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ENGINEERING AND SERVICES LABORATORY FY 84 TECHNICAL OBJECTIVES DOCUMENT

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HQ AFESC/RDX

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		Rapid Runway Repair

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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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This document has been reviewed and is approved for publication.

Francis B. Crowley III

FRANCIS B. CROWLEY III, Colonel, USAF
Director, Engineering and Services Laboratory

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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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ENGINEERING AND SERVICES LABORATORY

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 impacts virtually all segment of the Air Force mission: readiness, air base survivability, airfield maintenance, fire protection/rescue, facilities energy, and environmental analysis. 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 properly maintain the vast amounts of airfield pavements will materially aid in reducing 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 crucial. All of these areas are served by this laboratory.

INVESTMENT STRATEGY

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 provide the motivation for our efforts and investment strategy. Public law provides a major impetus for environmental research. A somewhat unique feature of our prioritization process for 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 which must be addressed in this thrust 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 in which advances must be made to solve these issues are rapid damage assessment, 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 after a non-nuclear attack for combat sortie generation.

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 which are being addressed are surface requirements for aircraft operations, pre-launch survivability of weapons systems, and multi-dimensional fire suppression. The primary deficiency in each area which must be solved are real time evaluation of pavement condition, hardened airbase facilities, and an air mobile fire suppression system, respectively. The payoffs from this thrust will be increased operational capability, increased wartime sortie generation capability, and a combat fire fighting 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 directed by public law. During peacetime operations, as directed by Presidential Executive Order, the 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 the environmental impact of Air Force fuels; the technology for recovery and reduction of toxic sludges; facility treatment and decontamination of hazardous wastes; developing techniques for monitoring and modeling of toxic vapors; developing environmental information exchange material for environmental impact analysis; emissions, properties of alternate fuels, decontamination of groundwater, Herbicide Orange decontamination and dense gas dispension characteristics.

Our highest priority is to develop materials and techniques to increase the Air Force's wartime sortie generation rates. Both 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 their environmental impact. We are concentrating on weapons systems and associated support facilities, and 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 their transport, interaction, and ultimate fate; and 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 the innovations that have been 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.

DIRECTOR'S ASSESSMENT

ORGANIZATION. The Air Force Engineering and Services Center (AFESC), an extension of the Air Staff, is a Separate Operating Agency (SOA) established in 1978 and located at Tyndall AFB, Florida. The Engineering and Services Laboratory (ESL) is a directorate of the AFESC which operates under a Memorandum of Understanding (MOU) with AFSC and functions as a Systems Command Laboratory. Under this MOU, AFESC provides ESL with manpower, facilities and O&M funding. All research and development (R&D) funding and program direction are provided by AFSC. The mission of ESL is to plan and execute research, development, test and evaluation (RDT&E) in the areas of civil and environmental engineering. The ESL is currently organized into three divisions. There are two technical divisions: the Engineering Research Division (RDC) which conducts all civil engineering RDT&E; and the Environics Division (RDV) which conducts all environmental RDT&E. The third division, Programs and Requirements (RLX), is responsible for the corporate planning and management of the laboratory. This organizational structure is reflected in the diagram on the following page.

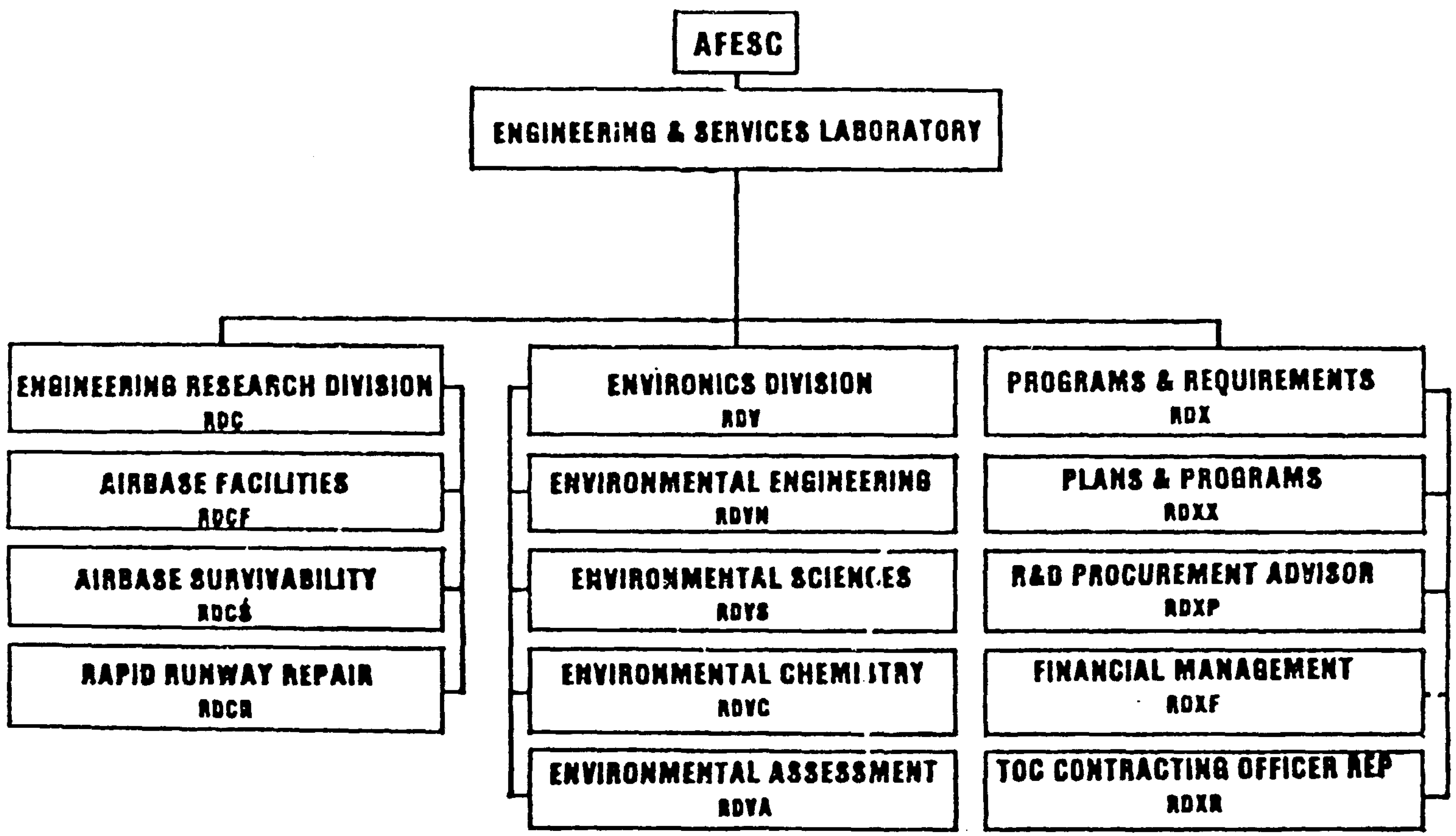
MISSION. The ESL scientific and technical mission stems from key roles assigned to Air Force Engineering and Services in military operations. These include: force beddown--both weapon systems and forces; emergency repair of war damage; operation and maintenance of facilities and installations; crash rescue and fire suppression. ESL has also been designated as the Air Force focal point for environmental research and is the lead laboratory for facilities energy research.

This mission directly impacts every aspect of Air Force operations. Dramatic improvements in post attack launch and recovery and airbase survivability are required to improve the Air Force in-theatre sortie generation rates. Significant improvements in our airbase pavements, including evaluation and management techniques, are required to insure the Air Force will be able to afford the repair/replacement costs. Improvements in ability to preserve and protect our airspace and airfield operability as well as ensure compliance with applicable federal, state, and local environmental regulations are essential for the Air Force to continue its peacetime operations unhampered. Finally, major changes in sources and amounts of energy the Air Force uses in its facilities must be developed to preclude soaring costs and prevent the United States from becoming a virtual hostage to the petroleum-producing nations.

The rapid advancement and continuing evolution of weapons systems mandate a search--that goes far beyond the state-of-the-art in industry--for breakthrough advances in the aeas of materials, methods and equipment required to assure availability and operability of the launch platform in the employment of airpower.

RESOURCES. ESL is part of the Air Force Engineering and Services Center (AFESC), a tenant on Tyndall AFB, Florida. AFESC provides all O&M support and manpower while the host command, TAC, furnishes facilities support. Funding for our R&D program is provided by AFSC. The laboratory is currently authorized 104 personnel, of which 58 are scientific and engineering personnel. The laboratory fully occupies two base facilities covering 10,700

ENGINEERING & SERVICES LABORATORY



square feet which are totally dedicated to environmental research; 6,200 square feet of office space is 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.

PROGRESS AND ACCOMPLISHMENTS.

1. Environmental Quality:

a. Alternate Aviation Fuels. The objective of this effort is to evaluate the environmental consequences of current and future synthetic jet fuels in the Air Force. Responding to a mandate from the South Coast Air Quality Management District to control vapor emissions from JP-4 storage tanks, we have developed a vapor condensation method which has demonstrated a 90 percent removal efficiency. This refrigeration unit recovered 1200 gallons in the first month of operation at March AFB. Extensive investigations have been completed involving the effects of aircraft fuel dumping. Findings will have a direct impact on fuel dumping policy and procedures in Europe where JP-8 is extensively utilized. Additionally, range-resolved laser technology was utilized to measure C-130 exhaust plume visibility. This effort resolved a major discrepancy between the Air Force design goal and EPA regulations which resulted in an engine development cost avoidance of $1 million and potential hardware cost saving of more than $16 million. Major research is continuing in the fields of atmospheric photochemistry, aquatic chemistry, and emission research to develop a sound data base which will ultimately allow us to make environmental assessments, weigh tradeoff decisions, and develop control strategies for alternate aviation fuels.

b. Hazardous Waste. Efforts in this area are aimed at analyzing the effects of toxic and hazardous materials and devising techniques to reduce and/or treat such materials in a cost-effective, yet environmentally sound, manner. This year, we published a report on methods to reduce the quantity of sludges produced at industrial waste treatment plants. Application of these techniques resulted in a cost savings of over $90,000/year at Tinker AFB and will result in an estimated cost avoidance of $12 million in the building of the new IWTP at Tinker. Next, we have completed installation of a full scale prototype packed tower air stripper to remove TCE from groundwater at Wurtsmith AFB. This prototype system is currently being tested to optimize air-to-water ratios and to determine operational and maintenance considerations. Initial indications are that the air stripper will save at least $200,000/year if used in conjunction with activated carbon filters and may save up to $600,000/year if the carbon filters can be removed. This technology demonstration will be of tremendous value at other sites with solvent contamination problems. In the area of hazardous waste recovery/reduction, we have assisted Hill AFB with the installation of a full-scale filtration system to recycle paint stripper. Currently in operation, this system is expected to save $50,000/month in operating costs and the capital cost of the system will be amortized in only four months. Additionally, a small scale solvent recovery system has been constructed at Tyndall AFB to recycle PD-680 solvent. Payback of the capital cost of this system is possible in approximately one year. In the area of treatment technology, we will soon be finishing an evaluation of an isolated and adapted organism that has the potential of treating phenol which is being discharged in large quantities as a result of aircraft paint stripping operations at Tinker AFB. In the field of site decontamination, the laboratory continues to conduct semi-annual sampling of Dioxin contamination at several Herbicide Orange storage sites and is beginning efforts to investigate in-situ chemical or biological degradation methods for eventual site restoration.

c. Assessment Technology. Environmental assessment technology is applicable to air quality, toxic spill management, and hazard analysis. We have completed a comprehensive analysis of existing air quality models and data bases used by the Air Force. Compatibility and short comings were evaluated and technology and data gaps were identified. This study is being used as the basis for developing a revised, advanced state-of-the-art, user-oriented air quality model by 1984. In the area of toxic spill management, several efforts are underway which will ultimately merge into a real-time display model with appropriate corrections for dense gas effects. This model will be used in the management of toxic spills that result from Titan II, MX, or Space Shuttle operations. Finally, we have developed a hazard analysis model for use by range commanders to optimize use of test ranges for firing of existing or future weapons. More than 74 ordnance impact descriptors, or "footprints" showing hazard contours have been developed. This model will directly benefit most air-to-ground weapon training ranges used by our Tactical Air Forces.

2. Facilities Energy

a. Fuels. Our fuels thrust develops the capability for the Air Force to use a multitude of conventional and alternate fuels in its large central and smaller, typically unattended and dispersed, heating and power systems. Our work is aimed at giving the Air Force the capability to take advantage of cost-effective fuels as they enter the market in the future, and to sustain airbase operation when conventional fuel supplies might be disrupted. Our primary emphasis in this area involves refuse-derived fuels (RDF). During the past 12 months, three technical reports have been published by the Engineering & Services Laboratory and one by the Occupational and Environmental Health Laboratory signaling the completion of four major technical milestones. These technical milestones consist of a determination of boiler performance and efficiency, high boiler load emissions, low boiler load emissions and conveyability of RDF and RDF/coal mixtures. Additionally, a technical effort to determine the management impact of cofiring RDF and coal is also complete. Our work in fuels is the cornerstone of a recent commitment by the Air Force to procure fifty thousand tons per year of RDF at Wright-Patterson Air Force Base for use in its coal plants. Energy obtained from firing RDF at Wright-Patterson AFB alone is providing half of all Air Force energy obtained from alternative fuels and projections are that this trend will continue. In FY 83-84, our RDF work is being directed at a comprehensive systems, integration effort and final report. In essence, this report will be a users guide providing overall recommended criteria and specification for firing RDF in new and converted military-scale heating and power plants. Also in the fuels thrust area, a technical effort was completed by ESL assessing the potential for using innovative biomass energy conversion technology to sustain total annual facility energy requirements on forested airbases. Work is continuing in the area of forested land management and it is anticipated that a small scale wood energy conversion system will be installed and evaluated on an Air Force installation within the next several years.

b. Remote Site Systems. The objective of our work in this area is to develop systems and technology to assure the conduct of strategic and tactical operations at remote sites and bare bases. In FY 83 we are continuing to pursue advanced concepts and technologies in airfield lighting systems. Alternative energy taxiway and runway distance markers have been installed at Tyndall AFB and have been locally evaluated. In addition, a statement of work is complete and coordination is underway for Arctic OT&E of radioluminescent runway edge and threshold lighting and a VASI landing system during Brim Frost 83 in Jan/Feb 83 in Alaska.

c. Weapons Support Systems. The objective of this thrust area is the development and utilization of electromechanical technology to directly support aerospace weapons systems. At this time, work is underway to determine the vulnerability of critical processes at our Air Logistics Center during energy and fuel supply disruptions. In accordance with the information derived from this assessment, a technical plan will be derived to develop sustainable Air Force facility power systems to support critical mission requirements.

d. Strategic C3 Energy. The objective of this thrust is to identify and recommend alternative power systems to sustain readiness requirements and to support the wartime mission of the next generation deep underground basing system for ICBMS and other fixed-facility strategic C3 systems. At this time, a technical approach has been formulated and coordinated with AFRCE-MX, however, funding is not available at present to accomplish this effort.

e. Management Technology. Here, the objective is to provide technology for planning, implementing and managing in-place, new and modified advanced aerospace facility energy systems. In support of this objective, the Department of Defense Energy Optimization Model was recently completed. This R&D effort was sponsored equally by the three services and has resulted in the development of a computer-assisted strategic planning tool for DOD utility managers to assist in prioritizing energy conservation programs and to rapidly assess the benefits of renewable and advanced energy technologies.

3. Postattack Launch and Recovery.

a. Bomb Damage Repair. A Prime BEEF team, equipped with Basic and Supplemental equipment kits, completed the simultaneous repair of 6 craters and swept a 5000 ft MOS during a test in October 1982, in under 3-1/2 hours. This is an improvement on 3 craters in 4 hours with a Basic team but requires more manpower and equipment. The potential for improvement in performance without additional manpower using a modified excavator was demonstrated in November, 1982. Work continued on the modification of crater repair cap materials, with a number of placement tests being done in rain and using wet aggregate. The work on external initiation of the start of curing of furan polymers was completed. Heat initiation showed some potential; but, the time of cure was too long for RRR purposes. Equipment manufacturers were invited to suggest development of special equipment the rapid placement of crater structural cap materials. Responses are expected in early 1983. Ballistics tests were conducted to test the effectiveness of different types of armor being considered for RRR equipment. Armor protection for 5 pieces of equipment were designed and one Case W24C front-end loader was fitted with armor to be evaluated during 1983. Testing continued to optimize the thickness and materials that can be used as a base course for crater repairs. The testing of foreign object damage (FOD) covers included tailhook impact tests. Final recommendations are expected early in 1983. Small scale tests showed many incidents of runway debris being lofted by an F-4 nose wheel. Full-scale, high speed tests will be done in 1983. Analysis work on flow fields around jet engines and the susceptibility of engines to damage caused by ingested debris has started.

b. Alternate Launch and Recovery Surfaces (ALRS). A program to validate existing computer prediction routines for aircraft operating on soil surfaces was continued with the flight dynamics laoratory. Slow speed tests using an instrumented F-4 aircraft were completed at McClellan AFB in July 1981. Based on these tests, aircraft insrumentation and data collection methods were improved and incorporated in the latest series of tests. These tests were accomplished at Kelly AFB TX during September-October 1982. The Kelly Tests focused on higher aircraft speeds than those achieved at McClellan, although slow speed tests were also conducted. Actual field data are now being compared with the computer predictions and program modifications will be made if required. The Naval Air Engineering Center conducted a study to identify potential problems encountered with aircraft arrestments on bomb damage repaired and alternate launch surfaces. A list of critical factors and parameters was developed and further testing is planned for 1983. A new study was initiated with the Flight Dynamics Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB. The object of the study was to determine the difference in the tire/surface friction for various ALRS and BDR surfaces. The surfaces will be tested under various simulated environmental conditions. These results will be used in the final ALRS design considerations. A new effort was initiated with the Waterways Experimental Station to develop a portable taxiway system which can be installed much more rapidly than current systems. The new system will be used for access to the minimum operating strip when permanent, pre-existing routes are damaged or destroyed. ALRS personnel continued to monitor and participate in the development and evaluation of the Mobile Aircraft Arresting System (MAAS). It is anticipated that a follow-on test program will be funded through ASD and managed by AFESC. A new subtask was initiated in March, 1982, with the task order contractor to optimize siting of redundant surfaces at specific airbases in Germany and Korea. The first phase of this effort was development of generic methodology to perform the optimization. This phase was followed by analysis of Hahn AB, Germany, and Osan AB, Korea. The Naval Weapons Center, China Lake, CA, conducted a study to evaluate damage to existing airfield pavements. The study, Phase I, was initiated in November 1981, and was completed July, 1982. Phase II is a follow-on, small-scale test phase, to obtain baseline data required to identify concepts/methods to harden pavements. The most promising concepts will be developed based on the results of these tests. An 18-month program was completed by Purdue University, West Lafayette, Indiana, studying soil reinforcement using geogrids and geotextiles. Plans are being made to perform testing of geotextiles under F-4 loads when funds become available. An 18-month program was initiated in January 1982, with the Waterways Experimental Station (WES) to determine the optimum asphalt pavement design that can withstand limited aircraft loadings, after long-term environmental exposure. Load cart testing of newly constructed sections at WES and existing pavements at Wright-Patterson AFB and Whiteman AFB demonstrated the ability of thin asphalt pavements to support F-4 aircraft loading. Optimum asphalt mix will be determined in 1983. A 13-month program was initiated in April 1982, with the University of Illinois at Champaign to develop chemically stabilized soil redundant surface designs. Test sections have been constructed at WES to be load cart tested in early 1983. A 9-month effort was initiated in June, 1982 with the BDM Corporation to establish geometric design criteria and study sortie generation capabilities of contingency runways. Criteria have been recommended and will be forwarded to Air Force agencies for comments. Computer modeling of ALRS geometric layouts to achieve standard sortie launch and recovery rates will be accomplished in 1983. An 18-month effort was initiated in December 1982 with the BDM Corporation to accomplish planning and engineering for aircraft testing of redundant surface designs and development test and evaluation of a full-scale alternate runway. Alternate surface test sections will be constructed and tested with aircraft in 1983. The full-scale alternate surface will be constructed at a site in Europe later.

c. Runway Surface Roughness. Final surface roughness criteria has been produced for the C-130. Interim surface roughness guidance has been completed for the F-15, F-16, and A-10. With the exception of the first 500 ft of the minimum operative strip, which requires high quality repairs, these aircraft are more tolerant of surface roughness than the F-4. HAVE BOUNCE testing has been completed on the F-15 and C-5A. The F-16, A-10, and F-111 HAVE BOUNCE tests are under contract and are scheduled for completion in FY 83. Surface Roughness Criteria development will be completed for the F-15 and C-5A by September 1983.

d. Postattack Environment. The postattack environment area includes: development of a rapid damage assessment system; integration of developments by other agencies regarding explosive ordnance disposal (FOD), chemical agent defense and decontamination; and development of a comprehensive post attack action planning guide to help base-level planners in recovering the installation. A conceptual definition contract and Type A specification were completed on the Airfield Damage Assessment System (ADAS). The Technical Reconnaissance SPO (ASD/PWTC) also conducted preliminary tests of thermal infra-red sensors at Eglin AFB in March, 1982. A conceptual demonstration of ADAS is scheduled for January 1983. Field tests of ground damage assessment systems were conducted in May 1982 at Kirtland AFB, New Mexico. The manual damage assessment systems were intended as near-term solutions to improve current field capability and serve as back-up to the ADAS. The alternate systems included an electronic position locator "man-pack" system, various procedural techniques using conventional electronic surveying equipment, and a manual estimating technique which relied on no other equipment. The field tests showed that the man-pack and electronic surveying system did not significantly reduce the total assessment time over manual techniques. Consequently, the manual technique was recommended as the standard and no further work on the improved manual damage assessment systems was conducted. The Civil Engineering Research Facility completed a software effort for Minimum Operating Strip (MOS) selection which incorporates aircraft surface roughness criteria for the first time. The final technical report for the MOS software effort was published in December 1982. The software code was delivered to AFESC for analytical work and to ASD for the airborne assessment system. A new effort was initiated through the task order contractor to develop integrated MOS selection procedures for multiple aircraft. The procedures will be manual techniques for field application and algorithms could serve as a framework for further software efforts. Testing of RRR activities in chemical warefare protective ensembles continued with major exercises conducted at the Eglin AFB Prime BEEF Training Site. The tests quantified the degree of auxiliary cooling required to delay heat stress casualties due to thermal loading from the CW suit. Additional task degradation tests were conducted throughout the year to develop data for RRR computer models and repair time estimators. An effort was completed to define the climatic conditions prevalent in Europe and Korea which may impact RRR activities.

4. Facilities Engineering.

a. Airbase Survivability. In response to a request from NATO to investigate construction criteria for semi-hardened wall structures, a series of blast tests were conducted on a variety of subscale wall designs. Based on this initial series of tests, indications are that the current NATO design criteria may be unnecessarily conservative. A detailed analysis is in progress and a second series of tests is planned to validate conclusions. At the request of PACAF, a study was conducted to determine the feasibility of providing an advanced protective shelter for E-3A aircraft. The threat considered in the study was similar to that used for the third generation aircraft shelter. A dynamic analysis conducted against the preliminary design indicated that this design may be satisfactory but further analysis will be necessary to verify this assumption. Due to the extremely high cost to construct such a shelter, no further analysis is planned without a specific requirement from the field. A study was initiated to determine the feasibility of small scale modeling the 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 penetration 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 improvements for these critical airbase assets. This year's efforts were devoted to clearly defining wartime sortie requirements and collecting data to conduct damage assessment analyses of the most critical assets. The actual damage assessment analysis will be started in the second year of the project. We have initiated an effort to develop an in-house capability to conduct dynamic structural analysis of facilities against conventional weapons effects to support USAFE and PACAF air base survivability programs. Six structural analysis computer codes have been installed and evaluated on the AFESC computer to identify their capabilities and limitations as tools to determine the survivability of specific protective structures under a prescribed level of threat. This in-house capability has been exercised several times and has proven quite valuable. In order to stay abreast of technology, new codes will be installed and evaluated as they become available. We initiated an effort in 1982 to develop a scaling technique to define the blast parameters in soil and concrete media from near field explosions of conventional weapons. During Phase I, the contractor completed a literature search and dimensional analysis to determine limiting parameters. During Phase II, the contractor completed a blast test series using a centrifuge. The test data collected under the increased gravity conditions of the centrifuge coorelated well with tests conducted in a 1-G gravity field. The centrifuge permits very small-scale structural testing for a wide range of weapons; allows repeated testing with only minor refurbishment; and achieves geometric, kinematic, and dynamic similitude between the model and prototype. In late FY 82, we conducted tests to determine the survivability and repairability of an in-shelter POL distribution pipeline system to meet the NATO threat. Four simulated pipelines were placed at varying distance from threat weapon. Two pipelines exposed in the crater were severely deformed but intact. The welded stainless steel pipe displayed a high degree of survivability to underground blast effects. A more versatile type coupling is required for a more expedient type repair condition. Also in 1982, we began investigations to develop protective antipentration systems for hardened facilities in Europe and the Pacific. Several tests are continuing on the use of a rock overlay designs with the addition of a reinforced concrete burster slab under the rock overlay. Continuing testing using howitzer and sled delivered weapons are being conducted at the Naval Weapons, China Lake, California test facility. Finally, in 1982, we initiated 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 will be programmed simulating a weapons blast situation and verifying the assumptions with analytical results.

b. Mobile Tactical Shelters. Currently, no work is in progress; however, R&D work on 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. Development and implementation of PAVER, the data storing and processing tool for the Airfield Pavement Management System, progressed through FY 82. A PAVER training course for the MAJCOM engineers was held in August and several commands have initiated implementation procedures. TAC and AFLC have actually accomplished implementation. FY 83 is expected to see the implementation of PAVER at six Air Force installations. Laboratory testing of Fuel Resistant Porous Friction Surface materials have identified products which appear to be resistant to damage from fuel spills. Field tests were conducted on the most economical binder candidate and preparations were completed for test sections to be laid in preparation for tests to be conducted in FY 83. A state-of-the-art survey of portland cement concrete recycling has been published, recommendations have been incorporated into a future project for which prices have been solicited. A six-year study was started in March to obtain criteria for selecting asphalt concrete recycling agents from a chemical perspective. A stress absorbing membrane interlayer (SAMI) of asphalt rubber was installed under an apron overlay in FY 81. The construction report and laboratory tests on duration of mixing time were completed in FY 82. In FY 83 complete SAMI design construction criteria will be developed. A durable airfield marking material which is a composite metal/ceramic has been developed and will be field tested in Alaska and PACAF during 1983. Preliminary studies have indicated that substantial life cycle savings can be achieved using this material to replace painted markings now in use. An evaluation of Air Force applications for the Non-Contact Deflection and Profile Measuring System was completed. While the system has tremendous potential, further development and improvement is required. An on-going study of heat transport during in-place surface recycling of asphaltic concrete is primarily funded by the AFOSR. This is the third year of the project but the first in which the Air Force has participated. 1982 work was to determine the thermal properties of asphaltic concrete and prepare for in-service testing to correlate previous lab work with actual conditions at Air Force installations. A stress wave generating non-destructive test system for airfield pavements was placed in operation during 1982 and is currently undergoing field evaluation by AFESC. Finally, development of a new aircraft barrier impact pad has been completed which will greatly increase the life of our barrier impact pads. Substantial runway maintenance cost savings will result from the installation of this new system Air Force wide.

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 to these areas time consuming and difficult. A contract has been awarded to design, construct, and evaluate a prototype penetrator to forceably gain entry and extinguish fires in these areas. The penetrator will be lightweight, hand-held, self-powered, and used as an auxilliary piece of equipment on the AS-32/P-13 air field ramp firefighting vehicle. This penetrator will be used to extinguish interior airframe fires that are inaccessible to nozzled equipment currently available. It is estimated that the penetrator will significantly reduce aircraft damage sustained from inaccessible interior fires. The requirement for oxygen to be carried on board military aircraft posed a significant increase in the fire hazard when aircraft are involved in accidents. The inadvertent release of oxygen in several recent military aircraft incidents involving fire have significantly increased the complexity of fire management and extinguishment of these type fires. The present method of mass application of Aqueous Film Forming Foam (AFFF) has failed to control these type fires. This FY 82 start will define the optimum fire suppressant and quantity required to extinguish fires in an oxygen enriched atmosphere inside a crashed airframe. Currently, firefighters cannot wear the proximity clothing and chemical warfare ensemble together. Present procedure is for the firefighters to remain in their vehicles wearing the ground ensemble and use exterior turrets to extinguish fires. This is required because once the current chemical warfare ensemble becomes wet, it loses its effectiveness against CW agents. A project is underway to develop an improved fire/chemical protective ensemble for firefighters which will provide both fire and chemical agent protection. 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 two hours of self-contained air or eight hours of filtered air.

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. There is little or no funding left to be applied to areas where we need technology breakthroughs. Some of the areas in which revolutionary work was missed are as follows:

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

Simplified MOS Selection Procedures for Rapid Runway Repair

F-15 HAVE BOUNCE Tests for Rapid Runway Repair

Large Crater Test Facility for Rapid Runway Repair

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 85 POM deliberations. The buildings housing our laboratory facilities are old, overcrowded, and outmoded. A new laboratory facility has been repeatedly requested. It was approved for the FY 83 MCP, but has been slipped to the FY 84 MCP, and now may be deferred until FY 85. In summary, the research and development that the ESL has been tasked to perform is vital to the Air Force wartime as well as peacetime mission. In order 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.

RESEARCH PROGRAMS

An ESL 6.1 program has been established in Civil Engineering Technology. This program was initiated 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.

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.

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.

PLANNED RESEARCH PROGRAMS

We are establishing a 6.1 program in environmental quality. The environmental quality 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.

TECHNOLOGY PROGRAMS

ESL technology programs encompass three fields: Environmental Quality, dealing with all areas and activites affecting or affected by air base development and operations; 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; 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
	2673	Civil Engineering Technology	3
63723F	2103	Environmental Quality Technology	1&2
	2104	Civil Engineering Technology	3
64708F	2054	Facilities Engineering Development	ALL
	2505	Fire Fighting, Suppression and Rescue	3
	2621	Rapid Runway Repair	3

TECHNICAL PLANNING OBJECTIVE

TPO 1: ENVIRONMENTAL QUALITY

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 the development of tactics and equipment.

The objective of this technology is to provide Air Force managers with the tools for making rational choices among alternatives in the design of future weapons systems and facilities to insure continued uninterrupted mission operation during peacetime in accordance with federal environmental quality laws, conservation of resources, and the development of facilities and services required to support Air Force activities. It includes all areas/activities affecting or affected by air base development and operational missions.

A long-range integrated environmental RDT&E program will preclude the Air Force from reacting to crisis situations which could stop or detract from the basic mission of national defense and result in delays in critical system acquisition or mission accomplishment. For environmental considerations to be evaluated realistically and promptly so as not to impede the overall decision making process, research and development in environmental quality is critical and operational requirements cannot be met without it.

SPECIFIC GOALS AND TECHNICAL APPROACHES:

The principal goal is to provide technology that will eliminate or reduce the generation of physical, chemical, and biological pollutants that adversely affect human health or welfare, and ensures compliance with environmental regulations, thereby maintaining readiness, allowing fiel' deployment of new weapons systems, permitting realistic and unimpeded peacetime training and operations. This should provide AF managers with the information needed to make valid environmental assessments and determine tradeoffs 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.

Three major task areas have been established under which technology will be developed. 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 the pollution emanating from operations, facilities, or equipment unique to the Air Force; thus meeting applicable environmental standards in situations 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 standards or criteria where none exist, 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 has equipment that is not available in 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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TECHNOLOGY PLANNING OBJECTIVE

TPO 2: FACILITIES ENERGY

GENERAL OBJECTIVE AND INVESTMENT STRATEGY:

Research, development, and investment in this technology area provides 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 technicallv feasible, cost-effective, military-applicable design criteria and specifications for these technology application must be in accordance with Congressional legislation and directives, Executive Orders, 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 is of paramount importance 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.

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 will have the capability of providing 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, fiberoptic, steam/hot water pipes, etc.

This fourth step will identify current and emerging systems capable of meeting the predetermined performance requirements and 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: 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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TECHNOLOGY PLANNING OBJECTIVE

TPO 3: CIVIL ENGINEERING TECHNOLOGY

GENERAL OBJECTIVE AND INVESTMENT 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 essential 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 to provide a continuing upgraded Air Force readiness posture worldwide.

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

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. Post Attack 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 one 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 which will provide a radically improved launch surface repair system to support tactical and logistical air operations in a sustained conventional conflict. The major tasks in this thrusts 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 are 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. There are two primary concepts which 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) using the validated code, 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. Post Attack 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 task are:

1. Airbase Survivability: Specific goals are 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 in the areas of 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 future years as AFESC continues to receive 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 be a continuing effort with periodic in-depth study. Airbase passive defense studies will be accomplished in-depth with interim criteria published as it becomes available. Achievement of defined

goals will serve as a deterrent to enemy attack and assure 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 as well as 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 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. Current airfield pavements are beyond their functional life in many cases which is resulting in increased FOD, roughness, and tire wear in the aircraft. Such pavement deterioration is placing rapidly increasing manpower and financial burdens upon Air Force civil engineering. During FY 82, two important long term goals were achieved. A total system for the nondestruction testing of pavements to determine load carrying capacity (64708F/2054) was transitioned to HQ AFESC/DEM evaluation teams. Secondly, a pavement maintenance management system (63723F/2104) was fully validated. This system will be functional at all levels of command for determining optimum airfield pavement maintenance methods and frequencies. It will also project consequence in terms of increased pavement deterioration if maintenance is delayed. During FY 83 thru 86 studies will continue to focus on reducing the costs of runway markings, improving barrier cable impact pads, and recycling pavement materials (63723F/2104) from pavements that are no longer functionally satisfactory. These recycling studies will reduce O&M costs and are supported by Public Law 94-580, "Resource Conservation and Recovery Act of 1976." Achievement of all these goals will assure that all AF O&M monies are being spent in the most efficient manner. Lastly, there will be full assurance 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 well be the most singly important technology in this thrust. 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, effort will continue toward

improving firefighting agents, agent systems, training equipment, and vehicles. In FY 83 equipment development will be undertaken to increase fire suppression capability under reduced manning levels. Also, development of mixtures of firefighting agents which increase effectiveness will 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 will have the capability of detecting, reporting, and extinguishing 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 cost 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 demand forceful pursuit of these goals. The saving of one life or of one aircraft will more than amortize the cost of the fire protection RDT&E program.

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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.

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.

TPO-2 -Facilities Energy and Resources 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 sub-committee 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.

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.