organization can contribute to the achievement of a specific technical goal. If such is the case, you are invited to discuss the objective further with the scientist or engineer identified with that objective. Further, you may have completely new ideas not considered in this document which, if brought to the attention of the proper organization, can make a significant contribution to our military technology. We will always maintain an open mind in evaluating any new concepts which, when successfully pursued, would improve our future operational capability.

On behalf of the United States Air Force, you are invited to study the objectives listed in this document and to discuss them with the responsible Air Force personnel. Your ideas and proposals, whether in response to the TODs or not, are most welcome.

HOW TO USE THIS DOCUMENT

Unsolicited proposals to conduct programs leading to the attainment of any of the objectives presented in this document may be submitted directly to an Air Force laboratory. However, before submitting a formal proposal, we encourage you to discuss your approach with the laboratory point of contact. After your discussion or correspondence with the laboratory personnel, you will be better prepared to write your proposal.

As stated in the "AFSC Guide for Unsolicited Proposals" (copies of this informative guide on unsolicited proposals are available by writing to Air Force Systems Command/PMPR, Andrews Air Force Base, Washington, DC 20334), elaborate brochures or presentations are definitely not desired. The "ABCs" of successful proposals are accuracy, brevity, and clarity. It is extremely important that your letter be prepared to encourage its reading, to facilitate its understanding, and to impart an appreciation of the ideas you desire to convey. Specifically, your letter should include the following:

1. Name and address of your organization.

2. Type of Organization (Profit, Nonprofit).

3. Concise title and abstract of the proposed research and the statement indicating that the submission is an unsolicited proposal.

4. An outline and discussion of the purpose of the research, the method of attack upon the problem, and the nature of the expected results.

5. Name and research experience of the principal investigator.

6. A suggestion as to the proposed starting and completion dates.

7. An outline of the proposed budget, including information on equipment, facility, and personnel requirements.

8. Names of any other Federal agencies receiving the proposal (this is extremely important).

9. Brief description of your facilities, particularly those which would be used in your proposed research effort.

10. Brief outline of your previous work and experience in the field.

11. If available, you should include a description brochure and a financial statement.

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SECTION I

LABORATORY MISSION

The Engineering and Services Laboratory (ESL) (HQ AFESC/RD) is the lead Air Force agency for research, development, test, and evaluation for civil engineering and environmental quality technology. In support of the Director of Laboratories, HQ Air Force Systems Command, ESL is designated the laboratory focal point for environmental quality technology and the lead laboratory for facilities energy R&D.

The mission of ESL affects virtually all segments of the Air Force mission: readiness, airbase survivability, airfield maintenance, fire protection/rescue, facilities energy, and environmental quality. ESL programs support all of the AFSC VANGUARD mission areas. The technology to provide for the launch of mission aircraft under wartime contingency operations with follow-on repair of bomb-damaged runways is vital. Equally important are the technologies that enable our aircraft and support facilities, such as jet engine test cells, to meet environmental pollution standards and continue operation during peacetime. Also required are those technologies that provide for improved protective construction for air-mobile facilities. In the less esoteric area of day-to-day civil engineering operations, the technology to efficiently maintain our vast inventory of airfield pavements will greatly reduce Air Force Operation and Maintenance costs. In this era of scarce energy resources and budget austerity, the technology to conserve energy and find alternate energy sources is also crucial. All of these areas are served by this laboratory.

SECTION II

INVESTMENT STRATEGY

Our investment strategy is motivated by Public Law; VANGUARD; Program Management Directives (PMDs); Statements of Need (SONs); Technology Needs (TNs); Logistic Needs (LNs); major command and product division requirements; and identified technology gaps. Public law provides a major impetus for environmental research. A somewhat unique aspect in the establishment of priorities for our investment strategy is an annual Engineering and Services Requirements Board, where all the major command Deputies for Engineering and Services meet to review current R&D efforts and make recommendations for future thrusts.

Our major program thrusts for FY 84-88 are Rapid Runway Repair, Civil Engineering Technology, and Environmental Aspects of Advanced Weapons Systems.

The Rapid Runway Repair program will dominate our efforts into FY 89. The requirements for this high-priority effort are the Tactical Air Forces Statement of Operational Need (TAF SON) 319-79, and the NATO Standardization Agreement 2929. The technical issues to be addressed are: base recovery operations in a hostile environment; faster runway/taxiway repairs; surface roughness criteria for fighter and logistics aircraft; aircraft operations on alternate surfaces, and damage-resistant runways. The key technical areas focus on development of: a rapid damage assessment capability; advanced repair materials and equipment; damage-resistant pavements; and low-cost redundant surfaces. The payoff from this thrust will be the ability to rapidly recover airbases for combat sortie generation after a non-nuclear attack.

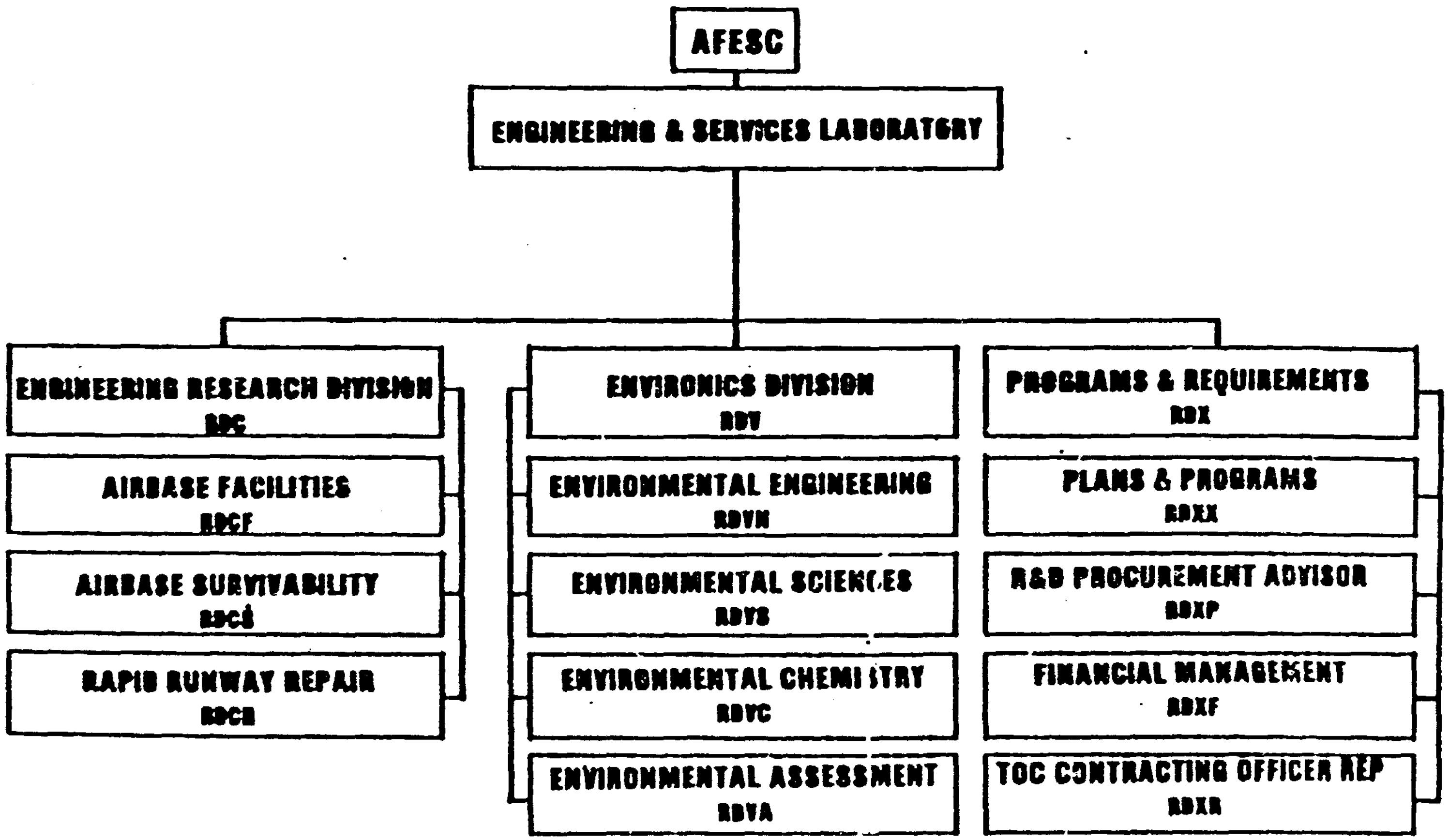
Our second major thrust, Civil Engineering Technology, deals with R&D in the areas of airfield pavements, airbase survivability, fire technology, and facilities energy. The technical issues to be addressed are: surface requirements for aircraft operations; prelaunch survivability of weapons systems; and multidimensional fire suppression. The primary capabilities which must be developed are, respectively, real-time evaluation of pavement condition, hardened airbase facilities, and an air-mobile fire suppression system. The payoffs from this thrust will be: increased operational capability; increased wartime sortie generation capability; and a combat firefighting capability. This thrust has been subsisting on minimal funding, due to the funding required for the high-priority Rapid Runway Repair program. We expect to substantially increase funding in FY 86 and beyond.

Our third thrust, Environmental Aspects of Advanced Weapons Systems, meets requirements of public law. As directed by Presidential Executive Order, the Peacetime Air Force must comply with federal, state, and local environmental regulations while conducting training and tactical missions, operating its support facilities, and deploying new weapons systems. This thrust area will address a number of technical issues. These issues include: environmental impact of Air Force fuels; technology for recovery and reduction of toxic sludges; facility treatment and decontamination of hazardous wastes; development of techniques for monitoring and modeling of toxic vapors; and development of environmental information exchange material for environmental impact analysis.

Our highest priority is to develop materials and techniques to increase the Air Force's wartime sortie generation rates. Our Rapid Runway Repair program, and airbase survivability efforts in our Civil Engineering Technology thrust support this goal. Major efforts will also focus on the early development of strategies and techniques to minimize the environmental impact of these programs. We are concentrating on weapons systems and associated support facilities, while emphasizing cost reductions.

Finally, we are committed to the development of a strong technology base in both environmental quality and civil engineering. Our environmental quality technology base will provide: methodologies and techniques for pollutant characterization; environmental assessment of pollutant transport, interaction, and ultimate fate; and pollution control methods to ensure peacetime mission accomplishment. We are just beginning to build a sound civil engineering technology base. This area has been long neglected and innovations made in the civilian research community have not been in areas where the Air Force has unique requirements, such as runway repair. We will move strongly into this area as soon as the necessary funding becomes available.

ENGINEERING & SERVICES LABORATORY



C. RESOURCES

AFESC provides all O&M support and manpower for ESL at Tyndall AFB while the host command, TAC, furnishes facilities support. Funding for our R&D program is provided by AFSC. The laboratory is currently authorized 104 people, of which 47 are scientific and engineering personnel. The laboratory fully occupies two base facilities covering 10,700 square feet, totally dedicated to environmental research and 6,200 square feet of office space, located in the modern Engineering and Services facility constructed in 1978. ESL also has a field test and evaluation facility, an enclosed simulated bomb crater site and an outdoor explosive crater site. Both sites match European soil and pavement conditions.

D. PROGRESS AND ACCOMPLISHMENTS

1. Environmental Quality:

a. Air Force Fuels.

This technology base program addresses the fate and effects of Air Force fuels in the environment. Fuels studied include aviation fuels such as JP-4 and JP-8, both petroleum-derived and syn-crude-derived; cruise missile fuels such as HP-10 and RJ-4; and space missile fuels sch as nitrogen tetroxide and the hydrazines. Studies have beenconducted in photochemistry, aquatic chemistry, and emissions research (both characterization and control) to develop a sound data base which will ultimately allow us to make environmental assessments, weigh trade-off decisions, and develop control strategies for Air Force fuels. Photochemistry studies were completed for a number of hydrocarbon fuels at both ground-level and high-altitude conditions (ESL-TR-81-53 and ESL-TR-82-38). These, coupled with fuel dumping studies (ESL-TR-81-13), provide the technology base for evaluating the fate and effect of aviation fuels in the atmosphere. Interactions of Air Force aviation fuels in water with soil sediments (ESL-TR-82-06) and the degradation of such fuels by microbial attack (ESL-TR-83-26) were studied. Impacts of fuel spills in water can now be assessed more readily and accurately. Considerable progress was made in measuring combustion emmissions characterization and sensitivity to fuel change. The chemical composition of the hydrocarbon emissions from a jet engine combustor rig was analyzed (ESL-TR-82-43). Tests are now being completed on two large engines with three different fuels. Diagnostic hardware was developed by Spectron Development Laboratories under subcontract to the University of California at Irvine to measure soot particles as small as 0.08 microns using an optical probe that does not interact with the flow or combustion processes. Work is ongoing to address the effects of fuel changes and additives on soot emissions. Studies were also completed on refrigeration and incineration techniques to control fuel-storage-tank emissions (ESL-TR-82-01 and ESL-TR-82-30). These were used in negotiating control strategies with the California South Coast Air Quality Management District.

b. Hazardous Waste.

DOD emphasis on hazardous waste management has grown signigicantly along with our R&D efforts to develop cost-effective technologies to control and decontaminate Air Force toxic wastes. In the area of groundwater decontamination, we completed testing of a full-scale prototype packed-tower air stripper at Wurtsmith AFB. This system reduced the influent trichloroethylene (TCE) concentration of 600 parts per billion (ppb) to a trace level. Operational use of this system has demonstrated a potential cost reduction of more than two-to-one over conventional activated carbon systems. This technology was expanded to include benzene. Despite the presence of iron, oils, and greases in the actual contaminated test waters, air stripping essentially removed the benzene. This is important for a POL-type cleanup since activated carbon has a very low capacity for hydrocarbons, making its use cost-prohibitive. While air stripping does not remove all hydrocarbons, it is a cost-effective alternative for the actual benzene component. At an increased number of USAF installations, groundwater contamination cleanup is such a complex problem that installation engineers and managers often lack the knowledge and experience to effectively address the technological and economic issues involved. To provide interim technology guidance to MAJCOM and base people, we published ESL Technical Report 83-39, Groundwater Contamination Response Guide. It provides the latest sampling methods, investigative techniques and remedial response options. Since decontamination of soils and aquifers is very expensive, research was expanded to develop in-situ treatment technologies to neutralize toxic effects of chemical and hazardous metal spills. In addition, sampling of dioxin contamination at several historical herbicide orange storage sites has been expanded, and in-situ decontamination research has focused on the dioxin problem. We made a signigicant breakthrough in industrial hazardous waste treatment by understanding the chemistry of ferous chromium reduction and the optimum use of ferrous and sulfide chemicals in the treatment process. Laboratory work shows that hexavalent chromium wastes can be reduced to the less toxic trivalent state and precipitated out without adjustment of pH and water point-source additions of ferrous and sulfide. This means significant reductions can be achieved in both the use of treatment chemicals and the generation of toxic sludges. To demonstrate that industrial waste treatment plant processes can be changed inexpensively to obtain the benefit of this new chemistry, pilot plant studies will be started at AFLC installations in FY 84. Work also progressed on pilot plant studies to evaluate the ability of adapted microorganisms to treat highly concentrated phenol wastes containing chromium. Results are so promising that the plant's technology is being considered in Kelly AFB's industrial waste treatment plant upgrade project, and for use at Hill AFB. Major research continues in hazardous waste recovery and reuse to develoop technology for extending use of strategic metals in electroplating operations while reducing the hazardous waste treatment requirements.

c. Assessment Technology.

Environmental assessment technology is applicable to air quality, toxic spill management, and hazard analysis. Its goal is the development of the technical base and assessment tools necessary to evaluate the impacts of Air Force operations. Monitoring of toxics/pollutants and modeling to predict and assess behavior in the environment comprise the major efforts. Emphasis is on the development of user-friendly models to accurately portray the environmental interactions of toxics/pollutants. During this period the Air Quality Assessment Model (AGAM), which comprehensively models all emission sources and their dispersion on an airbase, was transferred to the AF Occupational and Environmental Health Laboratory for field application. Jointly with the FAA, a handbook was developed to outline the detailed procedures for assessment of air quality at airports and airbases. Userfriendly routines were developed to accurately model emissions sources. Work has been initiated to develop an overall successor to AQAM that will be user-friendly. An onsite, mobile instrumentation package has been delivered and is being tested at a Titan II site to obtain real-time meteorological data for models which have been developed to provide real-time disperison modeling and hazard predictions for toxic missile fuel clouds. Work has progressed on detection instrumentation, especially for area/volume detection (as opposed to point monitors). Most promising is the development of laser remote sensing techniques using differential absorption light detection and ranging (DIAL). Work at Lincoln MIT Laboratory has demonstrated detection of carbon monoxide and ethyulene in the exhaust of an A-10 aircraft located 1.5 miles away from the apparatus. Average concentrations in the parts per billion range were measured. Similarly, other experiments using reference cells demonstrated a sensitivity to and capability of detecting hydrazine, unsymmetrical dimethyl hydrazine, and monomethyl hydrazine at concentrations of 20-60 parts per million over a 1-meter distance or 20-60 parts per billion over a 1-kilometer distance. Similarly, detection of HC1 has been demonstrated and backscatter of the natural aerosol in the tar has been measured. Results show that HC1 can be measured to detect a change in concentration of 1 part per million over 500 meters. A tunable laser source (a crystal diode laser using various frequency shifting techniques such as raman shifting in hydrogen gas, etc.) is being developed. This will allow detection of any desired species, i.e., a toxic, a pollutant, a chemical warfare agent, etc. Work is also in progress on increasing system sensitivity to both expand the range and allow greater resolution of the range.

2. Facilities Energy

a. Alternate Airfield Lighting:

The objective of our work in this area is to develop systems and technology for radioluminescent (RL) lighting. This lighting will assure the conduct of strategic and tactical operations at remote sites and bare bases. In FY 84 we are continuing to pursue advanced concepts and technologies in RL airfield lighting systems. During Brim Frost 83 RL lights for runway edge, threshold, and VASI systems were evaluated in Alaska. Results of this evaluation indicate that for large/fast aircraft, the system light intensity needs to be increased to provide a 4-6 mile acquisition range. Through continued research and development, our laboratory efforts have resulted in improvement to the first generation RL lighting intensity. In addition, a follow-on effort is currently underway for Artic OT&E of the second-generation radioluminescent runway edge, threshold and VASI lighting systems during FY 84 in Alaska.

b. Biomass:

Implementation strategies and techniques for a Biomass Energy Island (BEI) concept on a forested Air Force installation were developed (ESL-TR-83-04). This concept describes the ability of an installation to meet its facility-wide energy requirements for an indefinite period through the use of its own biomass resources without any external energy supply. The objective of this effort was to develop and recommend a cost-effective, pracical means of managing Air Force forested lands to supply quantities of wood required to support basewide biomass energy systems. This investigation provided a comprehensive technical-economic scenario for implementing the BEI concept at Eglin AFB, and supplied data which can be applied within the Air Force Facility Energy and Resource Conservation Program. It included an examination of biomass conversion systems; an identification of optimal timber management methods and forest land management practices; a determination of desirable methods and machinery for harvesting and transporting wood fuel; an estimation of BEI support costs and manpower requirements; an integration of the findings of preliminary studies pertinent to Eglin AFB as a BEI; and an identification of subject areas needing further investigation.

This study is the fourth in a series to explore the feasibility of developing a practical method of managing forested land on an airbase so that wood fuel can be provided to support a basewide biomass energy system. If found feasible, such a secure, renewable, local energy source could make an installation energy self-sufficient in the context of a Biomass Energy Island.

The study has explored the initial use of both a gasification/combined cycle biomass conversion system and a direct combustion co-generation system to compare the efficiency of each relative to anticipated energy consumption requirements. A companion approach studied the technology and economics of various industrial-sized wood energy systems available for generation of steam and/or electricity (ESL-TR-83-19). This study examined wood fuel combustion, handling and preparation equipment; wood gasification; retrofit of fossil-fuel boilers; cogeneration; pollution abatement; system economics; and procurement considerations. Ongoing efforts in 1984 will address an updated analysis of energy consumption at Eglin AFB and a revised economic analysis of biomass technologies proposed for use there.

c. High-Temperature Solar.

The Engineering and Services Laboratory recently completed an effort to support the operational test and evaluation of a 60-kilowatt/thermal point-focusing solar energy disk-type collector at Hill AFB, UT. The work included the acquisition and management of all services and equipment necessary to collect and analyze performance data, and to compare the collector system performance with that of similar plants. The solar plant demonstrated its general capability to deliver the desired energy product, displacing the consumption of fossil fuels. However, the unique seasonal dependence of solar energy systems and unusually poor weather conditions during the course of the experiment made it impossible to determine the capacity of the plant. It was found that System operability was high, and automated operation should be feasible, provided that a technician monitor the status of the plant on a daily basis. Compared with the earlier installation of a similar system, the project went smoothly. None of the plant failures were due to systemic causes. The study found that major problems were caused by the impact of weather on plant availablility and operation. The plant was down for 30 days because of failure of the drain down system. Additional downtime was also weather-related. We recommend that system designers consider weather-related impacts and experiences if the technology is to become generally acceptable to industrial users. The extra expense of a hot oil receiver and a heat transfer loop may ultimately be cost effective in comparison to the cost of fluid loop maintenance and plant downtime from water freezing.

d. Energy Security.

The Engineering and Sevices Laboratory has completed an investigation to identify long-term advanced technology approaches to minimize energy-related vulnerabilities of key air logistics facilities and processes. The investigaiton focused on the acitivities conducted at Hill AFB, UT; Kely AFB, TX; Robins AFB, GA; McClellan AFB, CA; Tinker AFB, OK; and Newark AFB, NJ. It includes a determination of the vulnerability of the exisiting domestic energy supply sytems feeding these facilities, identification and evaluation of critical activities (including processes, command, control and communication) and the associated energy flow at these facilities, evaluation of the flow of energy to and from utilities serving these facilities and identification of short and long-term energy technology needs to establish critical activity energy security. This work is part of a general multiyear effort to minimize potentially severe impacts on mission-related operational capability associated with the dependency of key Air Logistics processes on outside (particularly insecure) power sources. The energy supply and distribution systems at these installations were found to be highly vulnerable, with about 60 percent of all incoming power being mission essential. Only 10-30 percent of this mission-essential power can be backed up by onbase generation. The purchase of gas turbines is recommended to eliminate this condition at these installations. Follow-on efforts include a technical plan for developing sustainable power systems to support key AFLC processes and functions, the development of an energy vulnerability handbook for use by base-level engineers, and a broader use of the original effort, which is tentatively scheduled for application at a variety of other installations.

3. Postattack Launch and Recovery.

a. Bomb Damage Repair.

As a result of the analysis of the October 1982 multiple-crater repair test, an organizational structure and repair procedures for a Prime Beef team doing FOD cover repairs have been developed. The multiple-crater repair capability of the multifunction excavator was confirmed during extensive field tests in September 1983, using armored equipment. Final recommendations for crushed stone and FOD cover details have been made, and the first batch of covers for operational use will be fabricated under contract at Osan, Korea in April 1984. armoring kits for a front-end loader, dozer, grader and excavator have been fabricated and used on crater repair exercises. Final designs will be available by December 1983 for procurement when funding permits. Testing of 6-inch thick precast concrete slabs has shown that they can support F-4s, and field tests are planned for March 1984 to develop multiple-crater repair procedures. The development of materials for flush structural cap crater repairs produced two candidates that work over the required environmental range. Polyurethane was the candidate selected for further development. Placement equipment will be designed and fabrication of a prototype will begin in June 1984. We have completed the initial study of the mechanisms by which debris is lifted from the runway surface, is ingested and then damages jet engine components. Testing and computer simulations are continuing to determine the vulnerability of the F-4 to debris damage. If this analysis reduces the sweeping requirements for runway repair operations, it will be repeated for other fighter aircraft, starting in July 1984.

b. Alternate Launch and Recovery Surfaces (ALRS).

Siting studies to identify the locations of the most survivable redundant runways were completed in 1983 for Hahn and Spangdahlem ABs, Germany and Osan AB Korea. The reasons for the geometrical criteria used in runway construction have been examined, and less stringent criteria have been proposed to reduce the earthworks costs for redundant runways. The pavement construction methods of stabilized soil and compacted stone, both under a 2-inch thick layer of asphalt, have been extensively tested, and are the recommended construction methods for ALRS. Further testing is required to determine layer thicknesses for the recently announced heavyweight version of the F-15. Small-scale testing has been done to obtain baseline information on the resistance of conventional pavements to penetration by bombs. Further testing will continue in 1984 to determine the feasibility and likely costs of damage-resistant pavements.

4. Postattack Operations and Testing

a. Runway Surface Roughness.

Final Surface Roughness Criteria (SRC) have been completed for the F-15. The F-15 SRC defines repair quality standards and spacing criteria for aircraft weights up to 59,400 pounds. HAVE BOUNCE testing has been completed on the F-16 and A-10 and SRC development for both aircraft will begin after SRC development for the C-5A is completed in March 1984. The F-111 test program was cancelled due to the nonavailability of test aircraft; this means that the F-111 SRC will be completed without the benefit of a test program. Initial modeling work has been started on the A-7 and tentative plans have been made to conduct HAVE BOUNCE testing in FY 1984.

b. Postattack Environment.

The postattack environment area includes: development of an airfield damage assessment system (ADAS); integration of near-term damage assessment and minimum operating strip (MOS) selection procedures with ADAS; and, integration of developments by other agencies regarding explosive ordnance disposal (EOD), chemical agent defense and decontamination. An ADAS conceptual demonstration was conducted in January and February 1983 at Eglin AFB FL. The concept consisted of an infrared sensor on an airborne platform and a ground station (microprocessor and digitizing table). The concept demonstration was successful. An advance in sensor technology is required to fully meet the resolution requirements listed in TAF SON 319-79. The ground station proved to be adequately advanced in technology to justify an FY 1984 hardware procurement start and to begin full-scale development to upgrade the prototype software to operatinal status. The RRR task order contractor has completed the first phase of the integrated MOS selection procedures for multiple aircraft. Draft procedures have been delivered and are being prepared for development test and evaluation. Findings from these test results will be incorporated into the final version of the procedures. The second 2 phase of this effort will be to automate part of this procedure, using handheld, battery-operated microprocessors. A feasibility study was conducted to evaluate a method that would provide near-term improvement in airfield damage assessment capability by using hardened RRR equipment as an assessment vehicle. The results showed that the equipment can be used and provides several orders of magnitude increase in the survivability of assessment personnel. RRR teams in USAFE currently plan to use peacekeepers (armored personnel carrier) in their damage assessment procedures. An in-house effort will be initiated to combine the ongoing efforts of USAFE and AFESC to provide an Air Force-wide damage assessment procedure. Testing of RRR activities in chemical warfare protective ensembles continued at the Eglin AFB Prime BEEF Training Site.

5. North Field Validation Project

a. The Air Force's Rapid Runway Repair (RRR) Program passed another major milestone in its efforts to field fully tested methods allowing expedient postattack airfield operations. An AFESC RRR test of two alternate surface materials and two Bomb Damage Repair (BDR) methods was conducted at North Field, Shaw AFB, South Carolina. F-4 aircraft and F-4 load cart tests were conducted from 26-30 August. Additional load cart testing was accomplished with both F-4 and F-15 load carts in September.

b. Two alternate runway surfaces were tested, thin asphalt (2 inches of asphaltic concrete over 6 inches of crushed stone base) and stabilized soil (10 inches of soil stabilized with 7 percent portland cement). Two 50 by 100-foot test sections were constructed in July by members of the 823rd RED HORSE Squadron, Hurlburt Field Fl, under the direction of AFESC and the Army Waterways Experiment Station (WES). The thin asphalt construction used standard methods and equipment. The stabilized soil required removal of the soil, mixing soil and cement with a pulvimixer and replacing, remixing and compacting the soil in two lifts. Construction problems included excessive shoving of the top 2 inches of soil (during compaction of the top lift) and compaction of joints between paving lanes.

c. Two craters were explosively formed in the existing 6-inch portland cement concrete (PCC) runway by AFESC personnel. Two 15-to 20-foot apparent-diameter craters were formed (25-30 foot maximum repair diameter). Minimal upheaval around the crater was experienced, so repairs were essentially flush with the pavement. One BDR repair method used a polyurethane and fiberglass FOD cover. The second was with (German) 2-meter, precast concrete slabs. The FOD cover was over a base of debris and 18 inches of ballast rock choked with crushed stone. The base was compacted with a vibratory roller; the FOD cover was anchored with a newly developed low-profile bushing and modified WEJ-IT anchor bolt. The precast slab repair required removal of all debris. A high-speed saw cut the concrete to dimensions for repair with 4 by 5 slabs. The hole was filled with ballast rock and not compacted. A 2-to 4-inch leveling course of finely crushed stone (pea gravel) was placed on the ballast rock and hand-screeded to the required level. The slabs were placed in the crater on top of the uncompacted base materials. BDR work was accomplished by members of the 437th PRIME BEEF team from Charleston AFB SC.

d. An F-4C, from Eglin AFB's 4246 Test Wing, conducted operations on the test surfaces and repairs. The tests used reduced surface roughness criteria (75 percent of design limit), but contained severe test points of heavy braking, sharp turns, touchdown, and afterburner takeoffs over the surfaces. No problems were encountered with the F-4.

e. Several initial observations were apparent from the F-4 operations:

(1) The precast concrete slabs were quite effective at speeds greater than 40 knots, showing little vertical motion or horizontal movement.

(2) The precast slabs required some compaction of ballast base course. Without compaction, the slabs began sagging under only a few low speed passes (the underlying sub-base had been disturbed by the blast and both sub-base and ballast settled).

(3) The polyurethane FOD cover and new anchors appeared to be quite feasible for repairs in the touchdown zone.

(4) The thin asphalt did not show signs of major rutting or shoving, even during hot weather conditions.

(5) The stabilized soil can be a strong surface not susceptible to rutting, but requires a surface treatment to prevent damage from jet blast. Quality control during construction will probably necessitate using a pug-mill to mix the soil cement.

f. The tests were completed using F-4 and F-15 load carts to provide data necessary for designing new, low-cost alternate surface pavement systems, and to determine the actual methods of failure for BDR repairs. Preliminary data of all trafficking operations will be available in January 1984.

6. Facilities Engineering.

a. Airbase Survivability.

Analysis of the first series of blast tests for the semihardened wall structures has indicated that the NATO criteria of 2 percent steel ratio are unnecessarily conservative. A steel ratio of 0.5 percent or less will satisfy the structural requirements. The Series II Test is configured to provide solutions to the spalling problem; to lessen or eliminate its effect. The effect of berming, interior spall plate and increased wall thickness will be the parameters studied.

A study was initiated to develop a lightweight, easily erectable, cost effective, protective structure using hyperbolic paraboloid shell elements. Using composite materials of concrete, asphalt and an acrylic fabric, the Hypar structure shows excellent potential to resist blast loadings. The phase II effort will involve 1/5 scale blast testing, further dynamic analysis and refinements in the structural design.

Data have been collected and generated for functional area damage assessments of airbase assets critical to wartime sortie generation. These data will be used to prepare reliable survivability assessments geared toward identifying, prioritizing, and justifying specific levels of passive protection improvements for these critical airbase assets. Damage assessment analyses for two of the 10 assets selected have been completed. The remaining assets will be analyzed in the next year.

A study was initiated to determine the feasibility of small-scale modeling of penetration of kinetic energy penetrators into rock, soil, and concrete barriers. A modeling capability is desired to replace the costly full-scale testing conducted on supersonic sled tracks. The contractor, AVCO Systems Division, determined through a detailed dimensional analysis that strict geometric scaling is not valid for penetrations through rock rubble. However, it may be feasible to develop a small-scale modeling technique if the testing is designed to investigate specific phenomena occurring during penetration. Research was initiated to develop viable data for damage assessments of airbase assets critical to wartime sortie generation. This data will be used to prepare reliable survivability assessments geared toward identifying, prioritizing, and justifying specific levels of passive protection of a rock overlay designs with the addition of a reinforced concrete burster slab under the rock overlay. Continuing tests using howitzer-and sled-delivered weapons are being conducted at the Naval Weapons, China Lake, California test facility.

A study has been initiated to investigate the dynamic and static structural response and failure mechanism of underground reinforced concrete structures under a blast load of conventional high explosive weapons. An effort is being developed to characterize the constitutive relations for a cement product called New Inorganic Materials. This macro-defect-free cement will be subjected to various laboratory tests to determine its various static, dynamic, and penetration loading conditions.

We completed research to design and develop an optimal blast-absorbing structural system that will protect personnel, shelters, and equipment from devastation resulting from a conventional weapons blast. A computer model of the blast-absorbing structural system was programmed, simulating a weapons blast situation and verifying the assumptions with analytical results.

b. Mobile Tactical Shelters.

Work to support the development of lightweight armor for tactical shelters is anticipated. This requirement is currently under review by the Joint Committee on Tactical Shelters (JOCOTAS).

c. Pavements.

During FY 83, two very significant goals were achieved. A computer-oriented pavements maintenance management system, PAVER, was transitioned to AFESC/DEM and implemented (initially on a small scale) by three commands. Secondly, design and construction specifications for asphalt-rubber interlayers, to reduce reflection cracking in asphalt overlays, were made available to Air Force engineers. PAVER is now functional at all levels of command for determining optimum airfield pavement maintenance methods and frequencies. It will also project consequences in terms of increased pavement deterioration if maintenance is delayed. We are also particularly pleased with the progress of the study of asphalt modification during recycling. Hypothesis concerning chemical changes to aged asphalts and recycling agents were formulated in FY 83 and will be tested during FY 84 and 85. Other pavements research conducted during FY 83 concerned developing a model for heat transfer through asphaltic surfaces and wrapping up the laboratory portion of a study to produce fuel resistant binders for porous friction surfaces. Also during FY 83, field tests of a durable airfield marking composite of metal and ceramic was installed on the Elmendorf AFB, runway.

d. Fire Technology.

Current USAF firefighting equipment does not provide for rapid access to aircraft fires which occur in airframe voids where access ports are either limited or not provided. Various aircraft sizes, configurations, and the use of high strength metal alloys, make forced entry into these areas time consuming and difficult. A lightweight, hand-held, self-powered, aircraft penetrator device has been developed and is currently undergoing preliminary fire testing. The device will penetrate standard aircraft fuselages in 3 to 4 seconds and high strength alloys and honeycombs in 7 to 11 seconds; the device discharges Halon 1211 onto the base of the fire at 5.5 lbs per second. This penetrator will be used to extinguish interior airframe fires which are inaccessible to nozzled equipment currently available. It is estimated that the penetrator will significantly reduce aircraft damage sustained from inaccessible interior airframe fires. The recent decision to permit Intergrated Combat Turns in hardened aircraft. A contract has been awarded to design, contract and evaluate a detection/suppression system for HAS. This effort will result in a self-contained, combat-survivable, detection suppression system which will identify a fire, verify if it is an actual fire, and extinguish the fire within 15 seconds. Currently, firefighters cannot wear the proximity clothing and chemical warfare ensemble together. Present procedure is for the firefighters which will provide both fire and chemical agent protection. A CW undergarment for firefighters has been developed and is currently undergoing physiological tests at the Air Force School of Aerospace Medicine and operational testing at bases in Korea. This ensemble will not become chemically degraded when it becomes wet and will allow body heat to escape. The completed ensemble will also include a communications system and a breathing apparatus. The breathing apparatus will be capable of providing 2 hours of self-contained air or 6 hours of filtered air. Both the communication helmet system and breathing apparatus are in final prototype development and are expected to receive NIOSH approval in FY 84.

E. MISSED OPPORTUNITIES

Although we had a significant number of accomplishments, there were still a large number of missed opportunities due to funding limitations. the "squeaking wheel" syndrome demands that work supporting known (usually near-term) requirements be accomplished first. Little or no funding is left to be applied to areas where we need technology breakthroughs. Some of the areas in which revolutionary work was missed are:

Groundwater Modeling

Anaerobic Degradation of Hazardous Wastes

Surface Chemistry of Toxic Metals

Field Validation of Dense Gas Dispersion

Gas Turbine Engine Particulate Characterization

Hydrocarbon Fuel Spill Modeling

Advanced Construction Materials/Design

Nondestructive Test Methods

Pavement Recycling

Advanced Survivability Structures

Evaluation of millimeter waves for Airfield Damage Assessment

MOS Selection Procedures for Rapid Runway Repair

F-15 HAVE BOUNCE Tests for Rapid Runway Repair

Large Crater Test Facility for Rapid Runway Repair

F. SUMMARY

As the focal point for all Air Force Engineering and Services R&D, the ESL provides support to all MAJCOMs and AFSC product divisions. Research and development conducted by ESL addresses: rapid runway repair, facilities survivability, airfield pavement, environmental quality, civil engineering technology, facility energy survivability, energy conservation, and fire crash/rescue technology. ESL is vigorously pursuing advances in our areas of expertise and has indeed made significant progress in some areas. However, current RDT&E work in most areas is limited by inadequate facilities, R&D funding levels, and manpower constraints. Our current level of effort does not reflect the magnitude or severity of the problems we need to address. Specifically, (1) our funding, from Basic Research (6.1) through Engineering Development (6.4), is inadequate and, in terms of real spending power, is decreasing with time.

We need increases in manpower to support future technology requirements. Our capability to pursue research and technology in-house has been severely limited. A comprehensive manpower package to resolve this situation has been submitted for consideration during the FY 86 POM deliberations. The buildings housing our laboratory facilities are old, overcrowded, and outmoded. A new $4.7 million laboratory facility has been requested. Originally approved for the FY 83 MCP, it has been slipped to the FY 84 MCP, but construction is now expected to begin during the third quarter of FY 84. In summary, the research and development that the ESL has been tasked to perform is vital to the Air Force wartime and peacetime missions. To successfully meet these needs, we must have increased funding, more scientists and engineers, and a new laboratory facility. Without all three, solutions to critical Air Force deficiencies may not be achieved.

SECTION IV

RESEARCH PROGRAMS

An ESL 6.1 program has been established in Civil Engineering Technology to provide needed research in support of our Technical Planning Objective 3 (TPO-3) programs and is aligned with the Research Planning Guide, 1 February 1982. Major thrusts are in material mechanics, structural dynamics, soil mechanics and materials for construction. Past experience, particularly with Rapid Runway Repair (RRR), has shown that basic research in civil engineering is required to support advanced research and development programs. The major thrusts will support protective construction, future RRR and geotechnical engineering requirements. Initial emphasis will be in structural dynamics and materials research.

A. TASK 2307L1 TASK TITLE: Construction Materials

SUBAREA NUMBER AND TITLE: 6.4 Civil Engineering Technology

SPECIFIC GOALS:

1. Materials for Construction (RO 6.4.2) - Develop improved material for use as a pavement binder to decrease life cycle cost and dependence on petroleum-derived materials.

2. High Stress and Impact Loads (RO 6.4.5) - Develop improved materials for generic structural elements to withstand high-impulse loadings from weapon effects.

TECHNICAL APPROACH:

1. Materials for Construction (RO 6.4.2) - Experimental and theoretical investigations of new materials for composite materials, and material additives to provide higher strength materials to improve structural element response to high-impulse loading.

B. TASK 2307L2

TASK TITLE: Structural Analysis

SUBAREA NUMBER AND TITLE: 6.4 Civil Engineering Technology

SPECIFIC GOALS:

1. Structural Dynamics (RO 6.4.3) - Improve basic knowledge of structural response of generic structural components under high-pressure, short-duration dynamic loadings.

TECHNICAL APPROACH:

1. Structural Dynamics (RO 6.4.3) - Experimental and theoretical investigations of structural response and failure mechanics of construction materials and structural components under dynamic loadings.

C. PLANNED RESEARCH PROGRAMS

We are establishing a 6.1 program in environmental quality. This program will provide needed research in support of environmental quality development programs, and is aligned with the Research Objectives in Subareas 1.4 (Bioenvironmental Hazards), 6.5 (Environmental Aspects of Weapon Systems), and 5.2 (Airbreathing Propulsion) of the Research Planning Guide, 1 February 1982. Major thrusts are planned in abatement processes, predictions of environmental aspects, transport and impact mechanisms, measurement methodology, combustors, fuels, chemical emissions, and exhaust plumes. These thrusts will support development efforts in pollution control, environmental assessment, and monitoring of Air Force pollutants.

SECTION V

TECHNOLOGY PROGRAMS

ESL technology programs encompass three fields: (1) Environmental Quality, dealing with all areas and activites affecting or affected by air base development and operations; (2) Facilities Energy and Resource Conservation, dealing with facilities energy survivability, alternate energy sources for Air Force facilities, conservation of resources, and recovery of materials and/or energy from refuse; (3) Civil Engineering Technology, dealing with geotechnical engineering, rapid runway repair, protective construction, air mobility systems, facility corrosion, and fire protection systems. Detailed descriptions of the TPOs follow.

TABLE 1. TECHNOLOGY PLANNING OBJECTIVES AND PROJECT LISTINGS

The ESL technology areas and technology planning objectives are synonymous.

PROGRAM ELEMENT	PROJECT	TITLE	TPO
61101F	0100	Civil Engineering Technology	3
62601F	1900	Environmental Quality Technology	1&2
62601F	2673	Civil Engineering Technology	3
63723F	2103	Environmental Quality Technology	1&2
63723F	2104	Civil Engineering Technology	3
64708F	2054	Facilities Engineering Development	ALL
64708F	2505	Firefighting, Suppression and Rescue	3
64708F	2621	Rapid Runway Repair	3

A. TECHNICAL PLANNING OBJECTIVE 1: ENVIRONMENTAL QUALITY

1. General Objective and Investment Strategy:

The mission areas of Strategic Offense, Strategic Defense, Tactical Warfare, Recon/Intel, and Airlift all require operations during peacetime for training, and for development of tactics and equipment.

The objective of this technology is to give Air Force managers a rational basis for choosing environmentally safe weapons systems and facilities to insure continuous mission operations during peacetime. This is essential to comply with all federal environmental quality laws while developing and maintaining the required USAF mission support activities.

A long-range integrated environmental RDT&E program will keep the Air Force from having to react to crisis situations which could stop or impede the basic national defense and delay critical system acquisition or mission accomplishment. Research and development in environmental quality is critical to prompt and realistic evaluation of environmental considerations and meeting operational requirements.

2. Specific Goals and Technical Approaches:

The principal goal is to provide technology to eliminate or reduce the generation of physical, chemical, and biological pollutants that adversely affect human health or welfare, and ensure compliance with environmental regulations. This will enable USAF to maintain readiness while allowing field deployment of new weapons systems and permitting realistic and unimpeded peacetime training and operations. This should give AF managers the information needed to make valid environmental assessments and determine trade-offs and strategies for new weapons systems and AF-unique operations.

The technical approach is to investigate, understand, and model the basic phenomena underlying the pollution generation, transport, and control process. This includes identifying the source and character of significant emissions; evaluating pollutant life cycle interactions; defining environmental mechanisms which control transport and chemical reactions; developing control, detection, monitoring, disposal, recovery, recycling and abatement technology; and, finally, addressing environmental assessment and impact evaluation techniques using a systematic interdisciplinary approach for decision making.

Technology will be developed under each of three major task areas. Each task area has major supporting subtasks.

a. Air Force Fuels

Atmospheric Photochemistry

Aquatic Chemistry

Emissions Research

b. Hazardous Wastes

Recovery and Reduction

Treatment Technologies

Facility Decontamination

c. Assessment Technology

Modeling of Toxic Vapors

Environmental Quality Models

Environmental Information Network

Remote Sensing

The general criteria to be followed in carrying out the R&D efforts are as follows: (1) Develop the technology and hardware necessary to assess, control and/or abate pollution from operations, facilities, or equipment unique to the Air Force; thus meeting applicable environmental standards where operations or equipment may be adversely restricted or impacted because of lack of commercial solution; (2) Develop data pertinent to Air Force operations to serve as the basis for new standards or criteria, or modify existing standards or criteria that appear to be based upon inadequate data; (3) Develop R&D programs to make present pollution abatement technology more timely and cost effective; (4) Engage in R&D efforts necessary to evaluate and extend the technology base in a specific pollution-abatement area where Air Force has unique expertise or equipment not available to the civilian community. Criteria 1 and 2 are most important, and, in all cases, the Air Force will participate in joint R&D efforts with organizations engaged in mutually beneficial environmental projects.

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B. TECHNICAL PLANNING OBJECTIVE 2: FACILITIES ENERGY

1. General Objective and Investment Strategy:

Research, development, and investment in this area provide the technology base and hardware development for application of advanced power systems for C3 and long-term missile basing and for alternate sources such as waste-derived fuels and coal-oil mixtures for Air Force facilities. The development of technically feasible, cost-effective, military-applicable design criteria and specifications for these technology applications must be in accordance with Congressional legislation and directives, Executive Orders, and Environmental Protection Agency mandatory guidelines and DOD directives.

Development of alternate power systems to sustain readiness requirements and support the wartime mission of the next-generation underground basing systems for ICBMs and C3 are vital to the Air Force mission. Also, the development of renewable and/or alternate energy sources is essential to reduce dependence on limited fossil-based fuels. Continued reliance on petroleum, particularly from foreign sources, will result in increased susceptibility to energy shortages, ultimately challenging the Air Force's ability to fulfill its mission requirements. In addition, costs for petroleum products continue to rise rapidly, making it increasingly expensive to operate Air Force facilities. The ultimate goal of this technology area is to provide acceptable facility energy resources to meet the Air Force operational mission and to reduce maintenance costs through energy self-sufficiency consistent with national environmental and energy policy.

2. Specific Goals and Technical Approaches:

The principal goal of the facilities energy area is to provide technology that will lead to recommended advanced and/or alternative energy systems to maximize energy self-sufficiency for all Air Force facilities.

The technical approach is to investigate suitable advanced power systems for C3 and long-term basing via the following general steps:

a. Operational Mode Assessment.

The initial step will be to determine the peacetime and wartime operational mode of the next-generation C3 and ICBM support systems. Emphasis will be placed on quantification of electrical power and termal load requirements, including primary and backup/alternative energy supplies needed during normal operating conditions and in periods of exigency/mobilization. This step will be carried out in close consultation with AFRCE-MX/BMO and other military personnel and organizations as appropriate.

b. Threat Assessment.

The second step will be to quantify the current and potential threat environment in which the next generation C3 and ICBM systems will operate. This assessment will include sabotage, vandalism, severe climate, seismic and other geologic events, conventional weaponry, tactical nuclear weaponry, and strategic nuclear weaponry. The objective of the assessment is to develop data and information pertaining to survivability requirements of hardware and systems for supplying, converting and transmitting/distributing energy to and within the ICBM system.

c. Performance Requirements Determination.

The third step will be to quantify the performance or functional requirements of energy systems, subsystems and components within the Operational Mode Threat Matrix. Particular attention will be placed on identifying broad spectrum performance requirements which can provide sustained, highly reliable energy support throughout the expected life cycle of the C3 and ICBM systems.

d. Technology Assessment and Forecast.

The fourth step will evaluate current and emerging technologies for supplying energy to the C3 and ICBM systems. Performance requirements identified in the third step of the investigation will be considered an envelope within which potentially feasible energy technologies will be grouped. This step will include the following:

(1) Energy sources, including hydrogen fuel, methanol fuel, and geothermal energy;

(2) Conversion Systems, including fuel cells, nuclear/ radioisotope generators, advanced engines (Brayton, Stirling, etc.), Rankine cycle conversion systems, cogeneration systems;

(3) Transmission/Distribution Systems, such as hardware, fiber-optic, steam/hot water pipes, etc.

This fourth step will identify current and emerging systems that can meet the predetermined performance requirements this stop will, as applicable, determine development, research, demonstration and proof-of-concept needs of energy systems, subsystems and components before they can be considered feasible within the performance requirements envelope. This step will consider both primary and backup/alternative energy systems. It will also include special environmental/health constraints such as heat sinks, humidity control, noise/vibration, oxygen supply, and radiation exposure and safeguards.

e. Environmental Controls for Sophisticated Electronics Processes.

The fifth step is to develop procedures and techniques which provide adequate efficient environmental control systems to protect and optimize the effectiveness of sophisticated electronics systems. While the primary emphasis should be directed at underground and ICBM basing control centers, investigations will also include other confined USAF areas/environments also experiencing humidity and/or temperature problems that adversely affect sophisticated electronic control systems.

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C. TECHNOLOGY PLANNING OBJECTIVE 3: CIVIL ENGINEERING TECHNOLOGY

1. General Objective and Planning Strategy:

Civil Engineering Technology addresses a broad family of technical disciplines of which soil mechanics, engineering materials, structural analysis, engineering mechanics, and fire science and technology form subsets. Broad goals are to provide advanced civil engineering technology to worldwide elements of the Air Force to support day-to-day operations and wartime readiness. These goals contribute to all VANGUARD plans associated with real property facilities in support of all Air Force mission areas.

A long-range RDT&E program is needed to meet operation and maintenance requirements for unique problems with Air Force real property facilities. In addition, the changing threat posed by the Warsaw Pact makes research and development essential a continuing upgraded Air Force readiness posture worldwide.

Achievement of these goals will provide for reduced operating costs, improved mission response, and readiness posture.

2. Specific Goals and Technical Approaches:

Two major thrust areas have been established under which technology will be developed. Each thrust area has major supporting tasks.

a. Postattack Launch and Recovery (PALR) Thrust.

The overall goal for this thrust is to develop the capability to (1) launch mission aircraft from a bomb-damaged airfield within 1 hour after attack via alternate, unconventional surfaces, and (2) rapidly repair a segment of a bomb-damaged airfield to permit sustained aircraft operations within a few hours after attack. The aim of research and development in the rapid runway repair area is to develop technology to provide a radically improved launch surface repair system for support of tactical and logistical air operations in a sustained conventional conflict. The major tasks in this thrust are:

(1) Bomb Damage Repair. The goal of this task is to develop methods to rapidly repair pavements damaged by the full range of conventional (non-nuclear) weapons (i.e., from aircraft cannon fire to large iron bombs). Promising repair techniques are identified analytically, then initially tested on simulated craters at the Small Crater Test Facility using a mock-up of a typical European runway. The structural capacity of the various materials and repair systems is evaluated by the use of F-4 and C-141 load carts, which produce aircraft gear loads up to the maximum allowable weights of 27,000 pounds and 142,000 pounds, respectively. Repair systems selected are optimized (time, manpower and equipment) and validated by full-scale tests on actual craters created by explosives.

(2) Alternate Launch and Recovery Surfaces: The goal of this task is to develop contingency surfaces which will provide a higher probability of having useable launch and recovery surfaces available after an attack

on the airfield. Two primary concepts will be investigated: (1) increasing the redundancy of aircraft-operating surfaces by constructing additional low-cost surfaces, and (2) damage-resistant pavements. New technology is required for both approaches. Feasibility studies have been conducted and designs will be tested. Validation of developed surfaces will be conducted by tests with operational aircraft.

(3) Surface Roughness. The goal of this task is to determine how rough the aircraft launch and recovery surface can be without causing a mission failure (structural damage to the aircraft, causing it to lose its external stores, or causing the pilot to lose control). The rougher the allowable aircraft operational surface, the less time it takes to repair the surface and the quicker the surface can be used by aircraft. The approach is to (1) develop computer codes to simulate aircraft dynamic response over the surface, (2) field-test the aircraft to validate the code, and (3) use the validated code to develop surface roughness criteria. Five tactical fighter aircraft (F-4, F-15, F-16, F-111, A-10), and three cargo aircraft (C-130, C-141, and C-5) will be evaluated.

(4) Postattack Environment. The goal of this task is to develop techniques to rapidly assess damage after an attack and to develop a post attack action plan which states the timely actions that should take place following an attack. Also, under this task the EOD and CBW requirements associated with RRR will be identified to the DOD agencies responsible for R&D work in these areas. R&D work by these agencies will be monitored to insure that the RRR requirements are met.

b. Aerospace Facilities.

The overall goal in this thrust area is to insure sustained support for aircraft operations and other base missions and functions on a worldwide basis. The major supporting tasks are:

(1) Airbase Survivability: A specific goal is to provide a broad technology base for development of airbase passive defense measures to survive the effects of chemical, biological, and conventional weapons. Passive defense measures include hardened protective facilities, dispersal and mobility, camouflage, obscuration of target areas, chemical/biological protective facilities, and redundancy. Current efforts are concentrated on hardened facilities, tactical shelters, and CB protection facilities. During FY 83, we will complete the development of protective designs to meet current NATO semihardened facilities criteria, continue development of antipenetration systems for future threats to hardened facilities, and establish technology base programs in unconventional structural components for hardened structures, test modeling and load definition. Advancement in protective shelters offers significant opportunity for cost savings and improved survivability of strategic and tactical weapons systems. Such studies will continue in FY 83 and in future years as AFESC continues to meet unique requirements in structures and soil mechanics. Knowledge of airbase vulnerability to enemy threats will be maintained through airbase vulnerability studies in conjunction with AD/YQ. Threat assessment of airbase vulnerability will continue with periodic in-depth studies. Airbase passive defense studies will be accomplished in-depth and interim criteria will be published as they become available. Achievement of defined goals deters enemy attack and assures survival if that attack should come.

(2) Mobile Tactical Shelters. Goals for air mobility systems are aimed at improving the tactical or mobile shelters which the Air Force uses to support worldwide contingency operations. These shelters now house most forward-area electronic systems and provide temporary working and living space during rapid deployments of weapons systems and personnel in support of airlift, tactical warfare, strategic defense and reconnaissance missions. Beginning in FY 81, all work in the area was reviewed and approved by the Joint Committee on Tactical Shelters (JOCOTAS). USAF tactical shelter RDT&E requirements were forwarded by the Electronic Systems Division (ESD) for inclusion in the DOD program. AFESC will continue to perform R&D functions as requested and funded by JOCOTAS. Currently, no work is in progress; however, R&D work on development of lightweight armors for tactical shelters is anticipated. This requirement is currently under review by the JOCOTAS. The Shelter Management Office at ESD is the AF focal point for requirements and will provide the mechanism for technology transfer.

(3) Airfield Pavements. Specific goals are to provide criteria, materials, and technology to assure that all airfield pavements can support current and future Air Force flying missions in a safe and effective manner. Airfield pavement systems are essential to strategic offense and defense, tactical warfare, and airlift missions. In many cases, current airfield pavements are beyond their functional life, resulting in increased FOD, roughness, and tire wear in the aircraft. Such pavement deterioration is placing increasing manpower and financial burdens upon Air Force civil engineering. During FY 84, studies will continue to focus on recycling asphalt concrete pavement materials (63723F/2104) from pavements that are no longer functional. These recycling studies will reduce O&M costs and are supported by Public Law 94-580, "Resource Conservation and Recovery Act of 1976." Using materials from the existing pavements will help assure that AF O&M monies are being spent in the most efficient manner. In addition, studies seeking remedies to three serious airfield problems; fuel spills and rubber buildup on runways and reflection of base pavement cracks through asphaltic overlays will all be conducted through FY84. It is important to assure that the airfield pavement system is compatible with the high-value, high-performance aircraft that operate from them. Achieving these goals will greatly enhance the mission capability of the Air Force.

(4) Fire Protection. Fire protection and detection for Air Force real property as well as aircraft fire/crash rescue may be the most important technology in this thrust because this technical area impacts all Air Force mission areas. Goals are to provide for the earliest possible detection of fire in Air Force structures such as housing units, dormitories, hospitals, and warehouses. Improved firefighting equipment and agents, and rescue equipment are mandatory to protect high-value weapons systems and eliminate loss of life. During FY 83 -FY 87, efforts will continue toward improving firefighting agents, agent systems, training equipment, and vehicles. In FY 84, equipment developed was continued to increase fire suppression capability under reduced manning levels. Development of mixtures of firefighting agents which increase effectiveness will also continue. In FY 82, development of an improved aircraft rescue tool was initiated. This tool will replace the majority of manual and hydraulic tools now in use. Also in FY 82, the development of a selective extinguishing device with alarm reporting capability

was begun. This device can detect, report, and extinguish computer cabinet fires in their incipient stage. The most significant feature of this task is the development of a firefighter training simulator analogous to that used in flight training. Such a simulator will improve firefighter efficiency, reduce costs associated with live fire training, reduce equipment wear and maintenance, and reduce environmental complaints as a result of smoke generation from fire. The continued rise in the value of real property and aircraft systems demands forceful pursuit of these goals. The saving of one life or one aircraft will more than amortize the cost of the fire protection RDT&E program.

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D. PROGRAM RELATIONSHIPS

The three technology planning objectives (TPOs) established by ESL are: Environmental Quality (TPO-1), Facilities Energy and Resources Conservation (TPO-2), and Civil Engineering Technology (TPO-3). Close coordination with R&D programs of Army and Navy laboratories is done through the Joint Services Civil Engineering Research and Development Coordinating Group (JSCERDCG) on a regular, formal basis. This prevents duplication of effort and makes for maximum utilization of laboratory expertise and capabilities. Air Force civil engineering requirements are further defined and identified through the Air Force Engineering and Services R&D Requirements Council.

1. TPO-1 -Environmental Quality:

DOE and EPA dominate federal participation in this area. The objective of the ESL Environmental Quality Program is to investigate and provide the technology base to meet federal and state environmental regulations and solve environmental problems. The intent is to ensure that deployment of Air Force weapons systems and the operation of our facilities do not cause unnnecessary environmental degradation and that the ability of the Air Force to accomplish its peacetime mission is not compromised by delays from environmental litigation. ESL is the Air Force Systems Command Laboratory focal point for environmental quality research and coordinates this research with other DOD and federal agencies. Particular areas of interest are environmental chemistry and monitoring of Air Force pollutants, pollution control technology, and environmental assessment technology.

2. TPO-2 -Facilities Energy and Conservation:

DOE accounts for the majority of energy R&D. DOE is currently engaged in the full spectrum of energy R&D ranging from nuclear power production to methane production from waste. To date the vast majority of DOE work has been aimed at commercial-scale (considerably oversized for Air Force applications) energy systems. ESL and the Aeropropulsion Laboratory (APL) are the Air Force organizations responsible for conducting Research and Development in terrestrial energy systems. ESL is the AFSC lead laboratory for Facilities Energy and Resources Conservation research, including renewable/alternate energy sources, and remote-site energy requirements. APL is the lead laboratory for mobile, unattended, and special power functional areas. These and the programs of the other services are coordinated through tri-service working groups, the facility energy subcommittee of the JSCERDCG, and the Interagency Advanced Power group composed of Army, Navy, Air Force, NASA, and DOE representatives. Attendance at regional meetings, workshops and seminars provides interface with other governmental agencies and the private sector.

3. TPO 3 -Civil Engineering Technology:

Research and development in this area is conducted by the Air Force Weapons Laboratory (AFWL) and ESL. AFWL efforts are concerned with a nuclear weapons environment. ESL efforts apply a broad family of technical disciplines, such as soil mechanics, engineering materials, structural analysis, engineering mechanics and fire science and technology, to Air Force survivability in a non-nuclear environment. Work on tactical shelters is coordinated through the Joint Committee on Tactical Shelters and the Shelter Management Office at ESD. Work on rapid repair of bomb-damaged runways is coordinated with our foreign allies in NATO. Work on routine aerospace facilities operation such as airfield pavement maintenance is coordinated with the user through the Air Force Engineering and Services Requirements Board, conferences and workshops. ESL research is conducted through contracts with universities and industry, and joint efforts with the Army, Navy and FAA.