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Corps of Engineers Technology Adoption Processes (CETAP) Study, Volume II: Unabridged Report

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Many of the processes used to identify, assess, and incorporate new technologies into U.S. Army Corps of Engineers (USACE) practice are ad hoc, or task-specific and not standardized. Therefore, it is difficult to accurately assess USACE performance in this regard. This report summarizes a study by the U.S. Army Construction Engineering Research Laboratories (USACERL) of USACE pro-cedures for the identification, assessment, and adoption of new technologies. The two basic adoption mechanism types are described: general case mechanisms and project-specific mechanisms. A questionnaire was developed to assess these mechanisms, to identify problem areas, and to establish a benchmark for USACE performance in adopting new technologies. Comparisons of performance were made with outside government and private industry organizations that also completed the questionnaire. Suggestions are presented for improving USACE procedures for incorporating beneficial new technologies into construction operations. The aggressive identification, development, exploitation, and adoption of new technologies will help USACE maintain its excellence in providing the customers and the nation with the best value for their investment.

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Many of the processes used to identify, assess, and incorporate new technologies into U.S. Army Corps of Engineers (USACE) practice are ad hoc, or task-specific and not standardized. Therefore, it is difficult to accurately assess USACE performance in this regard. This report summarizes a study by the U.S. Army Construction Engineering Research Laboratory (USACERL) of USACE procedures for the identification, assessment, and adoption of new technologies. The two basic adoption mechanism types are described: general case mechanisms and project-specific mechanisms. A questionnaire was developed to assess these mechanisms, to identify problem areas, and to establish a benchmark for USACE performance in adopting new technologies. Comparisons of performance were made with outside government and private industry organizations that also completed the questionnaire. Suggestions are presented for improving USACE procedures for incorporating beneficial new technologies into construction operations. The aggressive identification, development, exploitation, and adoption of new technologies will help USACE maintain its excellence in providing the customers and the nation with the best value for their investment.

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LTC David J. Rehbein is Commander of USACERL and Dr. L.R. Shaffer is Director.

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CORPS OF ENGINEERS TECHNOLOGY ADOPTION PROCESSES (CETAP) STUDY: UNABRIDGED REPORT

1 INTRODUCTION

Background

The construction industry is perceived to change only in a slow and evolutionary manner. The introduction, acceptance, and widespread use of innovative materials or methods traditionally takes considerably longer in the construction industry than, for example, in electronics or medicine. It may take several decades for new building materials to capture a significant share of their potential markets; plywood, gypsum wallboard, and PVC pipe are well recognized examples.

The identification, assessment, and adoption of important new or alternative technologies in the construction missions of the U.S. Army Corps of Engineers (USACE) is most important in assuring that USACE continues to provide quality cost effective facilities. This has been an objective of Headquarters, U.S. Army Corps of Engineers (HQUSACE), for many years.

Two issues confront the Corps relative to the use of new or alternative building technologies in Army construction: (1) the ability to adopt such technologies within the existing USACE environment of regulations, engineering guidance, and standard practice, and (2) the ability to assess the effectiveness of USACE technology adoption procedures, both in an absolute sense and compared to other consumers of facility design and construction services.

Many of the processes currently used to identify, assess, and adopt cost-effective alternative technologies into USACE practice are ad hoc, or task-oriented and not standardized. Therefore, it is difficult to accurately assess USACE performance in this regard. Also, given the enormity of the Army's infrastructure and the comparatively small funding available to modernize and maintain it, the aggressive identification, development, exploitation, and adoption of improved technologies offers the Army the opportunity to "do more with less." The Corps must actively promote the use of new materials and technologies that can lower construction costs or improve the durability of facilities. The Corps of Engineers Technology Adoption Processes (CETAP) Study was initiated to address these issues.

Objective

The overall objective of this study is to make detailed recommendations on how the Corps can improve its procedures for the identification, assessment, and incorporation of new and alternative construction technologies.

Approach

The following tasks were established to accomplish the intended objective:

1. Development of an HQUSACE technology-based point of contact directory;

2. Provisions of an inventory of all mechanisms used by USACE for adopting new or alternative technologies into practice;

3. Establishment of a USACE technology adoption benchmark relative to outside Government agencies and private industry;

4. Assessment of USACE technology adoption mechanisms relative to this benchmark, and recommendation of positive changes or new mechanisms to improve the overall system.

Scope

This report summarizes the findings of the CETAP Study and provides basic information on how the Corps compares to other Government agencies and the private sector in the adoption of innovative technologies. This study focused on how the Corps adopts innovative technologies initiated either from within (i.e., by Corps research laboratories or other field operating activities [FOAs] or from without (i.e., by outside government agencies or the private sector.

Chapter 4 includes analysis of some regulations that have been updated or superseded since this study was conducted. These references have been retained because they were part of the regulatory environment affecting technology adoption in the past immediately before this study was begun.

The purpose of the survey of engineering and construction personnel reported in Chapter 5 was primarily to gather qualitative, not quantitative, information. It was determined that only open-ended questions (as opposed to short-answer or true/false questions) could provide the kind of feedback for survey respondents suitable to guide the researcher in making recommendations toward a coherent approach to technology adoption and management.

Definition of Terms

For this study, the terms "new," "alternative" and "innovative" technology refer to any construction material, system, method, or technique emerging in the commercial marketplace, about to emerge, or already commercially available and in use by the private sector but not commonly used by the Corps. (This definition does not include automated data processing hardware or software systems.) These commercially available technologies may also be referred to as "state-of-the-market" technologies (as opposed to "state-of-the-art"). Although the Corps must stay informed about state-of-the-art technologies, these technologies become most important to USACE when they are developed to the point of providing real benefits and approach introduction on the open market.

The term "adoption" is used to include the identification, testing, evaluation, and incorporation into practice of an innovative technology.

Mode of Technology Transfer

It is recommended that the findings of this study become part of future Corps policies and procedures. This could be accomplished through revision of various Engineer Regulations referenced within, and the establishment of new regulations and official policy doctrine.

2 POINT OF CONTACT DIRECTORY

Even before conducting the analysis of technology adoption mechanisms reported in Chapter 3, it was understood that the difficulty of locating an appropriate point of contact can be a major hindrance to product awareness and adoption within a large organization such as the Corps of Engineers. A directory of HQUSACE engineering technical proponents was developed to enable USACE to better direct inquiries concerning innovative technologies. In addition to an alphabetical listing, the directory was also compiled in *Masterformat*, a publication format developed by the Construction Specifications Institute (CSI) and familiar to many of that organization's members. After several drafts and reviews, the directory was turned over to Headquarters for continued maintenance, updating, and official field distribution. The first version of the directory to be published and distributed throughout the Corps is reproduced in Appendix A; a future edition of the directory may include the *Masterformat* section for the convenience of private-sector organizations.

3 TECHNOLOGY ADOPTION MECHANISMS

The various technology adoption mechanisms used by the Corps may be defined as one of two basic types: (1) project specific mechanisms or (2) general case mechanisms. A project specific mechanism is any mechanism used to incorporate new technologies into a specific construction project at any time after the decision to build has been made until the project is finished and turned over to the user. General case mechanisms are those procedures used to provide guidance and documentation necessary for the design and construction of future USACE projects. Ideally, a new technology successfully implemented in a project specific case will be appropriately documented for general case considerations.

Project Specific Mechanisms

Before discussing any of the project specific adoption mechanisms in detail, it is important to recognize the processes that these mechanisms affect: (1) military construction, Army (MCA); (2) civil works (CW); and (3) operations and maintenance (O&M). These processes are shown schematically in Figures 1 through 3. As indicated by the circular and rounded oblong figures in the schematics, several opportunities to incorporate new technologies are available during each process. The incorporation could be initiated by the designer, user, reviewer, or contractor. Opportunities for incorporating new technologies are also possible through special programs such as the Value Engineering (VE), Suggestion, and Model District programs. It seems clear that there are ample opportunities to incorporate new technologies into the construction and maintenance cycle. The problem is that the procedures and mechanisms available to accomplish this are either unknown, not well understood, or considered unfeasible to execute by the personnel who would take the action.

Project specific mechanisms include formal procedures (such as the VE program) as well as quasi-formal and informal procedures. (Quasi-formal procedures are those handled in a relatively loose fashion regarding required documentation and the formal approval chain.) The VE program is probably the most well known project specific mechanism, due largely to institutional publicity and related training available through the Corps. VE may be initiated by Corps personnel, architect/engineering firm (A/E) personnel, or the contractors working the project. The adoption of new technology through VE requires formal (or quasi-formal) organizational approval, and the degree of approval required usually depends on the nature of the technology and the degree of risk perceived in its use. (The levels of approval are discussed further in Chapter 4.) VE procedures also depend on whether the project is in the design or the construction cycle and whether it is military or civil works construction. There is a different VE process for each of the following four situations, as illustrated in Appendix B:

1. Civil works in the design cycle (Figure B1)
2. Civil works in the construction cycle (Figure B2)
3. Military projects in the design cycle (Figure B3)
4. Military projects in the construction cycle (Figure B4).

In addition to the VE program, other formal procedures (discussed in Chapter 4) govern the adoption of innovative technologies not covered by Corps guide specifications.

Informal procedures, through which an innovative technology is simply specified without any formal organizational approval, are also used, but typically only for a technology with a low risk or low cost of failure.

As stated earlier, successful applications of new technologies through a project specific mechanism should ideally be incorporated into a general case mechanism for use in future projects. However, not every new, beneficial technology will be appropriate for publication in formal guide specifications due to

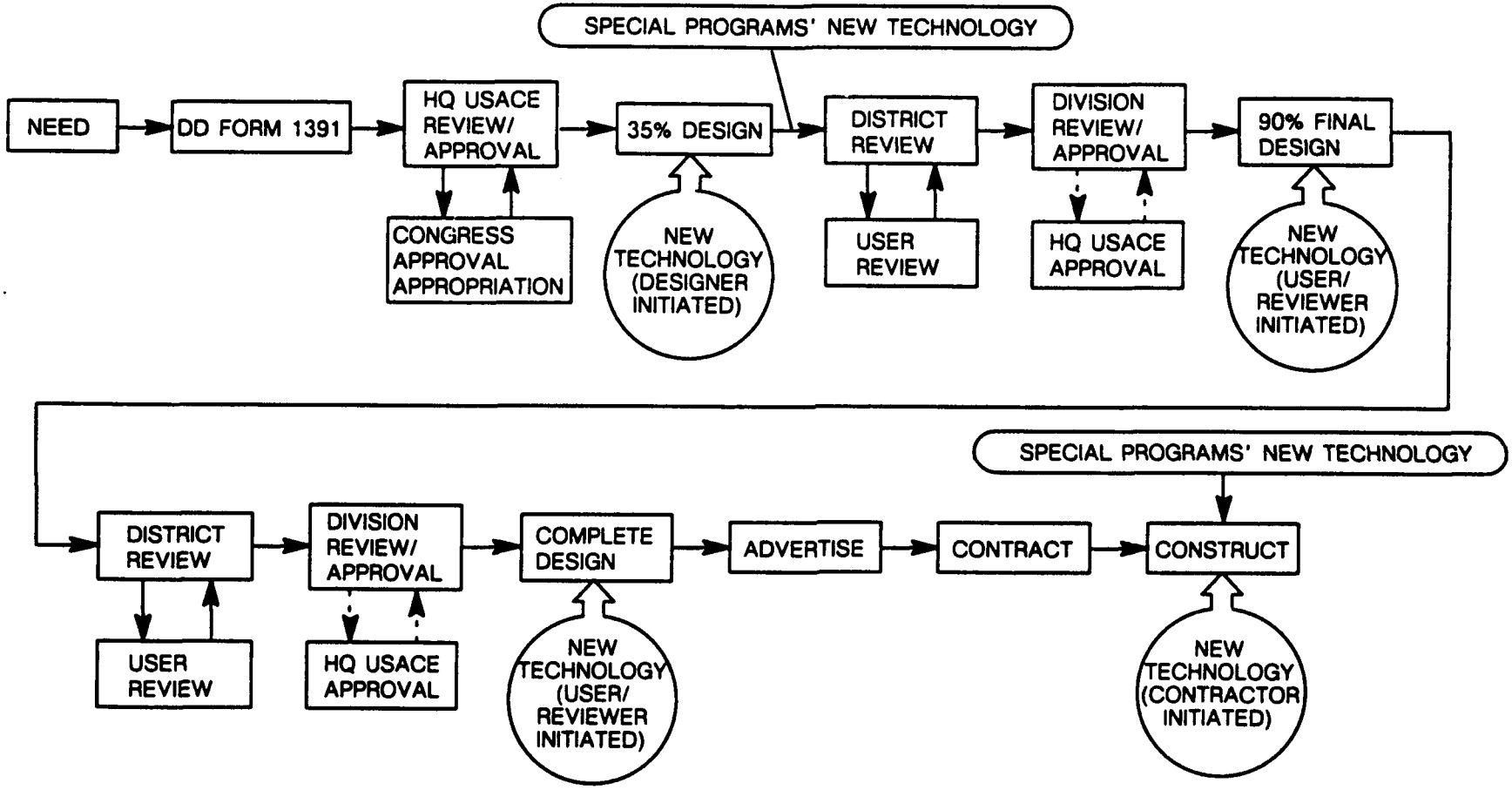

Figure 1. Military Construction Army (MCA) process.

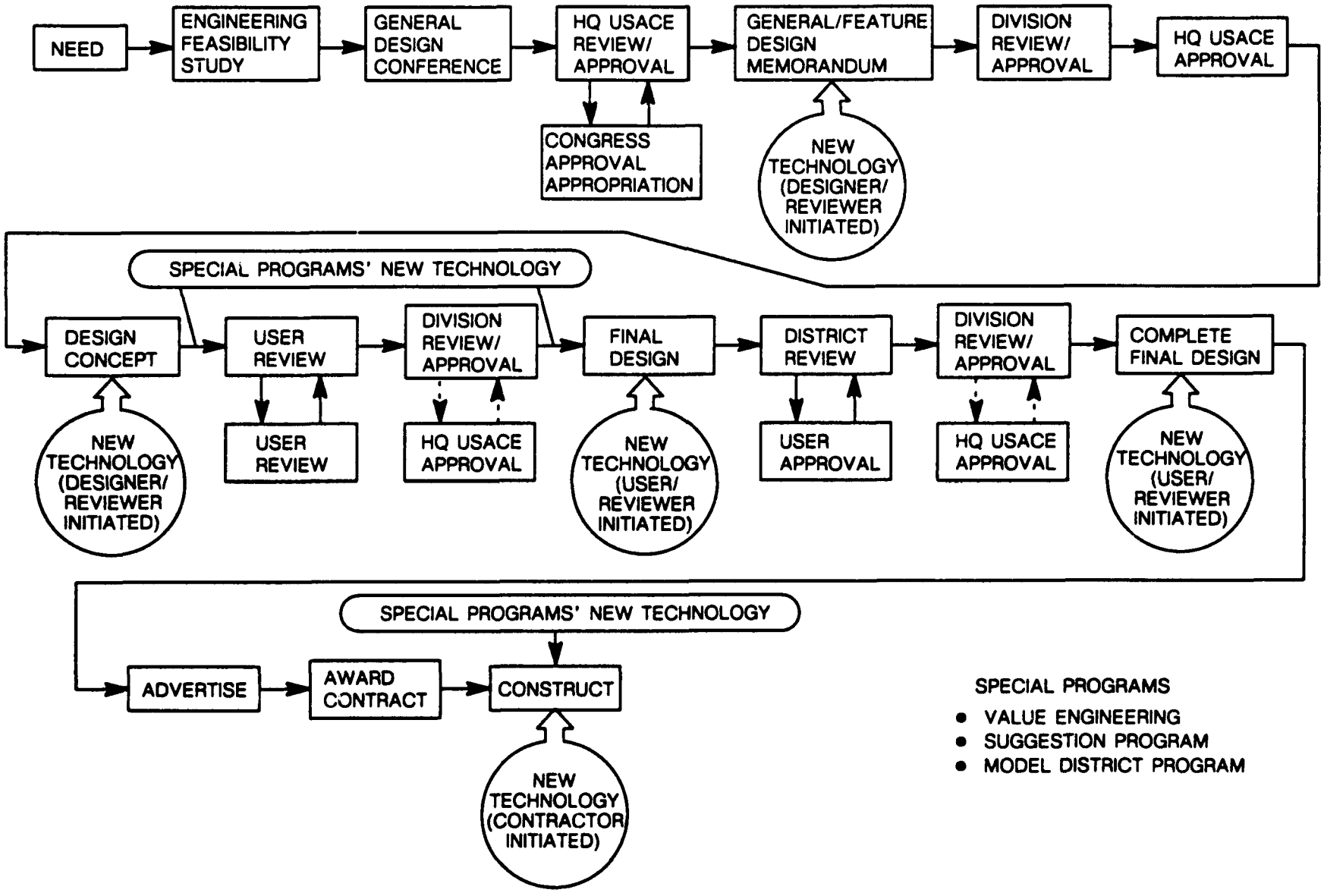

Figure 2. Civil Works Construction Process.

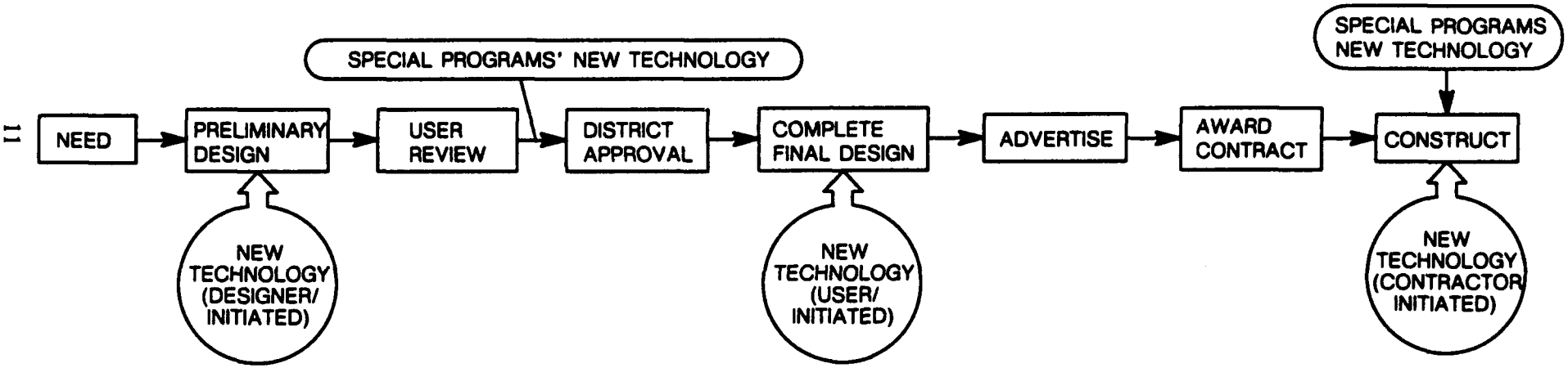

Figure 3. Operations and Maintenance (O/M) Construction Process.

its comparatively narrow scope of application or other reasons. Nevertheless, technologies not formally adopted as Corps standards must still be effectively communicated to the field designers and specifiers who need to know.

One of the most important positive influences on project specific technology incorporation mechanisms is the in-house "champion" or promoter of a specific technology. Another is the industry representative who claims to have "the best thing since sliced bread"; persistent representatives who actually have a worthwhile product (backed by necessary performance data) must not be underestimated in getting new technologies used for specific applications. Also, A/E personnel comfortable with an innovative technology (maybe having had previous success with it in non-Corps projects) may effectively champion that technology for Army projects. Finally, the customer or user, be it an Army or non-Army client, can also exert an influence by requesting the use of a specific new technology.

Problems With Project Specific Mechanisms

Several problem areas with the current project specific mechanisms tend to block effective technology adoption. One significant problem is the lack of any overall process or policy that promotes new technology adoption. Although they usually follow existing local office procedures for new technology incorporation, most personnel (including supervisors) do not know when or how the procedures were established or whether the procedures actually follow regulations. What they do know is that when these procedures are needed, they seem to work. In general, personnel may not even be aware that any formal process besides contractor-initiated VE exists.

Time and staffing constraints are also major factors that significantly restrict the adoption of new or innovative technologies by the Corps. Unless informal or quasi-formal approaches are taken, the required documentation and levels of approval (through HQUSACE level in some cases) may take more time than is even available in the project schedule. Extra staffing to help research and document performance claims for potentially useful new technologies could provide some relief, but this is an unlikely solution in the face of shrinking budgets and staffing limits.

A human factor—the resistance to change in general—can also impede the adoption of new technologies. This may take the form of a stubborn faith in established technologies, or perhaps a fear of the unknown. One person in the chain of approval with conservative attitudes about innovation can retard (or even stop) the adoption of a technology. Sometimes this reluctance may arise because the person does not want to be blamed if the technology fails to live up to its expected potential.

Although the ideal situation would be for innovative technologies that have been successfully adopted at the project level to subsequently be incorporated into general case documentation, there are no established mechanisms to effectively accomplish this. Under the current ad hoc system, adoption into general case documentation is haphazard. Many of the components required to make a process work are already in place, but proper organization and coordination are necessary to develop it into a cohesive *system*. Along with establishing appropriate procedures, incentives are needed to help overcome the time and staffing constraints that will surely remain.

General Case Mechanisms

A general case mechanism can generally be described by a Five-Step Technology Adoption Process as shown in Figure 4. This five-step process is how Corps laboratories introduce techniques they have developed or evaluated into general Corps practice. The first two steps are the research and development (R&D) phase; the last three steps are the technology transfer phase. For a given technology the cycle is not complete until the technology has found general acceptance and use within the Corps. It should be noted that this Five-Step Technology Adoption Process is not just applicable to Corps research

laboratories, but to the total Corps organization. In fact, some of the same thought processes are used for project specific cases.

The Five-Step Technology Adoption Process

Step 1—Determine Army Need. Logically, the first consideration is that the technology should be applicable to Army construction or maintenance needs. For example, technologies for high-rise construction (taller than 10 stories) are not of much interest because the Army does not typically erect such tall buildings.

Step 2—Technology Gap R&D. After a technology has been identified as potentially meeting Army needs, it must be assessed for technology gaps that would require more R&D before Army adoption. This approach has also been referred to as Smart Buyer R&D.

Step 3—Field Demonstration. Appropriately developed technologies are field demonstrated in actual-use situations. The field demonstration tests the technology outside the direct controls of the lab and gives potential users the opportunity to become familiar with the technology. The Corps' Facilities Engineering Applications Program (FEAP) and Technology Transfer Test Bed (T^3B) program represent the heart of this important step.

Step 4—Authorization. After a technology has passed the first three steps, complete engineering guidance and/or procurement documentation must be established so the technology can be specified.

Step 5—Application. The final step is to promote general acceptance and use of the technology within the Corps. Marketing activities (e.g., demonstrations, publications, videos, short courses) within the Corps may be necessary for this step to be fully realized.

Subprocesses in Technology Adoption

There are also several supporting processes (or subprocesses) that can affect one or more of the steps of the Five-Step Technology Adoption Process. The four most important are (1) feedback from field experiences, (2) Suggestion Program input, (3) engineering guidance review and updates, (4) the FEAP and T^3B demonstration programs.

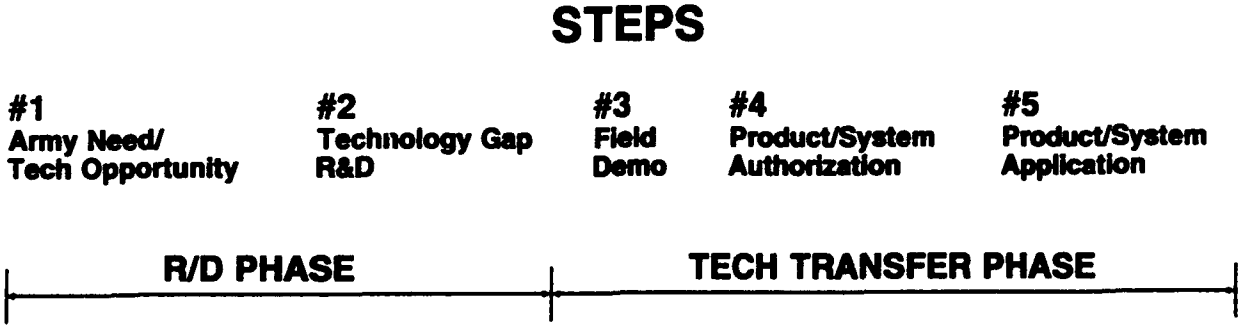

Figure 4. The Five-Step Technology Adoption Process.

Feedback From Field Experiences

Complete communication of field experiences with new technologies may be difficult for a large organization like the Corps to achieve at all levels. However, the importance of feedback from the field cannot be overstressed because it can affect every step in the five-step process. Technology needs communicated from the field help identify areas of needed R&D and new opportunities for the application of a beneficial technology (Step 1). Field feedback can help identify technology gaps (Step 2) by pointing out both problems and potential features that could make the technology more useful. The success of demonstration programs (Step 3) almost completely depends on good feedback from the field users, not with just the coordinating Corps laboratory, but with others throughout the entire Corps and Army. Feedback of experiences from field demonstrations must be incorporated into the guidance documents being developed for the technology as well as the upgrading of these documents (Step 4). Finally, feedback on the successful use of a new technology can promote the wider use of that technology (Step 5).

Feedback need not be positive to be useful; information on the negative aspects of a technology can trigger the action necessary to solve a problem and help prevent others from experiencing the same problem. Engineer Form 3078 should be used for communicating this type of information.

Suggestion Program Input

Suggestions for incorporating new technologies into official Corps guidance documents sometimes originate directly from FOA engineering or construction personnel. These suggestions are generally submitted through formal suggestion programs. Success of incorporation can depend on the amount and quality of supporting documentation because HQUSACE and/or Huntsville Division approval is necessary. The suggester must champion the technology and persist in its promotion.

Engineering Guidance Review and Update

Step 4 of the five-step process involves the development of guide specifications (or other formal guidance documents) to specify and procure the required process, material, or material system. Huntsville Division is responsible for the maintenance of the Corps of Engineers Guide Specifications (CEGS). Knowing that technologies change through product improvements or obsolescence, Huntsville has within the last 5 years established a CEGS review and updating process. A review is automatically performed every 3 years (assuming enough funds are available). A review cycle of less than 3 years can be triggered if more than five amendments were issued since the last complete review. Many CEGS reviews are performed by contractor A/E firms or other appropriate outside contractors. Depending on the subject matter, some reviews are also done through the Corps laboratories. Additionally, industry representatives often spur a kind of de facto review when they promote their new technologies and products through direct contacts with responsible personnel at HQUSACE and Huntsville Division. Other factors considered during these review cycles include formal suggestions, field feedback, and applicable technologies developed or evaluated by a Corps lab.

FEAP, T^3B, and the National Teams

The heart of Step 3 in the five-step process is represented by the FEAP and T^3B Programs. For people to want to use innovative technologies they must be aware of its existence and what it can do for them; they want reassurances about reliability and accurate information about the potential consequences of failure. They also need assistance as the technology is being assimilated. Dissemination of Corps-developed technologies has been enhanced and accelerated by the FEAP and T^3B programs. FEAP has existed longer than T^3B and, therefore, has a longer history of success. The Corps of Engineers National Energy Team (CENET), one of the main steering groups for T^3B, has rapidly grown as a progressive influence on the technology it is helping to transfer. Another national team, the Corps of Engineers National Advanced Construction Technologies Team (CENACTT), was also rapidly expanding its program

until recently, when its progress was stalled by leadership personnel reassignments resulting from the HQUSACE reorganization. CENACTT had been responsible for new construction materials, systems, and procedures—mission areas too important to neglect; the impact of such continued neglect would be delayed adoption of any innovative construction technologies the team was to be promoting.

Problems With General Case Mechanisms

Four problem areas with general case technology adoption mechanisms have been identified:

1. Five-step process deficiencies
2. Feedback process deficiencies
3. Updating of engineering guidance documents
4. Evaluation and documentation of potentially beneficial new technologies.

The Five-Step Technology Adoption Process is a logical sequence of events for fostering technology transfer and adoption within the Corps. This adoption process is, however, recognized mainly within the Corps laboratories. FOA and HQUSACE personnel also need to be aware of this mechanism, understand its significance, and use the mechanism and policies in their daily activities.

Lack of awareness of and practice of the five-step process are technology adoption deficiencies in an organizational sense, but the process itself also has some deficiencies. In view of their significance to the overall process, Steps 3 and 5 contain some especially significant deficiencies discussed below.

The value of field demonstrations (Step 3) is affirmed through the implementation of the FEAP and T^3B programs. However, to be most effective, field demonstration and technology transfer activities require an appropriate level of participation by the researchers who developed or evaluated the technology. Such participation is limited by insufficient funding for these demonstration projects. By virtue of working within the construction industry, Corps R&D laboratories must operate differently than the Army Materiel Command (AMC) laboratories developing weapons or intelligence systems. A broadened mission statement directing Corps laboratories to actively participate in the technology transfer process, along with supporting Research, Development, Test, and Evaluation (RDTE) advanced development funding, is needed to enhance the effectiveness of field demonstrations.

Step 5 (application of the technology) of the five-step process is not fully accomplished until the technology is used on a common basis (i.e., adopted). Defining when a technology is adopted can be an area of debate. One could actually define levels of adoption because use of a given new technology may differ at every installation or civil works site—or may never happen at all—because that technology is not appropriate or individual users prefer an alternative. Therefore, defining "adoption" as universal use is unrealistic. A workable definition of technology adoption, based on the researchers' experience and consensus, is when a minimum of five different installations use it. This use must be voluntary, not simply for a field test or demonstration project. Although five installations is a somewhat arbitrary number, that number certainly indicates that the technology has gained a reasonable degree of acceptance; barring any unforeseen deficiencies and availability problems, use of that technology should continue to grow.

Successful demonstration and documentation of a technology do not mean that the technology will be automatically used. A field demonstration may make a few people or field offices comfortable with the technology, but this does not mean others will share the same enthusiasm. Step 5 requires "after-demo marketing" to speed the process along. Such marketing could include special training sessions, seminars, product brochures, and/or additional demonstrations.

Many problems associated with effective field feedback are discussed in Chapter 5. At this point it is sufficient to say that poor communication limits the pace and effectiveness of the technology adoption process.

With a 3-year update cycle, guide specifications will probably not be too far out of date. Concerns remain, however, about whether new technologies are given adequate considerations during these review cycles. Also, no positive link exists between the demonstration tests and the CEGS review and update. Serious coordination problems exist between some CEGSs and their corresponding technical manuals (TMs) or engineering manuals (EMs). The Corps is responsible for CEGS while other agencies (or multiple agencies in the case of tri-service documents) may have proponency for the corresponding TMs. Misleading or conflicting information can result when corresponding guidance documents are not updated on a similar schedule. (This problem is discussed further in Chapter 5.)

The adoption of many new technologies is retarded either because the appropriate personnel (e.g., project designer, specification writer) are not completely familiar with the technology or have no way to verify performance. At the FOA and HQUSACE levels, identification and subsequent promotion of new technologies is undertaken, but it is not systematic, consistent, or even a mission requirement. Currently, if laboratory evaluations are required because of questions about a technology's performance, the office identifying these needs is required to fund this evaluation, even if it is performed at a Corps laboratory. Because of their 6.1 and 6.2 RDTE funding, the Corps R&D Laboratories have a mission that does not include exploratory product performance evaluations. A mechanism (including funding sources) is needed to provide "smart buyer" evaluations of innovative technologies identified as potentially beneficial but lacking performance verification.

4 REGULATIONS AFFECTING TECHNOLOGY ADOPTION

Technology Transfer Factors

A review of Corps documents indicates that a variety of policy documents govern some of the procedures used by the Corps for introducing innovative technologies, but there is no single source that provides a summary or collection of this guidance. Figure 5 shows five categories of technology transfer factors that help focus the following assessment of Corps regulations by assuring that the common channels of introducing innovative technologies are properly considered. The following is a brief explanation of each category, associated factors, and the major policy topics relevant to each category.

Source of Inquiry

The source of inquiry is defined as the individual or organization that initially makes the inquiry to the Corps about introducing an innovative technology to the Corps of Engineers. The most common sources of inquiry are those listed under that heading in Figure 5, and include sources from both within the Corps and from the outside. The policy issues in this category deal with policy and procedures that directly or indirectly promote the introduction of innovative technologies to the Corps.

Initial Contact/Action Office

This category lists the various organizations within the Corps, Department of the Army (DA), U.S. Department of Defense (DOD), Congress, and others that either initially receive the inquiry or serve as the action office responsible for assessing the applicability of the proposed technology to the Corps. The major policy issue in this category is the identification and distribution of points of contact (POCs) or proponents for the various areas of technical interest. When an inquiry is made anywhere within the Corps, the person handling the initial inquiry should forward the inquiry to the correct point of contact or proponent.

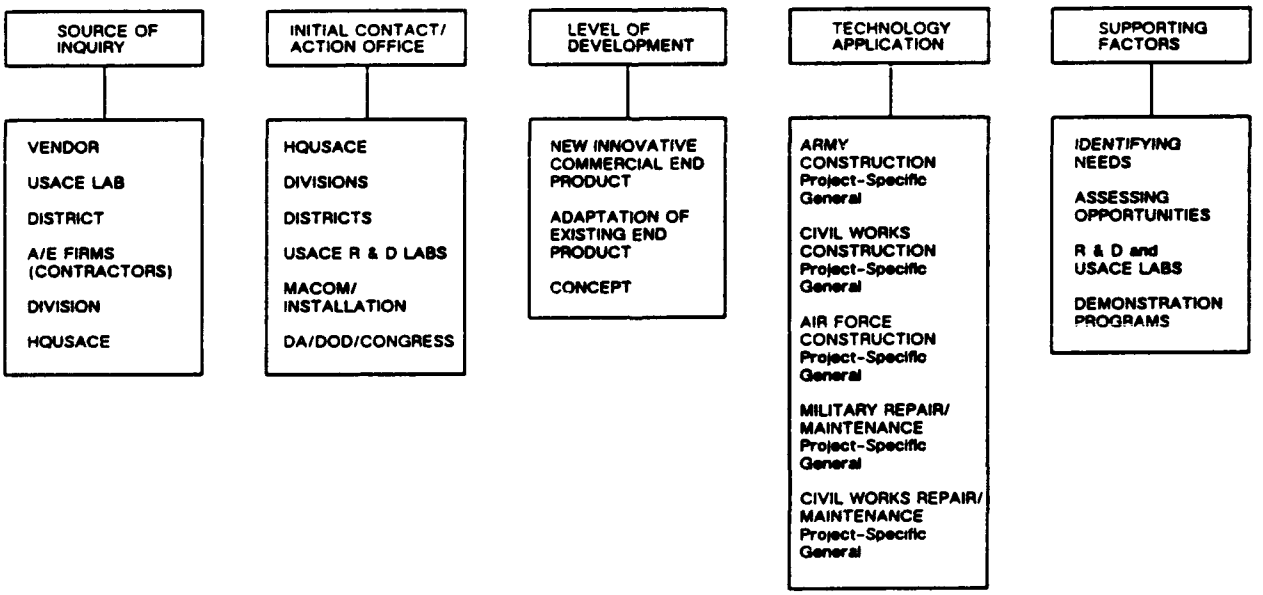

Figure 5. Technology Transfer Factors.

Level of Development

This category is divided into three sublevels to distinguish the degree of technology development: (1) an end product for a given application, (2) a new or modified application of an existing technology, and (3) a concept or idea. The same action office should handle policy issues for a given technology regardless of the level of development.

Technology Application

Technology application is divided into the major engineering, construction, and maintenance and repair (M&R) activities that the Corps is involved in. Each of these may be subdivided into general and job-specific applications. The policy issue in this category deals with the deviation from standard criteria, and the procedures for changing standard criteria.

Supporting Factors

The supporting factors include pertinent policies that have a significant impact on the introduction of innovative technologies to the Corps but are not necessarily inherent in, or exclusive to the Corps' engineering, construction, and M&R missions.

Corps Policies and Procedures That Affect Technology Adoption

The categories of policy documents listed below were searched to determine which ones affect the introduction of innovative technology into the Corps practice:

DOD Manuals
DOD Directives
Army Regulations (AR)
Engineer Regulations (ER)
Technical Manuals (TM)
Engineer Manuals (EM)
Engineer Circulars (EC)
Engineer Pamphlets (EP)

Table 1 lists specific regulation and policy documents that affect the adoption of innovative technology into Corps practice. Appendix C summarizes the impact that each document listed in Table 1 has on the introduction of innovative technologies. The following sections summarize the same policy and regulatory information for the factors and categories listed in Figure 5. The purpose of analyzing the policies and regulations in this fashion is to identify any areas for which regulations do not exist.

Sources of Inquiry

Inquiries to the Corps about introducing innovative technologies can be initiated from almost any source. Although there is no real restriction on who makes the initial inquiry, there are specific policies that promote such inquiry. The Value Engineering Program (EP 11-1-3 and EP 11-1-4), Technical Centers of Expertise (ER 1110-1-262), and the Corps Laboratories (EP 1-1-10)[1] are three examples.

[1] EP 11-1-3, *Value Engineering Officer's Operational Guide* (HQUSACE, 15 June 1976); EP 11-1-4, *Value Engineering Benefits and the Construction Contractor* (HQUSACE, 1 April 1981); ER 1110-1-262, *Corps-Wide Technical Center of Expertise Assigned to Divisions and Districts* (HQUSACE, 31 July 1985); EP 1-1-10, *Corps of Engineers Laboratory, Investigational, Research and Testing Facilities* (HQUSACE, 1 May 1985).

Table 1

Regulation and Policy Documents That Affect Adoption of Innovative Technologies Into USACE Practice

Regulation Reference	Regulation Title	Date
ER 10-1-3	Divisions and Districts	28 November 1986
ER 10-1-8	U.S. Army Engineer Waterways Experiment Station	15 July 1985
ER 10-1-25	U.S. Army Cold Regions Research and Engineering Laboratory	30 July 1987
ER 10-1-26	U.S. Army Construction Engineering Research Laboratory	28 July 1987
ER 10-1-45	U.S. Army Engineer Topographic Laboratories	25 October 1987
ER 37-1-18	Conferences and Workshops	14 July 1988
ER 70-1-5	Corps of Engineers Research and Development Program	28 November 1980
ER 70-2-6	Identification of Civil Works Research Needs	5 January 1982
ER 70-3-2	Military Construction Research Requirements and Research and Investigations Coordination in Field Activities	30 June 1971
ER 70-3-9*	Management and Execution of the U.S. Army Corps of Engineers Military Research, Development, Test and Evaluation (RDT&E) Program	31 March 1989
ER 415-1-13	Design and Construction Evaluation (DCE)	1 September 1987
ER 415-3-11	Post Completion Inspection Feedback	28 September 1984
ER 415-345-270	Administration and Regulation for Cost-Plus-A-Fixed-Fee Construction Contracts	1 July 1968
ER 1105-2-10	Planning Programs	18 December 1985
ER 1110-1-262	Corps-Wide Technical Centers of Expertise Assigned to Divisions and Districts	1 July 1985
ER 1110-2-1150	Engineering After Feasibility Studies	15 November 1984
ER 1110-2-1200	Plans and Specifications	12 June 1972
ER 1110-345-100	Design Policy for Military Construction	14 December 1973
ER 1110-345-720	Specifications	31 October 1989
ER 1130-2-417	Major Rehabilitation Program and Dam Safety Assurance Program	30 November 1980
EP 1-1-10	Corps of Engineers Laboratory, Investigational, Research and Testing Facilities	1 May 1985
EP 11-1-3	Value Engineering Officer's Operational Guide	15 June 1976
EP 11-1-4	Value Engineering Benefits and the Construction Contractor	1 April 1981
EP 70-1-3	Installation Support/One Stop R&D Service	30 May 1989
AR 34-2	Rationalization, Standardization, and Interoperability Policy	15 December 1980
AR 70-1	System Acquisition Policy and Procedure	10 October 1988
AR 70-15	Product Improvement of Material	15 June 1980
AR 71-9	Material Objectives and Requirements	20 February 1987
AR 415-10	Military Construction - General	1 March 1984
AR 415-15	Military Construction Army (MCA) Program Development	1 December 1983
AR 415-18	Military Construction Responsibilities	1 September 1982
AR 415-20	Project Development and Design Approval	15 March 1974
AR 420-70	Buildings and Structures	17 November 1976
AR 700-50	Development and Use of Non-Government Specifications and Standards	15 July 1977
AFM 88-15	Air Force Design Manual - Crieria and Standards for Air Force Construction	January 1975
AFR 88-15	Criteria and Standards for Air Force Construction, Interim Draft Ed.	January 1986
AFR 89-1	Design and Construction Management	November 1988
AFR 93-8	Applications Engineering Program	July 1980
AEI	Design Criteria	9 December 1991

Note: AEI = Architectural and Engineering Instructions
AFM = Air Force Manual
AFR = Air Force Regulation

* Superseded ER 70-1-9, *Transfer of Corps of Engineers Research and Development Technology* (HQUSACE, 28 November 1980), which was in effect over most of the period relevant to this study.

The VE program encourages (through a cash awards program) designers and builders of both military and civil projects to propose life-cycle-cost-effective alternatives during both design and construction of a project. VE is normally project specific, but value engineering principles can also be applied to general case applications. VE clauses are standard in most Corps construction contracts.

The regulation that establishes the technical centers of expertise (TCX), ER 1110-1-262, clearly states that each TCX is responsible for maintaining state-of-the-art technical competence in its assigned specialty.

Corps laboratories by virtue of their R&D mission, are inherently a major source of inquiry regarding innovative technologies in Corps practice. In fact, a significant number of Corps regulations and policies support the adoption of innovative technologies that have evolved from laboratory R&D programs. (These regulations are discussed in more detail in the *Supporting Factors* section of this chapter.)

Initial Contact/Action Office

All of the organizations listed under this category have been used as initial contact points for introducing innovative technology to the Corps of Engineers. The object of designating an initial contact is to assure that the individual with whom contact is made knows (or can easily find out) who has the action responsibility for the specific proposed inquiry. A review of current regulatory and policy documents indicates that no single document specifically lists action offices for the various common types of inquiries related to innovative technologies that the Corps handles.

The ER 10-1 series of regulations that establishes the mission and organization of the various Corps FOAs can help in the identification and location of an appropriate action office. ER 10-1-3, for example, is an excellent description of the various sub-elements and their responsibilities in a typical Corps Division and District office. The other ERs in the 10-1 series provide mission and function statements for the four Corps labs and the other FOAs in sufficient detail to provide some assistance in identifying the appropriate action offices for various technologies. The single biggest problem with this series of documents is that none describes the functions and responsibilities of the sub-elements within HQUSACE. This lack of detail is significant because much of the action responsibility for revising general criteria guidance relative to new and alternate technologies is assigned to various HQUSACE offices.

Two other documents that provide some assistance in locating an action office are ER 1110-1-262 and EP 70-1-3. ER 1110-1-262, as described in the previous section of this chapter, details that TCXs have the responsibility of maintaining state-of-the-art technical competence in their assigned specialty. Although not specifically stated, it is reasonable to assume that TCXs either have some action-office responsibility or know who does. EP 70-1-3 contains a list of technology capabilities in Corps laboratories, and provides a specific list of contacts by technical area listed.[2] This list was developed to provide Army installations in need of technical support with a directory of Corps laboratory capabilities. This same kind of list could be used for identifying laboratory or Corps-wide POCs. As with the TCXs, it can also be assumed that most laboratory POCs will know who has the action responsibility for their specific area of expertise.

Level of Development

As previously stated, Figure 5 contains three levels of product development: an end product intended for a specific application; an existing end product to be adapted for an application other than

[2] EP 70-1-3, *Installation Support/One-Stop R&D Service* (HQUSACE, 30 May 1989).

what it was originally intended; and a concept or idea that still needs development and testing. Corps policy and procedure documents do not specifically differentiate these product levels or who has the action responsibility for adopting new products.

Current Corps policy for the use of unusual or new methods and materials in military construction (ER 1110-345-100) states that "if a material previously untried for military construction is proposed by the industry for use in place of an accepted material, or as an option, it will be the responsibility of the manufacturer to prove the merit of the product..."[3] This statement implies that only new or alternative end products with an existing database sufficient to validate the merit of the product should be proposed for a specific military construction project. The Civil Works regulations, ER 1110-2-1150 and ER 1110-2-1200, are not specific in this area, but if the Corps chooses to bear the burden of validating the merits of an innovative technology, the cost and resources required must be included in the Plan of Action document for approval by the Division Commander.[4]

Based on the preceding paragraph and other policy statements that have similar indirect influence, it would seem that innovative technologies that already exist as end products (with a supporting database) can be considered for both project specific and general case applications. The proponent for general criteria and guidance is HQUSACE, and for job specific, the appropriate design District or Division. If the innovative technology exists only as a concept, the proponent will still be either HQUSACE or a District or Division depending on its applications, but in almost all cases Corps laboratories will play a significant role in concept assessment and development. In cases where labs have active programs in a given area, concept assessment and development can be initiated without direct contact with HQUSACE, Divisions, or Districts.

Technology Application

This category is divided into the three major users of Corps engineering and construction, and the two users of maintenance and repair criteria. For Army construction, ER 1110-345-100 and ER 1110-345-720 provide specific policy guidance for the use of new materials and methods. The policy states that "unusual or new materials or methods of construction may be specified if merit has been established and use has been approved by the Division Engineer."[5] Merit is defined as in the best interest of the Government from the standpoint of economy, lower life cycle cost and quality of construction. As indicated in the section on level of development, it is the responsibility of the manufacturer to prove the merit of a new material or method. In addition, ER 1110-345-100 references a series of ARs that the ERs must comply with. AR 415-20 clearly states the relationship between the using service and the Corps of Engineers in the planning and design of Army facilities: the using service has the responsibility of establishing facility functional requirements whereas the Corps of Engineers has responsibility for all design activities starting with the design criteria requirements.[6] The AR implies that the using service has little authority in proposing technical criteria alternatives, but does have numerous opportunities to comment on and review the Corps design. Thus, the using service has no authority to mandate the use of innovative technology but can suggest that the Corps consider such technologies in their project design.

Design and construction criteria for military facilities are presented in the Architectural and Engineering Instructions (AEI), Design Criteria. This AEI contains all current design guidance and criteria for Army facilities for use by all Corps of Engineers Major Subordinate Commands (MSC), District

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[3] ER 1110-345-100, *Design Policy for Military Construction* (HQUSACE, 14 December 1973), par 9.

[4] ER 1110-2-1150, *Engineering After Feasibility Studies* (HQUSACE, 15 November 1984); ER 1110-2-1200, *Plans and Specifications* (HQUSACE, 12 June 1972.)

[5] ER 1110-345-100, par 9; ER 1110-345-720, *Specifications* (HQUSACE, 31 October 1989), par 10.

[6] AR 415-20, *Project Development and Design Approval* (HQUSACE, 15 March 1974).

Commands, Field Operating Activities (FOA), and Major Army Commands (MACOM). This document states that facility "designs will consider economies that can be effected by the use of suitable local construction methods, materials, and skills that are consistent with the intent of these criteria." The use of any new materials and methods are, therefore, not included in the AEI document. Such approval procedures are covered by ER 1110-345-100 and ER 1110-345-720, as described above.

The design and construction criteria for civil works facilities are presented in ER 1110-2-1150 and ER 1110-2-1200. Engineering design and criteria methods described in ER 1110-2-1150 state that "engineer manuals and regulations in the 1110-1- and 1110-2- series are the basic technical guidance for design and construction of civil works projects. ...Advance approval of HQUSACE will be obtained for any significant departure from those criteria indicated as mandatory in the manuals and regulations."[7] All civil works projects at the general design and feature design memorandum stage are approved by the Division Commander, with HQUSACE holding approval for certain technologies such as pumping plants, spillways, and corrosion mitigation. Thus, all innovative technologies proposed for civil works construction must be approved by the Division Commander or Headquarters (unlike military construction, where such approvals may be made much closer to the working level).

Air Force facilities built by the Corps comply with the ER 1110-345-100 and ER 1110-345-720, and have the same requirements as Army facilities. The only difference is that Air Force Manual (AFM) 88-15 constitutes the design and criteria manual for Air Force facilities. This regulation "requires an economical selection of materials based on instructional maintenance costs."[8] "Fine safety, expected tenure of use, energy conservation and suitable appearance" are additional functional requirements for consideration before selecting a additional functional requirements for consideration before selecting a material for use. In the area of untested materials and methods it states that "Untried or unauthorized materials, components, and methods should generally not be used in conventional Air Force construction. If it has been determined definitely by careful evaluation that new materials and methods will give good results, they may be used on approval of HQUSAF/LEEE."[9]

The preceding discussions of this category have dealt with the procedures and regulations involved in using innovative materials and methods at a project specific site. In all areas of Corps construction, heavy reliance is placed on Corps guide specifications and engineer manuals for standard design and construction criteria. The procedure used by the Corps to keep these documents updated is a significant factor in the Corps-wide introduction of innovative technologies. Paragraph 21c of ER 1110-345-100 states that "Division and District Engineers are encouraged to inform DAEN-MCE of suggested changes to standard designs (both drawings and specifications) considered desirable to improve construction or functional use or to effect savings. Such information will include suggested improvement based on local experience and suggested optional materials and methods of construction. ENG Form 3078 will be used for reporting." Paragraph 9 of this regulation allows the use of unusual or new methods or materials previously untried for military construction if it can be shown that it is in the best interest of the Government. It also provides for, upon request from HQUSACE, an evaluation handout to assist in the evaluation of that merit.[10] ER 415-3-11 provides the general policy and procedures relating to feedback of information from field engineering and construction sources, and the processing and dissemination of such feedback information to appropriate levels of command.[11] Specific systems described in this policy are the Engineering Improvement Recommendation System (EIRS), the post-completion inspection (PCI), engineering and design coordination team visits, and the Design Criteria Feedback Program (DCFP).

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[7] ER 1110-2-1150, par 8.

[8] AFM 88-15, *Criteria and Standards for Air Force Construction*, (Headquarters, U.S. Air Force, January 1975), par 1-10.

[9] AFM 88-15, *Criteria and Standards for Air Force Construction*, (Headquarters, U.S. Air Force, January 1975), par 1-15.

[10] ER 1110-345-100, par 9.

[11] ER 415-3-11, *Post Completion Inspection Feedback* (HQUSACE, 28 September 1984).

With the purpose of improving USACE technical guidance and construction management systems, ER 415-1-13 provides for the technical evaluation and feedback of both military and civil works construction projects. This design and construction evaluation (DCE) may encompass all phases of a project including the criteria requirements, the design and materials selection, and the actual construction process. The scheduling goal is for a DCE team to visit each military district and each major civil works construction project annually. Normally projects of less than $1,000,000 are not evaluated. Feedback information is recorded on ENG Form 4702-R. Forms containing design and criteria feedback are to be distributed to appropriate HQUSACE Engineering Division personnel for necessary action. A possible problem with the DCE process is that innovative technologies could be identified but not necessarily in a positive way. Per ER 415-1-13, the focus of the DCE procedure is on identifying problem areas. Even if performing satisfactorily and fully authorized to use, reported innovative technologies may be viewed negatively. This is especially true if the new technology has replaced a material or system otherwise "authorized" by the Guide Specifications.

The EIRS Bulletin, which is defined in ER 415-3-11, is the document used to transmit advance information about problems and their probable solutions. The EIRS Bulletin publishes information on both military and civil works projects. The ability of the various feedback systems presented in ER 415-3-11 to assist in the introduction of innovative technologies is directly affected by the willingness of the Corps to try such technologies. If new technology is not tried on some basis then a feedback system can only address problems with existing standards.

The regulations and policies that affect the introduction of innovative technologies in the M&R area are much less specific about reliance on standard Corps criteria. In the M&R of Army facilities, AR 420-70 states that standards including military construction specifications apply to all facilities engineering work and functions relating to buildings and structures.[12] However, it is essential that guide specifications be adapted to local conditions which, in many instances, differ from assumptions made in the specifications. Even when a Corps District is involved in an Army installation's M&R project under the One-Stop R&D Service (EP 70-1-3), Corps engineers are not restricted to guide specification use as they are in military construction projects.[13]

Civil works maintenance and repair policy is covered in ER 1130-2-417. This ER is very specific in that major civil works rehab projects over $5,000,000 must comply with design criteria policies that are developed for new construction, i.e., ER 1110-2-1150 and ER 1110-2-1200.[14] But there is no specific policy for M&R projects that cost less than $5 million even though there are specific technical manuals and specifications for maintenance painting and concrete repair.

Supporting Factors

Included in this category are a variety of factors that obviously affect the introduction of innovative technologies but are not necessarily directly related to the engineering, construction, or M&R processes. These include identification of needs, assessment of opportunities, research and development activities, and demonstration programs.

ER 415-3-11 provides an extensive program for identifying, reporting, and disseminating information on guidance and criteria for military construction in a timely fashion to all FOAs. It should be noted, however, that for civil works there is no counterpart for this regulation. ER 1110-2-100, which provides

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[12] AR 420-70, *Buildings and Structures* (HQDA, 17 November 1976).

[13] EP 70-1-3, *Installation Support One-Stop R&D Service* (HQUSACE, 30 May 1989).

[14] ER 1130-2-417, *Major Rehabilitation Program and Dam Safety Assurance Program* (HQUSACE, 30 November 1980). This regulation was rescinded by Engineer Circular (EC) 25-1-70 (HQUSACE, 10 April 1989).

a policy for periodic inspection of civil works structures, does not cover feedback on design criteria or specifications.[15] (It is assumed that since HQUSACE provides technical reviews on most civil works projects that a separate feedback system is not required.)

In support of Corps R&D initiatives, formal procedures have evolved for identifying research needs in both civil works and military construction. ER 70-2-6 and ER 70-3-2 describe respectively the civil works and the military construction research needs policies. ER 70-3-2 is obsolete, however, and does not represent the current procedure and documents used to identify military construction R&D requirements.[16]

Certain Corps organizations not necessarily in the daily flow of Corps engineering, construction, or M&R activities significantly support the Corps' ability to assess opportunities as innovative technologies emerge; these are the Corps R&D labs and Centers of Technical Expertise. ER 10-1-8, ER 10-1-25, ER 10-1-26, and ER 10-1-45 respectively are the organization and function statements for the following Corps' laboratories: Waterways Experiment Station (USAWES), Cold Regions Research and Engineering Laboratory (USACRREL), Construction Engineering Research Laboratory (USACERL), and Engineer Topographic Laboratories (USAETL).[17] The mission and function statements of the various TCXs are published as appendices in ER 1110-1-262.

Other Policy Impacts

Other policies indirectly affect the assessment of opportunities for the adoption of innovative technologies in the Corps. These include policy restrictions associated with Corps of Engineer conferences and workshops, and travel restrictions associated with professional activities. Both policies have some potentially adverse impact on the ability of Corps personnel to be aware of and properly assess the implications of innovative technologies as they emerge. ER 37-1-18 specifies the restrictions on Corps-sponsored conferences.[18] Counter to these restraints, recent statements from the Office of the Chief of Engineers (OCE) have encouraged Corps personnel to support professional activities and societies such as the American Society of Civil Engineers (ASCE), the American Society for Testing and Materials (ASTM), and the American Society of Mechanical Engineers (ASME).

The opportunity to adopt certain technologies is limited by ER 1110-2-1200, which requires that nationally recognized industry and technical society specifications and standards shall be used to the maximum extent practicable to assure that requirements are compatible with current industry practices. If no suitable industry documents apply, then Federal or military specifications and standards are to be used. This policy could make the adoption of some technologies dependent on factors outside USACE.

The Corps laboratories and their research activities are a major factor in the introduction of innovative technologies to the Corps of Engineers. With the exception of USAETL, whose mission is outside the area of construction, all Corps laboratories play a significant role in this arena. Most of the policies and procedures that impact the Corps laboratories and their research and development activities are listed in the ER 70-1 series of policies. ER 70-1-9 provides a specific review and decision procedure

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[15] ER 1110-2-100, *Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures* (HQUSACE, 8 April 1988).

[16] ER 70-2-6, *Identification of Civil Works Research Needs* (HQUSACE, 5 January 1982); ER 70-3-2, *Military Construction Research Requirements and Research Investigations Coordination in Field Activities* (HQUSACE, 30 June 1971).

[17] ER 10-1-8, *U.S. Army Engineer Waterways Experiment Station* (HQUSACE, 15 July 1985); ER 10-1-25, *U.S. Army Cold Regions Research and Engineering Laboratory* (HQUSACE, 30 July 1987); ER 10-1-26, *U.S. Army Construction Engineering Research Laboratory* (HQUSACE, 28 July 1987); ER 10-1-45, *U.S. Army Engineer Topographic Laboratories* (HQUSACE, 25 October 1987).

[18] ER 37-1-18, *Conferences and Workshops* (HQUSACE, 14 July 1988).

for timely transfer and application of Corps-developed technology to the using activities of the Corps, the Army/DOD, and other users.[19] However, the authors are not aware of this policy having ever been used to date.

Full-scale field demonstrations of Corps-developed technology also promote the transfer of innovative technologies to Corps clients. Such programs, including FEAP and T^{3}B have evolved as part of the base support mission area because of the lack of advanced development (level 6.3 and higher) funding in this area. FEAP demonstrates technologies applicable directly at Army installations, and the T^{3}B program demonstrates technologies applicable to Corps military construction activities. An engineering regulation establishing specific policy for these demonstration programs has not evolved, nor are there regulations that provide policy for demonstrations funded from other sources. Thus, although the Corps has been involved in a variety of demonstration activities, there is no specific HQUSACE policy or procedure that defines what constitutes a demonstration or what happens after the demonstration has been completed. Also, these demonstrations are observed only by a few personnel, usually only by those tasked to assist in the project.

Policy Gaps and Deficiencies

Several policy gaps were identified during this research:

1. A list of Corps contacts or proponents for assessing innovative technologies does not exist.

2. There is no policy relative to demonstration projects funded by FEAP, T^{3}B, or any other source.

3. The current policy on military construction research needs is obsolete and needs revision to comply with current procedures.

4. There is no feedback policy for civil works engineering and construction criteria.

5. Policy documents do not specifically recognize the various levels of technology development or who has action responsibility.

In addition to the preceding list, a general deficiency is that Corps policy on the introduction of innovative technologies is spread throughout a very diverse set of documents. For example, Table 1 lists 39 documents, each of which contains some specific guidance that affects the way the Corps introduces innovative technologies. Thus, some form of document summarizing the Corps' overall technology adoption policy and referencing the appropriate existing policy documents should be useful in developing a general and consistent understanding of the Corps technology adoption process.

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[19] ER 70-1-9, *Transfer of Corps of Engineers Research and Development Technology* (HQUSACE, 28 November 1980). This regulation has been superseded by ER 70-3-9, *Management and Execution of the U.S. Army Corps of Engineers Military Research, Development, Test and Evaluation (RDT&E) Program* (HQUSACE, 31 March 1989). However, ER 70-1-9 was in effect over most of the time period relevant to this study.

5 BENCHMARK DETERMINATION AND COMPARISON TO OTHERS

Background

One task of this research was to establish a benchmark for comparing the Corps' performance in the adoption of innovative technologies to comparable agencies in the public and private sectors. A series of questionnaires was developed to assist in the establishment of this benchmark. The University of Illinois Survey Research Laboratory, Urbana, IL, was contracted to help develop these questionnaires. Each questionnaire was divided into four sections to address the following main issues:

1. Who is responsible for the introduction of new technologies?
2. What are the procedures for introducing new technologies?
3. How is information on new technologies disseminated?
4. How effective are the procedures for introducing new technologies?

Much of the information to be collected would have been difficult to extract from multiple choice or yes/no-type answers. Therefore, the questionnaire was designed mostly for the collection of narrative answers as part of a personal interview. To help provide some quantification for each of the four main topic areas, each area had at least one question asking the respondents to numerically rank the performance of their respective organization relating to that topic issue. In those questions a rating scale of 1 to 5 was used, with 1 meaning poor performance and 5 meaning excellent performance.

Table 2 lists the Corps Districts and Divisions, government agencies, and private industry organizations that participated in the study by filling out questionnaires and providing the interviews. The private industry firms were selected on the basis of having design, construction, or maintenance responsibilities similar to those of the Corps. Many other private sector firms could have been surveyed. However, given the Office of Management and Budget's limitation on the number of firms that could be interviewed without going through an involved approval process, the organizations were chosen to represent a cross-section of viewpoints. Three versions of the basic questionnaire were developed: one edition was tailored to the Corps of Engineers, one to the U.S. Army Directorate of Engineering and Housing (DEH), and one to non-government and private industry organizations. The same basic questions were asked in each version, but specific Corps organizational references were removed from the appropriate versions. Samples of each questionnaire can be found in Appendix D.

To provide the viewpoint of organizations that have dealt with the public and private sectors as a supplier of new technologies, another questionnaire was developed to survey various vendors. The list of surveyed vendor firms is shown in Table 3. Given the same previously stated limitation on the number of firms that could participate, the ones chosen included some that have been successful and some that have not been successful in having their new technologies adopted on Corps projects. A sample of the vendor questionnaire can be seen in Appendix D.

The issues and problems suggested by the findings of this survey are presented and discussed in the following sections.

Responsibility for Introducing New Technologies

A summary of the responses to a question about the organizational push for the introduction of new technologies is shown in Figure 6. Although the average (mean) effectiveness ratings are reasonably close for the Corps ($\bar{X}$=3.2) versus the private sector ($\bar{X}$=3.8), the distribution of responses is very interesting. Based on these responses, it appears that private sector respondents perceive that their organization promotes the use of new technologies to a greater extent than do their counterparts in the Corps. The narrative answers showed a diverse response among Corps offices. Some Corps offices actively stressed

Table 2

Location Surveyed

Headquarters, U.S. Army Corps of Engineers

Corps Field Operating Activities

- Albuquerque District
- Baltimore District
- Detroit District
- Kansas City District
- Little Rock District
- Lower Mississippi Valley Division
- Louisville District
- Mobile District
- Missouri River Division
- Norfolk District
- Omaha District
- Ohio River Division
- Sacramento District
- Seattle District
- South Atlantic Division
- Vicksburg District

Non-Corps Government Agencies

- Capital Development Board (State of IL)
- General Services Administration
- Naval Facilities Engineering Command
  (Great Lakes, IL; Norfolk, VA; San Bruno, CA)
- U.S. Veterans Administration

Directorates of Engineering and Housing

- Fort Eustis, VA
- Fort Hood, TX
- Fort Knox, KY
- Fort Lewis, WA
- Fort Ord, CA
- Fort Rucker, AL
- Fort Sill, OK

Private Industry Organizations

- Bechtel Civil Inc.
- Bethlehem Steel
- Fluor Daniel
  (General Motors (Argonant Division)
- GTE Service Corp.
- IBM
- Marriott Corp.
- Tishman Research Corp.
- Xerox Corp.

Table 3

Vendors Surveyed

Alside, Inc.
A.W. Chesterton
Belzona Molecular
Glidden
Norandex, Inc.
Omega Engineering, Inc.
USG Corporation
U.S. Steel
W.R. Grace Co.

the adoption of innovative technologies—especially those with potential benefits. In other Corps offices, however, the use of innovative technologies was a more neutral issue, judging from the responses. Personnel were neither encouraged nor discouraged from using new technologies. Most Corps personnel surveyed were not aware of any specific organizational policies about the use of innovative technologies.

Procedures for Introducing New Technologies

Survey results revealed some interesting items regarding Corps FOAs' interpretation and execution of the regulations covering the adoption of new technologies. For example, most of the FOA respondents were unfamiliar with the provisions of the relevant ERs (except the VE program). Most FOA respondents said they have procedures to incorporate new technologies into project plans and specifications. However,the respondents were not sure that these procedures conformed to the regulations—they just followed what they had done previously or what someone else before them had done.

When asked to identify the greatest hindrance to the processes used to incorporate new technologies into use, 60 percent of the Corps respondents who answered pointed to the various long and involved review and approval processes. (Generally, a project schedule does not allow time for any approval process beyond the local office.) Thirty percent of the respondents said time and staffing constraints were the major hindrances; they said there is no time to collect any reliable technology performance data if such information is not already on file.

Several Corps respondents said they believe the VE program is worthwhile by encouraging the Corps/Army to use and benefit from alterative materials, material systems, and technologies. However, nearly an equal number of respondents stated that the VE program was far too often just an opportunity for the contractor to profit from substituting inferior materials on a job.

Some survey questions addressed the influence of CEGS on the adoption of innovative technologies. Several expressed the opinion that anything not in the Guide Specifications is not allowed to be used on Corps projects. (Two people from different offices admitted that this response is sometimes used as a "cop-out" when someone suggests a technology not in the guide specifications but no one has time to evaluate it. Others felt that CEGS are too restrictive, and that following them too closely "stifles" their ability to use new technologies. Approximately 50 percent of the Corps employees surveyed said they believe CEGS do not reflect the state of the art. (Although the questionnaire used the phrase "state of the art," the term was defined for participants to mean "state of the *market*" in accordance with the definition of terms in Chapter 1.) About 30 percent of the Corps respondents stated that, for the most part, CEGS do reflect the state of the art. The remaining respondents were noncommittal on this question. None of the respondents was aware of the automatic CEGS update and review cycle.

(SELF-ASSESSMENT BY RESPECTIVE GROUPS)

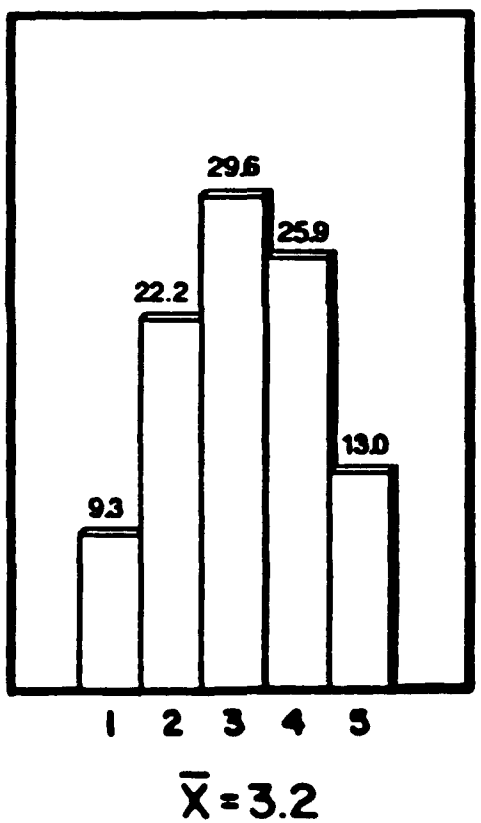
1 = Strongly Disagree (doing a poor job)

5 = Strongly agree (doing an excellent job)

CORPS

PRIVATE

PERCENT OF RESPONSES



PERCENT OF RESPONSES

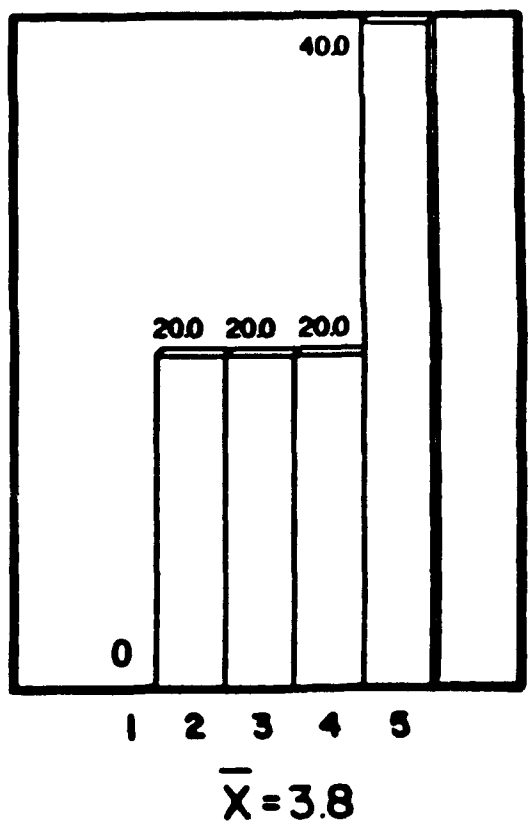


Figure 6. Assessment of Organized Push for Introducing New Technologies.

Several engineers from different FOAs gave an example where the guide specification for an electrical switching device they had been using for years represented old technology. In fact, this particular outdated device was a special-order item because it had been replaced on the market by a newer off-the-shelf technology. The Corps, therefore, was paying more to acquire an outdated technology simply to meet an outdated guide specification. However, one office showed that the Corps had finally caught up, having just published a new CEGS for the newer technology item.

Several FOAs also gave examples where the CEGS and the corresponding TMs and EMs for that technology are not consistent. Usually TMs and EMs are several years out of date, and may even contradict the CEGS. One FOA gave an example where an architect/engineer (A/E) firm designing a project was going to select an alternative material listed in the CEGS. The firm had specified this type material on many non-Corps projects and had complete confidence in its application for this project. However, the corresponding TM they were given stated that HQUSACE approval was necessary before this technology could be used. The A/E decided not to specify the material of first choice, but used another that did not require a lengthy approval process. When the contract was awarded, the contractor submitted the A/E's material of first choice as a VE suggestion, and the contractor's suggestion was accepted. Thus, the contractor ended up making money (and the Corps ended up spending money) on a VE suggestion to use a technology that the A/E firm was originally going to specify had the outdated TM not discouraged it.

Disseminating Information on New Technologies

The questionnaires revealed that most of the Corps personnel surveyed felt that feedback was a major problem in the adoption of new technologies. Most stated that communication deficiencies exist in every direction within the Corps hierarchy. In particular, feedback (e.g., case histories, lessons learned) from field experiences with new technologies is considered unsatisfactory. Personnel are reluctant to communicate failure and yet have little time to properly document their successes. The result, however, is that others in the Corps who need such information do not receive it. A Corps office may either overlook an application of a beneficial new technology, or may "reinvent the wheel"—including any bad experience—because of the lack of shared information.

Most Corps respondents said that Engineer Form 3078, "Design or Project Deficiency Report and Recommendation," is ineffective in communicating information on specific field applications. One respondent stated that he no longer bothers with the 3078 since it appeared no one paid any attention to them anyway. Civil Works personnel were unfamiliar with this form and do not use anything like it.

The Corps questionnaire was mainly intended for engineering personnel but several construction personnel also answered the questionnaire. Their responses were tabulated separately. Figure 7 summarizes the responses by both engineering and construction personnel to a question on the effectiveness of Corps procedures for the dissemination of information. About 40 percent of the Construction Division personnel interviewed rated these procedures as poor because of inadequate communication of field experiences back through the organization.

Part of the communication problem arises from the size of the Corps, which has 40,000 employees distributed among 37 offices worldwide. Nevertheless, better communication on the use of innovative technologies would be of benefit to the Corps.

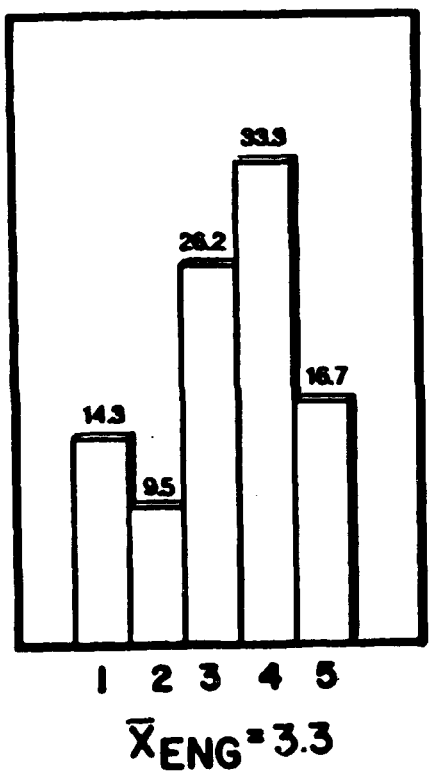
(SELF-ASSESSMENT BY RESPECTIVE GROUPS)

1 = Strongly disagree (doing a poor job)

5 = Strongly agree (doing an excellent job)

ENGINEERING PERSONNEL

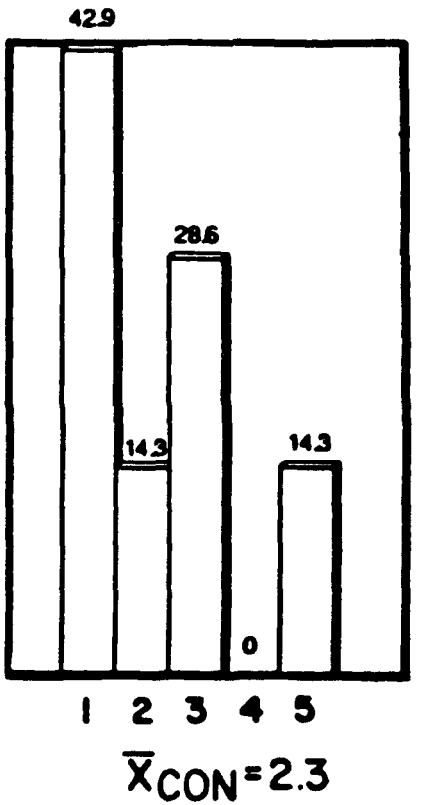
PERCENTAGE OF RESPONSES



$\bar{X}_{ENG} = 3.3$

CONSTRUCTION PERSONNEL

PERCENTAGE OF RESPONSES



$\bar{X}_{CON} = 2.3$

Figure 7. Assessment of Processes to Disseminate Information.

Effectiveness of the Procedures for Introducing New Technologies

Several factors that can promote the adoption of new technologies were identified in the survey:

1. Supportive management atmosphere;
2. Individual drive;
3. Customer needs;
4. Cost savings;
5. Improved system performance; and
6. Adequate time to respond.

The survey indicated that most Corps personnel believe there are few incentives to make the extra effort usually required to become an all-out champion for a new technology. Some respondents listed professional recognition and monetary awards from suggestion programs as incentives, but monetary awards currently available were not considered to be significant. On the other hand, private industry personnel listed monetary awards (sometimes up to 50 percent of their annual salary) as their top incentives available for promoting new technologies. A summary of responses on incentives is given in Table 4.

The top two deterrents to the adoption of new technologies by both the public (including non-Corps Government agencies) and the private sectors were the same: (1) risk (unknown performance) and (2) time constraints (Table 5). The narrative answers from the questionnaires, however, revealed significant differences in the meaning of these answers between the two groups. The private sector would often spend the extra time (i.e. over and above normal expected performance) to research the available information in order to minimize risk* and develop accurate expectations about performance. Although Corps personnel exhibit high levels of professional integrity and initiative, numerous institutional disincentives greatly discourage their extra effort. Survey responses indicate that public-sector personnel widely perceive that the disincentives for extra effort outweigh the potential rewards. In the private sector the rewards can be substantial thereby encouraging an "above and beyond" effort.

Figures 8 and 9 compare how various categories of survey respondents ranked their respective organizations' overall effectiveness at adopting innovative new technologies while assuring the construction of reliable, low-maintenance facilities. Figure 8 shows that engineering personnel believe the Corps is effective in this regard while over half of the construction personnel surveyed believe the Corps could be doing much better. With an average rating of 4.5 (Figure 9), the private sector respondents perceive their organizations as very effective at adopting innovative technologies into construction and maintenance activities.

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* The issue of risk as a deterrent to the adoption of innovative technologies applies to A/E contractors as well as Corps personnel. A/E risks and opportunities must be considered in the context of USACE guidance and direction. An A/E firm under contract with USACE will ultimately assume responsibility for the integrity of a facility's design. If USACE design reviewers are not comfortable with an innovative product being promoted by an A/E, it is unlikely the item will be approved. Likewise, if USACE personnel promote a new or innovative technology, the A/E must be equally confident in its use and anticipated performance in order to assume that responsibility. If the A/E does not concur with such a recommendation, it is unlikely that an FOA will mandate the use of the item. Even in the established practice of value engineering, an A/E's acceptance of VE study recommendations is generally voluntary. An FOA will generally not mandate VE recommendations over an A/E's objection. The mitigation and/or transfer of risk must be addressed both in technical communications between Corps and contractor and in the composition of the contract itself. Another deterrent to A/E promotion of innovative technologies can be attributed to the current design services fee structure, which does not allow an A/E firm to conduct extensive product research during design development. Also, exploration of innovative technologies is further discouraged (at least implicitly) with the extensive engineering guidance the Corps provides contractors. Such guidance can imply a technology which is "acceptable" and "safe" to the Corps.

Table 4

Existing Incentives To Use Innovative Technologies (in Design Phase)

Corps/Government Agencies	Private Sector
None	Monetary awards
Professional recognition	Cost savings
Monetary awards	Repeat business
Self satisfaction	Professional recognition
Customer need	None

NOTE: Survey responses are listed in descending order from most common to least common.

Table 5

Existing Deterrents To Using Innovative Technologies (in Design Phase)

Corps/Government Agencies	Private Sector
Risk, unknown performance	Risk, unknown performance
Time constraints	Time constraints
Level of effort necessary	Cost, (need for profit)
Guide specifications	Resistance to change
Resistance to change	None

NOTE: Survey responses are listed in descending order from most common to least common.

(SELF-ASSESSMENT BY RESPECTIVE GROUPS)

1 = Strongly disagree (doing a poor job)

5 = Strongly agree (doing an excellent job)

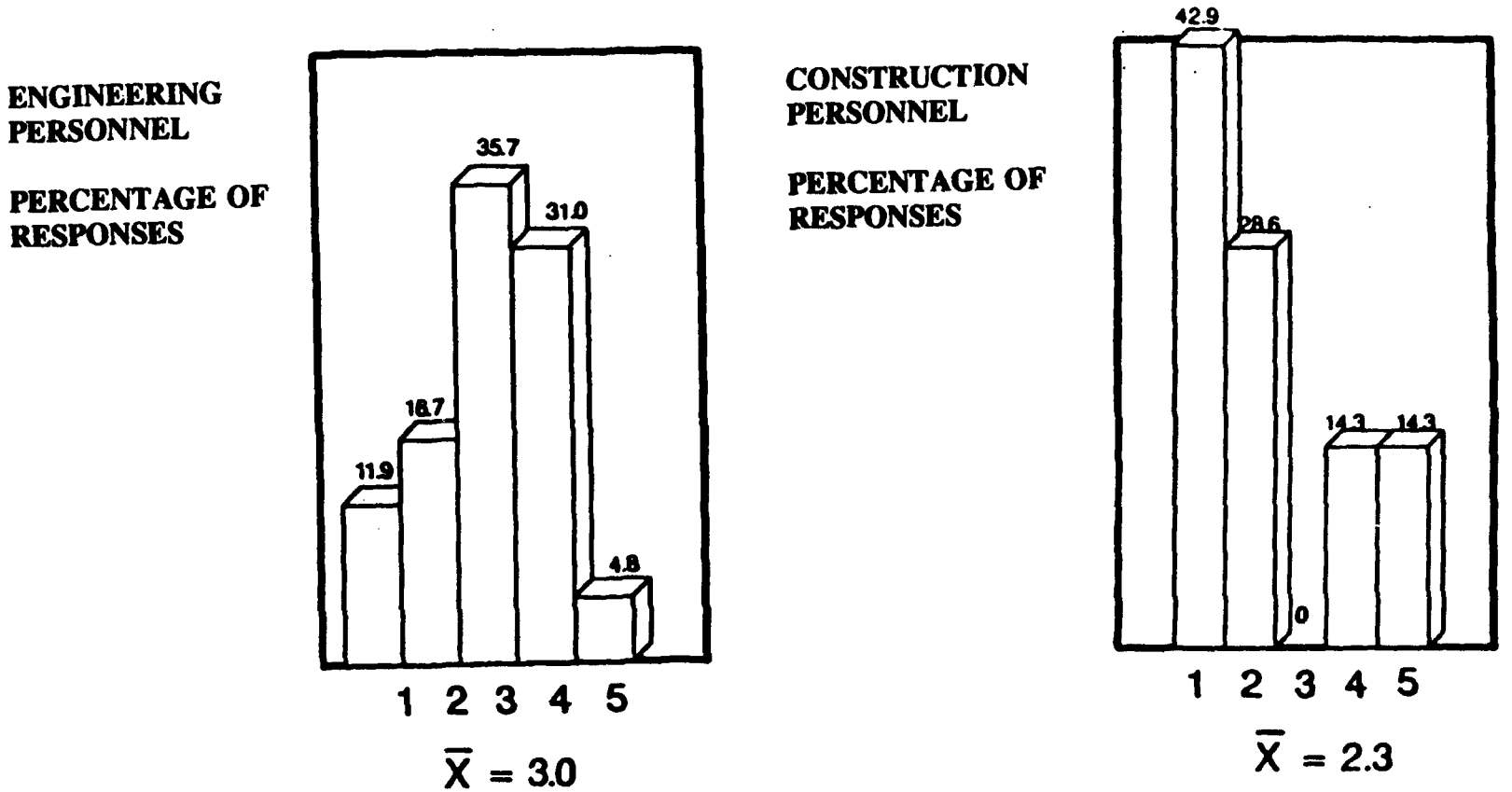

Figure 8. Corps Effectiveness in Adopting Innovative Technologies While Assuring Construction of Reliable, Low-Maintenance Facilities (as Rated by Personnel Surveyed).

(SELF-ASSESSMENT BY RESPECTIVE GROUPS)

1 = Strongly disagree (doing a poor job)

5 = Strongly agree (doing an excellent job)

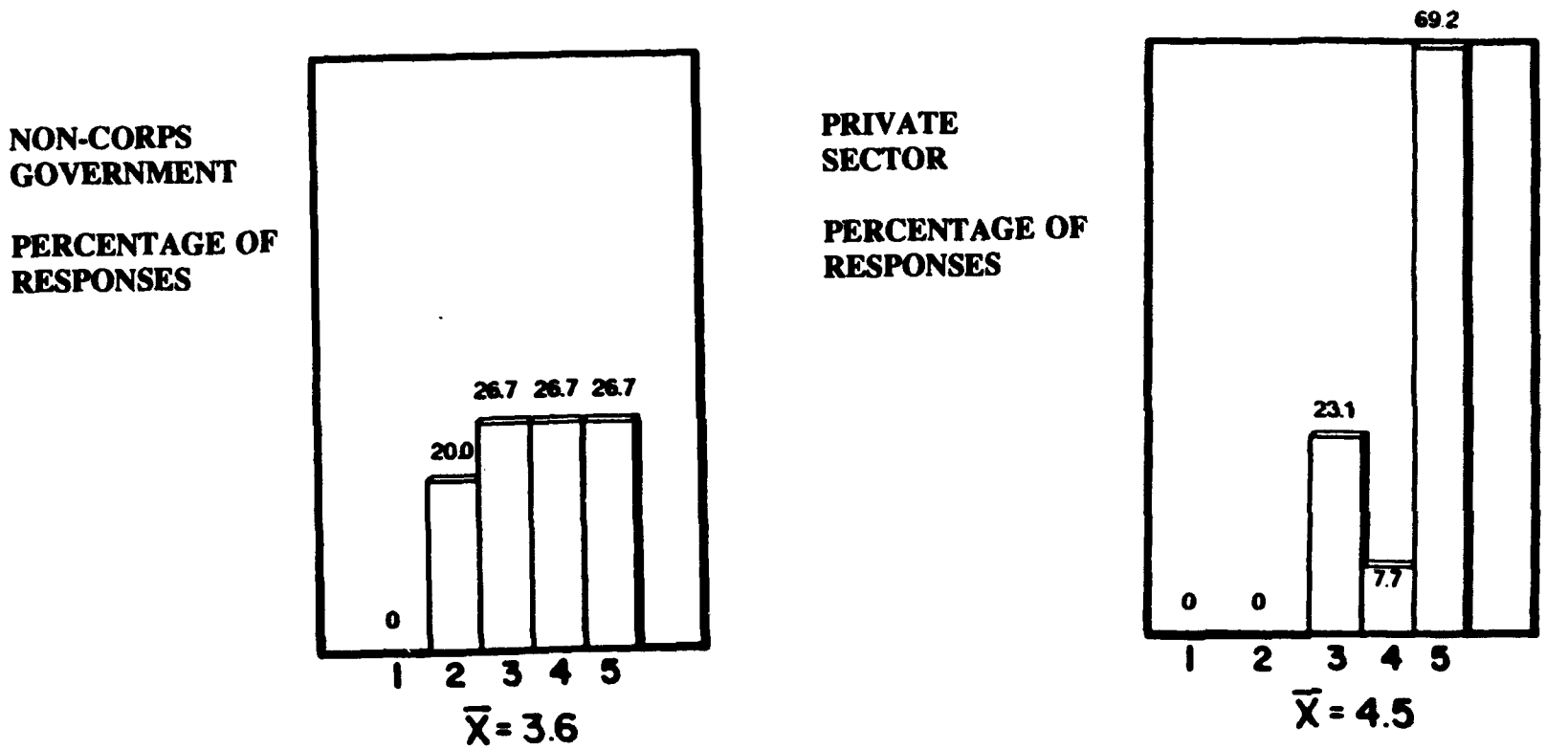

Figure 9. Effectiveness of Non-Corps Government Agencies and Private Industry Organizations in Adopting Innovative Technologies (as Rated by Personnel Surveyed).

Implementation of Innovative Technologies—Two Case Studies

In a further effort to establish a benchmark of performance and identify any additional factors that influence how technologies are adopted, case studies of two different technologies were initiated: passive solar heating and single-ply roofing. These two items were selected because of their levels of development; it was believed that the Corps was ahead of the private sector in passive solar heating but behind in the application of single-ply roofing. The study was performed on contract to maximize objectivity.

It was found that the Corps can be considered about 5 years ahead of the private sector in using and benefitting from passive solar technology.[20] This difference is largely due to the economic situation at the time the study was conducted. With energy costs low, as they were when the study was done, the private sector has little incentive for specifying or further developing this technology. The Corps, on the other hand, has been mandated by Congress to use this technology. This is not to say that the Corps' lead in this area is permanent; the private sector could very well catch up if spurred, for example, by a significant permanent increase in fuel costs.

In the area of single-ply roofing applications the Corps was found to be about 10 years behind the private sector.[21] Much of this lag is due to the Corps' conservative approach to new technologies and its reluctance to accept and enforce long-term product warranties. Again, this is not to say that the development gap will remain fixed. In fact, increased acceptance of this technology by Corps FOAs has already begun.

The purpose of these case studies was to demonstrate that the Corps can be ahead of the private sector in some technologies while behind in others. The findings demonstrate that it would not be easy to accurately quantify, in absolute terms, an overall difference between the Corps and the private sector in terms of their success at adopting innovative technologies.

One major inherent difference between the Corps and the private sector deals with the Federal Acquisition Regulations (FARs) and how they govern the Corps procurement practices. The fact that innovative technology developments are often proprietary also limits how and when one specifies a technology for a Corps project. Other factors, such as the requirement for multiple bids and public announcements of contracts over a given dollar amount, also affect how and when the Corps utilizes new technologies. By nature, Government organizations operate differently than the private sector, and this may effectively burden the Corps with an inherent overall lag behind the private sector in the adoption of innovative technologies. However, this lag does not mean that the Corps must be a constant follower; for certain technologies the Corps should be the leader while in other technologies it should be progressive enough to minimize the lag behind the private sector and benefit from the new technologies without undue delay.

DEH and Air Force Interviews

DEH and U.S. Air Force (USAF) personnel were interviewed to learn how well the Corps' customers believe the Corps is doing in providing reliable, cost-efficient facilities that employ the latest technology advances. A separate questionnaire was developed for DEH personnel (Appendix D) and Air Force personnel were interviewed in person based on the DEH questionnaire.

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[20] Charles C. Lozar, *Innovation Adoption Case Studies: Passive Solar and Roofing Technology*, unpublished report, contract DACA88-87-M-1724 (Architects Equities, Inc., Champaign, IL, 14 November 1987).

[21] Charles C. Lozar.

The DEH responses to the four main topic areas were very similar to those obtained from the Corps District and Division offices. A major difference was noted, however, between certain limitations that the DEH and the Corps Districts and Divisions work under: the DEH is not required to use CEGSs unless the project is to cost more than $200,000. (When construction or rehab projects exceed $200,000, job authority reverts to the Corps District office with appointed jurisdiction and the project is subject to CEGS again.)

Of the DEH engineers interviewed, less than 25 percent knew anything significant about (or had any involvement with) FEAP. However, most of those who were familiar with the program acknowledged its benefits and stated their support.

Interview responses by Air Force Engineering Command personnel at three site offices indicated reasonable pleasure with Corps support, with only two areas of concern cited:

- The Air Force Engineering Command is not afraid of the Corps designing anything less than reliable faciliti In fact, the concern is actually one of over-design, which in most cases means higher costs ov more conservative designs. Although this may not have any direct bearing on the Corps performance in adopting/incorporating new technologies, it is important to make note of the Air Force's perception regarding this issue.

- Respondents indicated that they felt the Corps is sometimes unresponsive to Air Force requests regarding the incorporation of certain new technologies that the Corps has not yet adopted, or even more common items not normally covered in the Corps' specification/procurement packages (e.g., office furniture).

Vendor Questionnaires

As previously stated, the vendors of new technologies were also included in this study to provide an assessment of the Corps by an external observer familiar with the organization. The vendor questionnaire focuses on how the vendors develop and promote new technologies, with specific references to their dealings with both the public and private sectors. A strict one-to-one correlation between questions on the Corps questionnaire and the vendor questionnaire was not established, however; it was considered unrealistic to ask the vendors to judge how the Corps performs its duties in the framework of the four previously described main topic areas. Vendor responses are recognized to be somewhat subjective and opinionated, but they provide useful insights not available through other groups surveyed.

All of the vendors acknowledged that either selling directly to the Corps or serving as a supplier for a Corps project usually required more time and effort than dealing with the private sector. One respondent even stated that his firm was not sure it was worth dealing with the Corps because the effort required to conform to the procurement rules significantly increased overhead and reduced profits. The situation this vendor described is mainly due to the FARs. The vendors also stated that private-sector organizations were more likely to specify and use a new technology sooner than most public-sector organizations. Overall, the vendor responses support the survey findings and self-assessments pertaining to the organizations' effectiveness in adopting innovative technologies.

Usefulness of Survey Responses in Setting Technology Adoption Benchmark

A few words should be said at this point about the subjective nature of the responses obtained by the questionnaires. It is true that the answers to most of the questions were not quantitative in nature, but mainly reflect the opinions of the people surveyed. In the section "Effectiveness of the Procedures for Introducing New Technologies," the private sector responses showed that its personnel perceive the firms

they represent to be more advanced and effective in adopting new technologies than their USACE counterparts do about the Corps. Corps respondents think their organization is doing an average job in the adoption of innovative technologies, collectively rating themselves 3 on a scale of 1 to 5. It may be asked whether this self-assessment reflects the perceptions of the respondents or rather what they think everyone else perceives. For the purposes of this study, however, the question is moot. The validity of the self-assessed ratings of both the Corps and private-sector groups surveyed is supported by the responses of vendors involved with both groups. Self-perception is an important factor to measure in this research; it can have the effect of a self-fulfilling prophecy. It makes no difference what technology adoption mechanisms are in place if the users of these mechanisms (i.e., HQUSACE and FOA personnel) do not perceive that they are effective and, consequently, fail to use them.

The best useful benchmark this research can establish for Corps performance in adopting innovative technologies is the Corps' average effectiveness self-rating of 3.0 (as assessed by engineering division personnel and shown in Figure 7). This rating is 1.5 points below the private-sector rating of 4.5 shown in Figure 8. This benchmark, however, does not imply that the Corps is some number of years behind private industry. The two case studies cited illustrate why the benchmark has no meaning in that regard; the Corps may be years behind the private sector in some technologies and years ahead in others. This research makes it apparent that to establish a more absolute performance rating would be very difficult (and expensive) if possible at all. Although this study did not establish an absolute benchmark as originally envisioned, the questionnaires revealed important problems to address and, to a significant extent, verified the generally perceived strengths and weaknesses of the current technology adoption process. This research leaves little doubt that the Corps, like other Government agencies, has an inherent adoption lag compared to the private sector in technologies developed in the private sector—especially in proprietary technologies. With this as a given, the job now is to address the identified deficiencies and improve the overall system. With actions to improve the current system (e.g., develop a Corps of Engineers Technology Adoption System [CETAS] as described in the following chapters) and to encourage the organizational perception of being one of the leaders (or key partners) in the development of advanced construction technologies, the Corps will be able to minimize any technology lag, much to the benefit of its customers and the nation.

6 CONCLUSIONS

1. There is no single institutional, Corps-wide approach to the exploration and adoption of innovative building technologies. Although some parts of the overall facility-delivery system address this issue, the system generally functions in an ad hoc manner in this regard, which inhibits efficient technology adoption.

a. No coordinated or cohesive procedures for adopting innovative technologies are organizationally recognized within USACE. An identifiable mechanism and policy is needed to support an approach to *technology management* that explicitly defines responsibility for action. This mechanism must be recognized throughout USACE as the standing operating procedure (SOP) in the programming, planning, design, and construction of military and civil works projects.

b. The existing ad hoc technology adoption process does not provide a uniform practice or policy for Corps FOAs to consider and adopt innovative technologies. Guidance on the use of innovative technologies is dispersed among many documents. Familiarity with (and interpretation of) this guidance differs among FOAs. Some assume a more liberal practice—they use items not currently included in Corps guide specifications and develop local specifications. Other FOAs are more conservative—they will not use any item until it is included in official Corps guide specifications.

c. The existing ad hoc process does not foster efficient *technology management* because it does not provide personnel with sufficient incentives to encourage the initiation and follow-through on potentially beneficial applications of innovative technologies. Corps personnel individually exhibit high levels of professionalism and initiative, and are receptive to new technology developments. However, numerous factors inhibit their incorporation of innovative technologies into daily practice. These disincentives are not necessarily institutional or overt, but they are inferred and perceived to exist; thus, these disincentives are real to those who perceive them. Becoming a "champion" of a new technology requires more time, personal effort, and risk than many are willing to take within the current working environment. Researching and acquiring complete information on a new technology is often not possible within project schedules. Proposing a new technology without sufficient information or validation of performance creates an element of risk. Typical project conditions, therefore, force personnel down the path of least resistance toward the "acceptable," "low-risk," and "achievable." It is widely perceived by Corps personnel that the negative incentives (both obstacles and penalties) far outweigh the potential rewards of championing a new technology.

d. A general Five-Step Technology Adoption Process is practiced in some Corps activities, but it is not universally recognized or practiced throughout USACE. It may be practiced informally to some extent (especially by USACE R&D laboratories), but is not considered a deliberate technology management strategy throughout USACE. Furthermore, not all of the steps function as well as they might. Insufficient funding for field demonstrations (Step 3) greatly hampers the effectiveness of this important step. Also, demonstrations seldom include all elements necessary to fully implement a demonstrated technology. Overlooked elements may include effective publicizing of results, revision or development of engineering guidance documents, training, or authorization documentation. Even after the technology has been demonstrated through some formal demonstration process and the basic engineering guidance necessary to specify or procure the technology has been provided, the success of Step 5 (Application/Use) is not assured. Continued marketing and education are often necessary to make personnel familiar and confident enough with the technology for them to specify its use (i.e., to achieve adoption throughout the Corps and the Army).

2. The existing ad hoc process does not provide sufficient feedback (e.g., case histories, lessons learned) about field experiences with new technologies to potential Corps users or HQUSACE for effective *technology management*. Unless field experiences are part of a formal program (such as T^3B or FEAP, technology applications on the project or FOA level are not usually documented in a way that will be

useful and available to the rest of the Corps. Likewise, information about problems or failures involving new technology applications is generally not disseminated as widely as required. This is probably due to the negative reflections on whoever reports the failure, but the result is that others in the Corps who need the information do not receive it. For this reason, Corps organizations may either overlook the application of a beneficial technology or may "reinvent the wheel"—including any problems—because of the lack of documentation.

3. The existing ad hoc process is nonresponsive to efficient *technology management* for the following reasons:

a. It typically takes too long to draft, review, and publish new or updated engineering and construction guidance documents.

b. It has produced inconsistencies and contradictions between the Corps guide specifications and corresponding engineer manuals and technical manuals. EM and TM content may lag years behind the information in guide specifications.

c. It initiates review and update of CEGS every 3 years, but TMs, EMs, and other engineering guidance documents are not reviewed and updated at the same time, leading to the inconsistencies referred to in the preceding paragraph.

d. It does not include a deliberate and systematic exploration of innovative technologies not already covered by existing guidance documents or practice. It has no effective way to take advantage of actual use of technologies with the process of document revision.

4. The Corps' existing ad hoc technology adoption process does not provide sufficient information on innovative building technologies in a timely fashion. There are no standard format or information content requirements (e.g., performance information, life-cycle cost data, risk factors) for documentation of innovative technologies under consideration. Absence of a cohesive *technology management* approach to documentation inhibits FOAs and HQUSACE from adopting a new technology. Lack of information is an implicit risk; furthermore, there is always some risk associated with an individual's or organization's first use of a technology, even one successfully used in other markets. In many cases technical information may reduce the perceived risk, particularly where failure would not pose a life-safety threat. When such information is not readily available to the appropriate USACE and A/E personnel, however, project schedules and conditions tend to inhibit the effort required to obtain it.

5. The existing technology adoption system does not generally accommodate the time, effort, and review procedures required to promote the adoption of new technologies within the constraints of a specific project schedule. As previously mentioned, a project schedule may not allow the time to collect the information needed to lower the perceived risk to an acceptable level. Also, the time needed for higher-level reviews may not be available. Reliance on the status quo is all that is generally allowed. A system of effective *technology management* must address this practical problem by identifying the cases where local office or field personnel are capable of evaluating and approving an innovative technology application without a high-level review (and the delay it causes).

7 RECOMMENDATIONS

Draft preliminary recommendations have been presented to HQUSACE personnel for their reactions and comments at various times during the latter stages of this study. Over the course of this study, the authors have also given several briefings to HQUSACE personnel regarding the study findings. HQUSACE is obviously interested in improving the Corps performance in this area since some efforts in this direction have already arisen from these briefings and draft recommendations. This report represents a final list of recommendations based on the present study.

The following information addresses the need to establish a single, comprehensive approach to the adoption of innovative building technologies, whether developed inhouse (i.e., through a USACE R&D laboratory) or in the commercial marketplace. This comprehensive approach includes a number of recommendations: some are specific, others are general or abstract, but all have a role in a systematic approach to technology adoption.

Recommendations pertaining both to global technology adoption needs and specific needs are made. In some cases the recommended action is very specific; in others, it is more conceptual. Some recommendations will require additional development before they can be implemented. In these cases, the required level of detail exceeded the scope of this general study. Each recommendation is considered to be of about equal importance and all are necessary for the maximum enhancement of the Corps' effectiveness in adopting new building technologies. Some action items will require more time and resources than others, especially those for which further development is necessary. Simultaneous action on several recommendations is feasible and expected; completion of one recommendation is not necessary for the initiation of another.

Overall Technology Adoption Needs

The most important overall need is to establish a cohesive, universal Corps of Engineers Technology Adoption System (CETAS) to identify and adopt new construction and maintenance technologies that will reduce costs for the Army, improve product performance, increase productivity, etc. The success of CETAS will depend on two considerations:

1. An overall institutional environment within which CETAS can exist, including administrative endorsement and continuing support of CETAS, effective applications, appropriate personnel and time considerations, and practical use of CETAS in USACE operations.

2. Effective mechanics of CETAS, including detailed mechanism procedures, the interrelationship of various mechanisms and activities, and information and technology transfer media.

The current technology adoption process has some, but not all, of the necessary elements for CETAS. The following recommendations are made to create a cohesive system from the incomplete ad hoc process currently in place. These recommendations would establish the required elements of an institutional environment and the adoption mechanisms for CETAS to successfully sustain itself as standard USACE practice.

Recommended Action Items

1. Provide a single, clear statement, applicable at all levels of the organization of CETAS philosophies and goals regarding the application of innovative construction technologies. This statement should serve as an identifiable model for USACE personnel at all policy, management, and technical levels to foster a team approach. The statement should clarify the USACE objective of achieving economic and

performance advantages available from new technologies. It should also reinforce USACE quality objectives through pursuit of new technologies in a calculated manner to avoid undue risk. To better ensure uniform practice, a single unifying Engineering Regulation should be written to provide guidance to FOAs on how to accomplish the stated goals.

a. This guidance can encourage positive action toward innovative technology adoption by making the "rules of the game" known and understood by everyone involved. For the same reason these "rules of the game" should be made known outside the Corps (i.e., to the design and construction technology community) as well as within.

b. Changes to existing ERs or the issuance of a new ER on the adoption of new construction and maintenance technologies will not in itself effectively inform personnel at the grass roots level within the Corps. A multidirectional approach, including training seminars, will be needed to promote USACE policies and philosophies concerning the use of new technologies. Policy and philosophy information can be passed on to the design and construction technology community via press releases, seminars, and everyday professional and business contacts.

c. While a single ER may be the "beacon" for new technology policy, a thorough document review will be necessary to achieve and maintain consistency. The ER on CEGS, for example, will have to be revised to encourage exploration of new technologies, expedite the review and approval process for non-CEGS technologies, etc.

Published engineering guidance may effectively inform USACE personnel of an institutional policy on the exploration and adoption of innovative building technologies, but translation into practice must address a multitude of issues and constraints. Some of these include personnel incentives and disincentives, the assumption of risk, time constraints, information availability and dissemination, procedures involving the USACE and Army chain of command, and the expectations of USACE customers about time, cost, and quality. These issues are addressed in the following recommendations.

2. Establish the Five-Step Technology Adoption Process as the recognized Corps mechanism for carrying out CETAS policies and philosophies concerning the adoption of innovative construction and maintenance technologies.

a. In addition to the basic functions described in Chapter 3, the Five-Step Technology Adoption Process must also fully address the following issues to be most effective:

- Actively identifying new technologies whether developed within the Corps or somewhere else.
- Determining the suitability of innovative technologies to the needs of USACE and the Army.
- Evaluating, testing, or otherwise validating the performance of innovative technologies under consideration.
- Acquiring pertinent technical information and disseminating it to all appropriate parties.
- Actively implementing and promoting technologies into USACE practice at the working level.

- Monitoring a new technology's performance and providing feedback into the technical information system.

- Maintaining current information and practice pertaining to the new technology.

b. While everyone in the organization will not affect every step of the process, or even every component of a given step, the importance of each persons' contribution to the five-step process must not be underrated. Success on an institutional level will depend on a successful team effort, with everyone recognizing their potential contribution and acting accordingly. For this to happen, the five-step process must be introduced into everyday thinking of the Corps family, especially technical and professional personnel involved in any phase of project design and specification. Everyone must become aware of the philosophies and components of the five-step process and understand how they may best support the process in their everyday activities.

c. Establish a single, identifiable means of coordination among all HQUSACE Engineering disciplines, the national teams, and USACE laboratories to promote and direct CETAS. The Corps of Engineers Advanced Construction Technology Team (CENACTT) would be a logical candidate to assume a technology advancement liaison and steering capability, as this relates directly to its charter. With the necessary authorization and authority within USACE, and input from the other national teams, HQUSACE Engineering and Construction divisions, labs, and TCXs, CENACTT would act as the promoter and manager of this process.

3. Enhance the incentives for initiating and following through on the application of new technologies in support of CETAS. Rewards are needed for individuals who go "above and beyond" what is considered reasonable effort within project conditions. Also, institutionally imposed disincentives should be removed to encourage new levels of individual professionalism and initiative.

a. Provide individuals with incentives to champion new building technologies. Reward project personnel on a project-specific basis where adoption of a new technology has resulted in a higher quality project delivered on time and under cost. Also provide individuals with incentives to champion new technologies that will improve the productivity and efficient use of resources in serving military facilities on a general basis. Individuals should also be offered incentives to actively promote new technologies through Engineer Form 3078s and the Suggestion Program. Proposals would be encouraged, and would be rewarded if submitted in a manner complete and compelling enough to merit further investigation, document revision, or other action toward implementation by HQUSACE.

b. Encourage professional and personal initiative by removing the disincentives to consideration of innovative building technologies. Provide complete and timely technical information to reduce the perceived risks involved with first-time use. Also, establish a capability or service (either internal or out-of-house) to generate and provide pertinent and complete technical information to the appropriate personnel within project time constraints. This service would explore technology alternatives and provide information to keep HQUSACE and project personnel abreast of new technology developments. Work descriptions at both HQUSACE and FOA levels would include consultation of this service, and would also encourage participation in national teams, technology user groups, and professional society committees.

c. Encourage the effective use of technical information by making the necessary adjustments in daily practice. Allow for the routine review of technical information in the day-to-day activities and responsibilities of Corps personnel. Time should be dedicated on a regular basis to reviews of USACE technical information, new product literature reviews or information services, reviews of A/E recommendations, product expositions, or trade and professional seminars. Because the individual's time

is dominated by many demands, technical information must be compiled and disseminated as concisely and efficiently as possible, and readily retrievable for future reference.

d. Simplify the review and approval process for initiatives to use new building technologies not included in current CEGS. According to HQUSACE personnel, a reduction in the number of review approvals for certain technologies has already been initiated, reducing the disincentives posed by time-consuming multiple approvals. The impact of this action, however, was not apparent to FOA personnel surveyed in this study. Since these actions were recent enough that their effects may not have been felt at the FOA level during the time of this study, a follow-up survey on this topic is recommended for sometime during the next 3 to 5 years.

Identifying, creating, and administering the appropriate incentives is a complex issue and must be explored in detail before any attempt at implementation. Such a program must be designed for *concrete results* and must provide *opportunities at every level of the organization.*

4. Actively manage CETAS procedures for drafting, reviewing, and publishing updated engineering and construction guidance documents (CEGS, EMs, TMs, Engineer Technical Letters [ETLs], etc.) for use throughout the Corps. CETAS procedures should treat these documents as a system of documents, and take into account differences in particular media and the various levels of jurisdiction. Publication, review, and update need to be coordinated so one document does not contradict or unnecessarily restrict the guidance presented in another.

a. Initiate a comprehensive *project management* approach to the development and maintenance of *all* relevant engineering and construction guidance documents and other sources of technical expertise. HQUSACE personnel have begun efforts to streamline and expedite the CEGS updating process. However, these improvements may not be far-reaching enough. Project managers would use update "triggers" that initiate revisions in CEGS to also initiate the appropriate revisions of TMs, EMs, and other associated documents. Where these other documents are outside of USACE jurisdiction or follow different revision cycles, explicit guidance should be included in the USACE document on how these externally published documents are to be observed. Update triggers must also require an exploration of emerging technologies that are related in function, nomenclature, or category classification, but may not be covered in the subject document. Rather than preclude the use of a potentially useful new technology by omission, such technologies must be addressed in the existing document, or else a new guidance document must be initiated. Proponents of CEGS normally have a tracking system within their own organization for reporting status to upper management. Instead of establishing another tracking system, the publication, review, and update process could be consolidated into a project management approach involving both the engineering and construction disciplines.

b. Assign the project managers the prime responsibility for developing a process to reduce the technology gap that currently exists between the CEGS and the corresponding manuals. *This is the most important improvement needed in the area of guidance documentation.*

c. Develop a comprehensive information feedback system that will better assist HQUSACE branch chiefs and Huntsville Division personnel in their reviews of new technologies and considerations for CEGS modifications. Development and management of this information feedback system could be responsibilities for the Corps laboratories.

d. Ensure that new technologies originating from all sources are given prompt and appropriate consideration. Draft design and construction guidance (CEGS, EMs, etc.) should be developed and sent to Huntsville Division for further action immediately upon successful demonstration of new technologies in FEAP, the T^3B program, and other demonstrations. Successful demonstrations should be

publicized to other FOAs and DEHs through newsletters and bulletins. Real technology "winners" should be reported repeatedly in new contexts (e.g., performance updates or experiences at different sites) at all levels of the Corps. Providing a complete awareness of the technology, its performance and its benefits at all levels of authority would greatly promote Army-wide adoption of any new technology.

e. Use additional vehicles (e.g., new publications, training programs) for successful dissemination of new building technologies. Some new media arising from this recommendation were launched even before this report was finished. One such publication, the *Engineering Improvement Recommendation System (EIRS) Bulletin*, serves the dual purpose of introducing a technological improvement before its publication in applicable technical documents as well as providing a channel for feedback from field experiences. Other technology transfer media that could play an important part are the *FEAP flyers* and national team bulletins and newsletters. Where appropriate, introduce new technologies in USACE training as soon as practicable, use training provided through private and industry sources, strategic support centers, and TCXs.

5. Establish a CETAS procedure for acquiring and disseminating (i.e., managing) complete and accurate information on new technologies not covered in existing Corps guidance or documentation. This information should be applicable and usable within project-specific requirements and conditions. Complete, credible information will promote appropriate applications of innovative technology, prevent inappropriate applications, increase confidence in satisfactory performance, and reduce the overall risk perceived for a new technology. Providing clear and timely information is imperative so it is useful in the context of project-specific schedules and conditions.

a. Establish a systematic approach to information acquisition and management. Information must be complete, concise, accurate, and current for all new technologies emerging in the construction marketplace. It must be quickly and readily accessible by those who need it, and presented in a usable format. Information on innovative building technologies must be actively sought, gathered, and distributed. Responsibility for compiling information on new technologies may be assigned to the specialists in the technical areas throughout USACE who are routinely involved in the development, maintenance, and management of USACE guidance documents. This responsibility would also include input into a USACE database on what is being done where; those who compile and communicate technical information must be knowledgeable and keep up to date with developments in their area of specialty. Information would also include that generated by the national teams. If USACE is unable to undertake these activities inhouse, then a service to provide this information to USACE, for USACE purposes, should be sought. Professional contacts with appropriate professional and industry groups must be maintained and encouraged. It is critical that the individuals in this information function be knowledgeable and energetic advocates (champions) for the advancement of technology in their specialty area. They should be encouraged to chair appropriate technology-based user groups.

b. A very important part of establishing a cohesive technology adoption system may be Corps support for and participation in the Advanced Construction Technology System (ACTS), an information service currently being developed by the Construction Industry Institute (CII) and USACERL under the USACE Fiscal Year (FY) 89 Construction Productivity Advancement Research (CPAR) program. ACTS would handle the technology transfer of USACERL's Building Technology Forecast and Evaluation (BTFE) system to the construction industry at large. USACE would be a customer of the ACTS service, being both a CII member and cosponsor of ACTS development. The ACTS service will identify new construction technologies (to promote awareness) and compile and transmit information as required by individual customers to provide specific working information. ACTS services could also include technical evaluations, performance monitoring, information dissemination, and other activities to be arranged on a customer-specific basis. This procedure represents a proactive (rather than a reactive) approach to the acquisition and dissemination of information on new technologies. It is expected that this

information will enable HQUSACE-personnel, project managers, and design and engineering personnel to more efficiently assess the feasibility and potential applications of a new technology in a timely manner, and help them make the appropriate selection, design, and specification using that technology. This information should be applicable throughout the Corps on a project-specific basis. A liaison will act as an intermediary between the ACTS service and its customers, providing the avenue by which ACTS customers can input their technology interests and information requirements into the system. The ACTS service will, in short, be a responsive provider of usable information for its customers. It is expected that an ACTS service will be established and operational by the fall of 1992. The ACTS service, therefore, will be in a position to conduct technology exploration, evaluation, and information management on behalf of USACE without involving a considerable amount of inhouse resources. While ACTS itself will not constitute the entire CETAS, its contribution should be significant.

c. Identify the critical information requirements at different USACE levels relative to the preparation of CEGS and manuals for new construction as well as project specifications for facilities maintenance. Information should be packaged appropriately for the needs of the affected USACE users at every level of the organization. T^3B and FEAP processes may serve as models.

d. Ensure that information generated from T^3B and FEAP Programs is included in the Corps-wide pool of information—especially the ACTS service—on new technologies. Require a plan for each demonstration to identify any necessary actions (document revision, document development, training, etc.) and who should implement the subject technology within USACE. Specifications or other appropriate guidance media should be drafted for those technologies that have had successful demonstrations and sent to HQUSACE and Huntsville Division for further action. As part of this effort, take advantage of technology user groups, the T^3B national teams, and USACE laboratory resources.

e. Obtain and provide complete operation and maintenance information for new technologies since maintainability is a major consideration when adopting new technologies. This information will reduce the resistance to new technologies that arises from lack of information about operating expertise, spare parts inventories, maintenance activities, etc. Training seminars may also be necessary to prepare the user to implement the new technology and use it to its maximum capabilities. Maintenance feedback must be gathered to establish a history file on performance reliability that would feed back into the document review and update process.

f. Support the development and adoption of new technologies through the CPAR program. CPAR activities by USACE laboratory and FOA personnel should include acquisition and dissemination of information on the technologies developed through the program. CPAR provides an excellent opportunity to cooperatively develop (with university and private-sector partners) innovative construction and maintenance technologies that can benefit both the Corps and the construction industry.

g. Overall, FEAP is considered by many in the Corps to be very successful in its mission of technology transfer partly because the program coordinators are constantly looking at how to improve the program. (For example, current program discussions deal with how to facilitate Army-wide adoption.) The T^3B Program is not as old as FEAP but is growing in importance, as is CENET, one of its steering groups. Another national team, CENACTT, has languished since the HQUSACE reorganization, however. To counter this problem, reactivate CENACTT, select a new HQUSACE co-chair who is an active supporter of adopting innovative technologies, and designate CENACTT as the lead team within USACE for the adoption of innovative construction technologies. This would involve many of the recommendations included in this study. Funding and staff commitment to CENACTT activities must be at a sufficient level to accomplish this mission. CENACTT is also a logical candidate to represent USACE (alone or with others) in an ACTS liaison functions. Continuation of the working relationship between the Construction Research Center (CRC) of Georgia Institute of Technology and CENACTT is also

encouraged. Georgia Tech has just completed a conceptual plan for the establishment of a technology transfer and information retrieval center accessible to the Corps. This retrieval system would support the CENACTT mission and augment the ACTS service previously described.

h. New construction materials, systems, or procedures can take several years of laboratory development to be ready for field demonstration projects. At current RDTE budget levels, the annual number of technologies developed by the four Corps laboratories that fit under the mission of CENACTT and that are ready for technology transfer activities will be small. Many innovative construction materials and systems developed in the private sector do not need further R&D to be used by the Corps and Army. All that is needed is knowledge—awareness of the technology and performance/design information. The scope of CENACTT should be broadened to include evaluation and documentation of externally developed new technologies used on Army sites, governmental projects, and private-sector jobs. (This assumes approval by private sector owners of the technologies of interest.) This new CENACTT activity could provide valuable information not otherwise readily obtainable. In addition to the usual T^3B technology transfer procedures, the information from these evaluations would also be forwarded for inclusion in the ACTS service information.

i. A single T^3B or FEAP demonstration project and the subsequent report on its results is usually not sufficient to effectively disseminate or transfer a technology throughout the Corps/Army. An "after-demo" marketing plan should be developed especially for major technologies that offer a significant benefit to the Army but require an extra effort to make people aware of and comfortable with the technology. Such a plan would require multimedia release of information and a training program. Each national team or FEAP coordinator would be responsible for the development and execution of an appropriate marketing plan.

j. Complete and accurate information on all aspects of a new technology is needed before that technology will find general acceptance. In some cases, however, the existing information base may not be sufficient, or the validity of performance claims may be questionable. In these situations, evaluation by one of the Corps R&D laboratories may be warranted, especially if the technology offers high potential benefits. The Corps R&D laboratories' mission should, therefore, include the responsibility to investigate promising new technologies that would otherwise be missed in the R&D effort. (This mission would not include evaluation or testing of an item from a new vendor if that item represents an already established level of technology used by the Corps.) Requests for technologies to be evaluated could come from HQUSACE, FOAs, DEHs, or laboratory personnel. The benefits of such a mission would be twofold: first, it would provide the performance information needed in the field to more effectively and safely specify the use of a given technology; second, exposure to new ideas developed out of house can stimulate additional ideas for the advancement or innovative application of the technology, creating extra benefits to the Army.

6. Introduce a *technology management* approach, specifically and directly in support of CETAS, to acquiring and disseminating feedback from field experiences with new technologies. This would involve consolidating the existing feedback channels, both formal and informal, and expanding them into additional areas. Both successes and failures (i.e., failure to perform up to expectations) should be communicated; detailed communication on failures is quite important. Sometimes only a minor design or application change is needed to transform a technology failure into a success. Also, the failure of a technology for one particular application does not necessarily mean that the technology will not succeed in another application with a different set of circumstances. In general, an effective feedback process would do much to expedite the widespread use of successful new technologies and add to the database of performance expectations and maintenance requirements. Such information must be readily available to project management and design personnel to be useful on a project-specific basis.

a. Maximize the use of information available from field and construction experiences, and disseminate it to all appropriate USACE offices. Encourage the use of Engineer Form 3078 through appropriate incentives or inclusion in employee performance standards. Include issues other than deficiency reports on 3078s, such as experience with a new technology, recommended applications, or sources of information. The scope of Engineer Form 3078 should be expanded to include civil works as well as military activities. Prevent any negative impacts on personnel who report negative experiences or failures if such occurrences were not the result of negligence or an obvious misuse of technology.

b. Expand the use of feedback information sources currently available to USACE. The Value Engineering Retrieval program (VETRIEVAL) is one such source. Currently, VE experiences are logged and filed but are not readily known outside of the personnel directly involved. Many ideas and potential lessons learned are also acquired at the construction site; collection of such construction expertise must be encouraged, and the information must then be adequately disseminated for use in design development on a project-specific basis. Private-sector experiences with new technologies should also be documented by performing case history studies on selected topics (e.g., the previously proposed CENACTT activities concerning evaluations of private sector applications of innovative technologies). Involve designers in construction projects to promote exchange of ideas between designers and builders.

c. Require FOAs to be responsible for the evaluation and documentation of first-time applications of new technologies, either by inclusion in the original project specification or through field-initiated modifications (VE program, etc.). Reevaluations must also be made periodically to assess long-term performance. This process would help establish an historical database on the performance and maintenance needs of the technology. Information about successful uses of new technologies should be forwarded to HQUSACE and Huntsville Division for possible inclusion in USACE guidance documents.

d. All feedback information from FOAs should be made available for inclusion in the ACTS information service. This feedback would help in the reevaluation of technologies catalogued in ACTS. In this capacity the ACTS service would provide another channel to help communicate feedback throughout the Corps.

7. At an appropriate time in the future, perform follow-up work to evaluate the effectiveness of any actions initiated as a result of this study and recommend further improvements.

This CETAP study provides a "big-picture" view of the Corps' operation and where improvements can be made in the incorporation and adoption of innovative technologies. Given the complexity of the organization, however, the impact of an established official CETAS and other recommended procedural changes will not occur rapidly. At minimum, the questionnaire developed for Corps personnel response should be redone within the next 5 years to evaluate these actions. The findings at various levels within the Corps would indicate how effective the improvements arising from this study have been, and where any additional improvements or changes may be needed.

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APPENDIX A:

TECHNOLOGY-BASED POINT-OF-CONTACT DIRECTORY

Headquarters, U.S. Army Corps of Engineers
Engineering Divisions of Military Programs and Civil Works Directorates

This directory was developed for the U.S. Army Corps of Engineers and the U.S. design, engineering, and construction communities to help better direct inquiries about the use of innovative technologies on projects by or for the Corps.

Column 1 lists the subject or technological area of interest. Column 2 lists the office code for the most appropriate initial point of contact in the Engineering Division of either the Directorate of Military Programs or Directorate of Civil Works. Column 3 lists the office's telephone number. All telephone numbers are for Area Code 202, and are current as of May 1990.

ALPHABETICAL LISTING

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Access Flooring	CEMP-ES	272-1185
Acoustical Treatments for Walls and Ceilings	CEMP-ES	272-1185
Adhesives	CEMP-ES	272-1185
Aggregate Coatings	CECW-EG	272-0207
Aggregates (for Concrete)	CECW-EG	272-0207
Air Handling and Distribution	CEMP-ET	272-8622
Air Pollution Control Equipment	CEMP-ET	272-8619
Air Supported Structures	CEMP-EA	272-0439
Airfield Lighting	CEMP-ET	272-8625
Airfield Paving.	CEMP-ET	272-0222
Airfield Planning	CEMP-EA	272-8817
Animal Shelters	CEMP-EA	272-0438
Architectural and Ornamental Metals	CEMP-ES	272-1185
Architectural Plastics	CEMP-ES	272-1185
Architectural Woodwork	CEMP-ES	272-1185
Artwork	CEMP-EA	272-0437
Asbestos Abatement	CEMP-RT	504-4706
Audiometric Rooms	CEMP-EM	272-1544
Audio-Visual Communications Systems	CEMP-ET	272-8626
Audio-Visual Communications Systems, Medical	CEMP-EM	272-1597
Aviation Fueling Systems	CEMP-ET	272-8621
Barriers and Enclosures, Security.	CEMP-ET	272-1436
Blast and Bullet Resistive Protection	CEMP-EA	272-1436
Blasting, Sitework	CECW-EG	272-8682
Boiler Plants	CEMP-ET	272-8619
CADD	CEMP-ES	272-1246
Carpentry	CEMP-ES	272-1185
Carpet	CEMP-ES	272-1185
Cast-in-Place Concrete	CECW-EG	272-0207
Cathodic Protection (Civil Works).	CECW-EE	272-8617
Cathodic Protection (Military).	CEMP-ET	272-8623
Ceiling Suspension Systems	CEMP-ES	272-1185
Cement, Asphalt (Civil Works)	CECW-EG	272-0207
Cement, Asphalt (Military)	CEMP-ET	272-8675
Cement, Grout	CECW-EG	272-0223
Cement, Portland	CECW-EG	272-0207
Chilled Water Distribution Systems	CEMP-ET	272-8621
Chilled Water Plants	CEMP-ET	272-8619
Cladding and Siding	CEMP-ES	272-1185
Closed Circuit Television	CEMP-ET	272-8626
Coastal Engineering	CECW-EH	272-8500
Coatings	See Finishes or Paints	
Cofferdams	CECW-ED	272-0220
Cold Storage Facilities	CEMP-ET	272-8619
Compartments and Cubicals	CEMP-ES	272-1185
Comprehensive Planning	CECW-P	272-8528
Compressed Air Systems & Equipment(Civil Works)	CECW-EE	272-8614
Compressed Air Systems & Equipment (Military).	CEMP-ET	272-8622
Computer Systems and Applications	CEMP-ES	272-1246
Concrete Accessories	CECW-EG	272-0207
Concrete Admixtures	CECW-EG	272-0207

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Concrete Finishing	CECW-EG	272-0207
Concrete Formwork	CECW-EG	272-0207
Concrete Materials Testing	CECW-EG	272-0207
Concrete Paving.	CEMP-ET	272-8675
Concrete Reinforcing	CECW-ED	272-0220
Concrete, Structural	CECW-EG	272-0207
Conductive Flooring	CEMP-ES	272-1185
Connectors and Supports, Wood and Plastic	CEMP-ET	272-1185
Controlled Environment Rooms	CEMP-ET	272-8619
Corrosion Resistant Masonry	CECW-ED	272-0220
Cranes	CECW-EE	272-8614
Cryogenic Systems	CEMP-EE	272-8622
Custom Casework	CEMP-ES	272-1185
Dam Safety - Hydrology.	CECW-EH	272-8500
Dam Safety Studies.	CECW-EG	272-0209
Decks	CEMP-ES	272-1185
Demolition	CECW-EG	272-8682
Detention Equipment	CEMP-ES	272-1185
Dewatering	CECW-EG	272-0207
Digestion Tank Covers and Appurtenances	CEMP-EH	272-8688
Dome Structures	CEMP-ET	272-1436
Doors and Door Frames, Metal	CEMP-ES	272-1185
Doors and Door Frames, Wood or Plastic	CEMP-ES	272-1185
Door and Window Screens	CEMP-ES	272-1185
Door Opening Assemblies	CEMP-ES	272-1185
Drainage Systems (Civil Works).	CECW-EG	272-0207
Drainage Systems (Military).	CEMP-ET	272-8623
Draperies, Blinds and Shades	CEMP-ES	272-1185
Dredging	CECW-EH	272-8502
Drilling and Coring Equipment	CECW-EG	272-8682
Dual Temperature Water Distribution System	CEMP-ET	272-8621
Earthwork (Civil Works)	CECW-EG	272-0207
Earthwork (Military)	CEMP-ET	272-8675
Electrical Distribution Equipment (Civil Works)	CECW-EE	272-8615
Electrical Distribution Equipment (Military)	CEMP-ET	272-8625
Electrical Power Equipment (Other)	CEMP-ET	272-8625
Electrical Power Generation Systems(Civil Work)	CECW-EE	272-8615
Electrical Power Generation Systems(Military).	CEMP-ET	272-8623
Electrical Power Systems, Exterior (Civil Work)	CECW-EE	272-8615
Electrical Power Systems, Exterior (Military).	CEMP-ET	272-8625
Electrical Power Systems, Interior (Civil Work)	CECW-EE	272-8615
Electrical Power Systems, Interior (Military).	CEMP-ET	272-8623
Elevators	CECW-EE	272-8614
EMP/EMI/TEMPEST Shielding/Effects	CEMP-ET	272-1436
Energy Control Devices	CEMP-ET	272-8619
Energy Monitoring and Control System (EMCS)	CEMP-ET	272-8625
Energy Recovery Systems	CEMP-ET	272-8622
Environmental Geology.	CECW-EG	272-0207
Evaporative Cooling Systems	CEMP-ET	272-0430
Excavation Support Systems	CECW-EG	272-0207
Expansion Control Accessories	CEMP-ES	272-1185
Exterior Insulation & Finish Systems.	CEMP-ES	272-1185

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Fabric Structures	CEMP-EA	272-0437
Fans and Blowers	CEMP-ET	272-8622
Fasteners, Sheet Metal or Wood.	CEMP-ES	272-1185
Fasteners, Structural.	CEMP-ET	272-1436
Fences, Gates, and Hardware.	CEMP-ET	272-1436
Fiberglass/Plastic Fabrications	CEMP-ES	272-1185
Filter Underdrains and Media	CEMP-ET	272-0420
Finishes, Architectural	CEMP-ES	272-1185
Finishes, for Hydraulic Structures	CECW-EE	272-8617
Fire Protection Planning.	CEMP-ET	272-8677
Fire Alarm and Detection Systems (Civil Works)	CECW-EE	272-8615
Fire Alarm and Detection Systems (Military)	CEMP-ET	272-8625
Fireproofing/Firestopping	CEMP-ES	272-1185
Flag Poles and Accessories	CEMP-ES	272-1185
Flashing and Sheet Metalwork	CEMP-ES	272-1185
Flood Control Equipment, Electrical	CECW-EE	272-8615
Flood Control Equipment, Mechanical	CECW-EE	272-8614
Floor Coverings, Rugs and Mats	CEMP-ES	272-1185
Flooring and Floor Coverings	CEMP-ES	272-1185
Floor Plates & Gratings	CEMP-ES	272-1185
Fluid Waste Treatment and Disposal Equipment	CEMP-EB	272-8688
Food Service Equipment	CEMP-ES	272-1185
Forced Entry Restrictive Protection	CEMP-ET	272-1436
Fortifications	CEMP-ET	272-1436
Foundation Engineering (Civil Works).	CECW-EG	272-0207
Foundation Engineering (Military).	CEMP-ET	272-8675
Fuel Distribution, Aviation and Vehicular	CEMP-ET	272-8621
Fume Exhaust Systems	CEMP-ET	272-8622
Furniture and Accessories	CEMP-EA	272-0437
Gabions	CECW-EG	272-0420
Gas Piping and Distribution Systems	CEMP-ET	272-8621
Gates, Fences, and Hardware.	CEMP-ET	272-1436
Geophysical Investigations	CECW-EG	272-0207
Geotechnical, Cold Regions	CEMP-ET	272-8675
Geotechnical Data Instrumentation	CECW-EG	272-0207
Geotechnical Investigations (Civil Works)	CECW-EG	272-0207
Geotechnical Investigations (Military)	CEMP-ET	272-8675
Geotextiles	CECW-EG	272-0420
Glazed Curtain Walls	CEMP-ES	272-1185
Glazing, Glass or Plastics	CEMP-ES	272-1185
Gratings and Floor Plates	CEMP-ES	272-1185
Ground Cover	CEMP-EA	272-8820
Ground Water Investigations.	CECW-EH	272-8500
Grouting, Masonry	CEMP-ET	272-1436
Grouting, Foundation	CECW-EG	272-0207
Gypsum Board	CEMP-ES	272-1185
Handrails	CEMP-ES	272-1185
Hardened Facilities	CEMP-ET	272-1436
Hardstand Parking Areas	CEMP-EA	272-8817
Hardware for Doors and Windows	CEMP-ES	272-1185
Hazardous Materials Procedures	CEMP-EH	272-8879

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Heat Generation	CEMP-ET	272-8621
Heat Pump Systems	CEMP-ET	272-8622
Heat Transfer Equipment	CEMP-ET	272-8621
Heating, Ventilating and Air Conditioning	CEMP-ET	272-0430
Heat/Vent/Air Conditioning Control Systems	CEMP-ET	272-8619
Heavy Timber Construction	CEMP-ET	272-1436
Hoists and Cranes	CECW-EE	272-8614
Hot Water Heat Distribution Systems	CEMP-ET	272-8621
Hydraulic Designs	CECW-EH	272-8500
Hydraulic Engineering	CECW-EH	272-8500
Hydraulic Gates and Valves	CECW-EE	272-8614
Hydraulic Structures	CECW-ED	272-0220
Hydroelectric Power	CECW-EH	272-8500
Hydroelectric Power Plants, Electrical	CECW-EE	272-8615
Hydroelectric Power Plants, Mechanical	CECW-EE	272-8614
Hydrology	CECW-EH	272-8500
Ice Engineering (Civil Works)	CECW-EH	272-8500
Ice Engineering (Military)	CEMP-ET	272-0420
Incinerators	CEMP-EB	272-8688
Industrial Systems Controls	CEMP-ET	272-8625
Installation Support Books	CEMP-EA	272-8821
Insulation, Building	CEMP-ES	272-1185
Insulation for Mechanical Systems	CEMP-ET	272-0430
Integrated Logistic Support	CEMP-EA	272-0499
Interior Plants and Planters	CEMP-EA	272-0437
Intrusion Detection System	CEMP-ET	272-8626
Irrigation Systems	CEMP-EB	272-8688
Joint Sealers for Building Construction	CEMP-ES	272-1185
Joint Sealers for Pavements	CEMP-ET	272-0222
Landscaping	CEMP-EA	272-8820
Lath and Plaster	CEMP-ES	272-1185
Laundry and Dry Cleaning Equipment	CEMP-ET	272-8622
Lifts	CECW-EE	272-8614
Lighting, Exterior	CEMP-ET	272-8625
Lighting Fixtures, Airfield	CEMP-ET	272-8625
Lighting Fixtures	CEMP-ET	272-8625
Lighting, Interior	CEMP-ET	272-8623
Lighting, Security	CEMP-ET	272-1436
Lightning/Static Electricity Protection Systems	CEMP-ET	272-8625
Liquid Waste Handling Equipment	CEMP-EH	272-8688
Loading Dock Hardware	CEMP-ES	272-1185
Louvers, Grilles and Screens	CEMP-ES	272-1185

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Manufactured Casework	CEMP-ES	272-1185
Masonry Accessories	CEMP-ET	272-1436
Masonry Grouting	CEMP-ET	272-1436
Mass Concrete	CECW-EG	272-0207
Material Transportation and Storage	CEMP-ET	272-0207
Medical and Hospital Equipment	CEMP-EM	272-0421
Metal Building Systems, Pre-Engineered	CEMP-ES	272-1185
Metal Decks and Gratings	CEMP-ES	272-1185
Metal Doors and Door Frames.	CEMP-ES	272-1185
Metal Fabrications	CEMP-ES	272-1185
Metal Fasteners	CEMP-ES	272-1185
Metal Finishes	See Finishes	
Metal Repair Compds,Hydraulic Structures/Equip	CECW-EE	272-8614
Metal Support Systems, Non-Load Bearing.	CEMP-ES	272-1185
Metal Repair Compounds, Special Coatings	CEMP-ES	272-1185
Metal Windows	CEMP-ES	272-1185
Mobilization Facilities	CECW-OE	272-0454
Mobilization Master Planning	CEMP-EA	272-8821
Monitoring Wells	CEMP-EH	272-0208
Mortar	CEMP-ET	272-1436
Mortuary Equipment	CEMP-EM	272-1544
Motors and Controls	CEMP-ET	272-8625
Multiple Seating	CEMP-ES	272-1185
Munitions Storage Facilities	CEMP-ET	272-1436
Navigation Equipment	CECW-EH	272-8502
Navigation Equipment (Airfield)	CEMP-ET	272-8625
Navigation Lock and Dam Equipment, Electrical	CECW-EE	272-8615
Navigation Lock and Dam Equipment, Mechanical	CECW-EE	272-8614
Nuclear Weapons Effects	CEMP-ET	272-1436
Optics and Optical Equipment	CEMP-ET	272-0207
Outdoor Recreation Area Planning	CEMP-EA	272-8814
Oxygenation Systems	CEMP-EB	272-8688
Paints, Architectural.	CEMP-ES	272-1185
Paints, for Hydraulic Structures	CECW-EE	272-8617
Parking Control Equipment, Security Related	CEMP-ET	272-1436
Parking Structures	CEMP-ET	272-1436
Partitions(Demountable, Portable, or Wire Mesh)	CEMP-ES	272-1185
Partitions, Operable	CEMP-ES	272-1185
Paving and Surfacing	CEMP-ET	272-0222
Pedestrian Control Devices	CEMP-ES	272-1185
Pest Control, Electrical.	CEMP-ET	272-8626
Physical Security	CEMP-ET	272-1436
Piles and Caissons	CECW-ED	272-8673
Plaster and Lath	CEMP-ES	272-1185
Plastic/Fiberglass Fabrications	CEMP-ES	272-1185
Playground/Recreational Area Planning	CEMP-EA	272-8814
Playground Equipment	CEMP-EA	272-8814
Plumbing Systems	CEMP-ET	272-8621
POL Storage Facilities and Equipment	CEMP-ET	272-8621
Ponds and Reservoirs	CECW-EH	272-2509

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Port Facilities	CECW-EG	272-0207
Port Mobilization Planning	CEMP-ET	272-8675
Portland Cement	CECW-EG	272-0207
Postal Specialties	CEMP-ES	272-1185
Power Generation Equipment	CECW-EE	272-8615
Power Generation Equip,Diesel/Gas Turbine/Steam	CEMP-ET	272-8623
Power Supplies, Uninterruptible	CECW-EE	272-8615
Power Supplies, Uninterruptible	CEMP-ET	272-8623
Power Transmission	CECW-EE	272-8615
Pozzolan	CECW-EG	272-0412
Precast Concrete	CEMP-ET	272-8675
Pre-Engineered Structures, Buildings	CEMP-ET	272-1436
Pre-Engineered Structures, Fabric	CEMP-EA	272-0437
Pre-Engineered Structures, Metal Buildings	CEMP-ES	272-1185
Prefabricated and Preassembled Masonry	CEMP-ET	272-1436
Prefabricated Exterior Specialties	CEMP-ES	272-1185
Prefabricated Structures	CEMP-ET	272-0220
Preformed Wall and Roof Panels (Metal)	CEMP-ES	272-1185
Pressure Vessels	CEMP-ET	272-8622
Protective Covers	CEMP-ET	272-0222
Protective Design (Hardening, Security)	CEMP-ET	272-1436
Pumping Station Equipment, Electrical	CECW-EE	272-8615
Pumping Station Equipment, Mechanical	CECW-EE	272-8614
Quarrying	CECW-EG	272-8682
Radiation Protection	CEMP-ET	272-1436
Railroad Planning and Design	CEMP-ET	272-8675
Recreation Facilities Planning	CECW-EA	272-8820
Refractories	CEMP-ET	272-0222
Refrigeration Systems	CEMP-ET	272-8619
Reservoir Regulation	CECW-EH	272-8509
Restoration and Cleaning of Concrete	CECW-EG	272-0207
Restoration and Cleaning of Masonry	CEMP-ET	272-8675
Retaining Walls, Concrete	CECW-ED	272-0207
Retaining Walls, Marine, Wood or Steel	CECW-ED	272-0220
Robotics	CEMP-ET	272-0220
Rock and Soil Testing	CECW-EG	272-0207
Rock Bolting and Anchoring	CECW-EG	272-8682
Roller Compacted Concrete Pavements	CEMP-ET	272-8675
Roller Compacted Mass Concrete	CECW-EG	272-0412
Roofing and Siding, Preformed	CEMP-ES	272-1185
Roofing Materials	CEMP-ES	272-1185
Roofing Specialties and Accessories	CEMP-ES	272-1185
Sealants	CEMP-ES	272-1185
Security Access Systems	CEMP-ET	272-8626
Security and Vault Equipment	CEMP-ET	272-1436
Security Control and Alarm Systems	CEMP-ET	272-8626
Security Construction	CEMP-ET	272-1436
Security Doors, Screens, and Windows	CEMP-ET	272-1436
Security, Physical	CEMP-ET	272-1436
Sedimentation	CECW-EH	272-8500

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Septic Systems	CEMP-ET	272-8688
Service Station Equipment (Fueling System)	CEMP-ET	272-8621
Service Wall Systems	CEMP-ES	272-1185
Sewerage Systems	CEMP-ET	272-8688
Sheet Metal Enclosures	CEMP-ET	272-8677
Sheet Metalwork	CEMP-ES	272-1185
Shotcrete	CECW-EG	272-0207
Siding and Roofing, Preformed	CEMP-ES	272-1185
Signage, General	CEMP-EA	272-0437
Signage, Traffic	CEMP-ET	272-8675
Site Engineering (Military)	CEMP-ET	272-8675
Site Preparation (Civil Works)	CECW-EG	272-0207
Skylights	CEMP-ES	272-1185
Slope Protection and Erosion Control	CECW-EG	272-0207
Sludge Conditioning Systems	CEMP-EH	272-8688
Soil and Rock Testing	CECW-EG	272-0208
Soil Stabilization	CECW-EG	272-0207
Soil Treatment	CECW-EG	272-0207
Soils, Cold Regions	CEMP-ET	272-8675
Solar Energy Systems	CEMP-ET	272-0430
Solid Waste Handling Equipment	CEMP-EH	272-8688
Special Coatings, Repair Compounds	CEMP-ES	272-1185
Special Doors and Closures	CEMP-ES	272-1185
Special Surfaces (Finishes)	CEMP-ES	272-1185
Special Windows	CEMP-ES	272-1185
Stairs and Stairway Accessories, Metal	CEMP-ES	272-1185
Stairs and Stairway Accessories, Wood	CEMP-EA	272-0438
Static Electricity Protection Devices	CECW-ET	272-8623
Steam Distribution Systems	CEMP-ET	272-8621
Stone	CECW-EG	272-0207
Storage Shelving and Lockers	CEMP-ES	272-1185
Storage Tanks, Liquid and Gas	CEMP-ET	272-8621
Structural Metal Framing	CEMP-ET	272-8677
Structural Plastics	CEMP-ET	272-0220
Stucco	CEMP-ES	272-1185
Subsurface Investigations	CECW-EG	272-0207
Sun Control Devices	CEMP-ES	272-1185
Swimming Pools	CEMP-ES	272-1185
Tailpipe Exhaust Systems, Vehicular	CEMP-ET	272-8622
Temporary Structures	CEMP-ET	272-0220
Termite Control	CEMP-ES	272-1185
Terrazzo	CEMP-ES	272-1185
Therapy Equipment	CEMP-EM	272-1543
Tile for Walls, Ceilings or Floors	CEMP-ES	272-1185
Toilet and Bath Accessories	CEMP-ES	272-1185
Traffic Control Devices	CEMP-ET	272-8675
Traffic Control Devices, Security Related	CEMP-ET	272-1436
Transfer Switches, Automatic (Civil Works)	CECW-EE	272-8615
Transfer Switches, Automatic (Military)	CEMP-ET	272-8625
Trees, Shrubs and Vines	CEMP-EA	272-8820
Tunneling	CECW-EG	272-0220
Turf, Natural and Artificial	CEMP-EA	272-8820
Underground Heat Distribution Sys. Restoration	CEMP-ET	272-8621
Unit Masonry	CEMP-ET	272-1436

AREA OF RESPONSIBILITY	OFFICE SYMBOL	TELEPHONE NUMBER
Utility Control Systems, Power Generating (CW)	CECW-EE	272-8615
Utility Control Systems, Power Generating (Mil)	CEMP-ET	272-8614
Vapor Barriers	CEMP-ES	272-1185
Vehicle Barriers, Security	CEMP-ET	272-1436
Ventilation and Exhaust Systems	CEMP-ET	272-8622
Wall and Corner Guards	CEMP-ES	272-1185
Wall Coverings	CEMP-ES	272-1185
Wardrobe and Closet Specialties	CEMP-ES	272-1185
Water Control	CECW-EH	272-8509
Water Disinfection	CEMP-ET	272-8688
Water Distribution	CEMP-ET	272-8688
Water Quality	CECW-EH	272-8509
Water Supply and Treatment Equipment	CEMP-ET	272-8688
Waterproofing and Damp-proofing	CEMP-ES	272-1185
Water Wells	CEMP-EG	272-0207
Weatherstripping	CEMP-ES	272-1185
Welding and Welding Equipment	CEMP-ET	272-8673
Window Assemblies, Metal.	CEMP-ES	272-1185
Window Assemblies, Wood or Plastic	CEMP-ES	272-1185
Windows/Bullet, Blast, & Forced Entry Resistant	CEMP-ET	272-1436
Wood or Plastic Connectors and Supports.	CEMP-ES	272-1185
Wood-Metal Systems	CEMP-ES	272-1185
Wood Treatments.	CEMP-ES	272-1185

APPENDIX B:

SCHEMATIC REPRESENTATIONS OF THE FOUR VALUE ENGINEERING PROCESSES

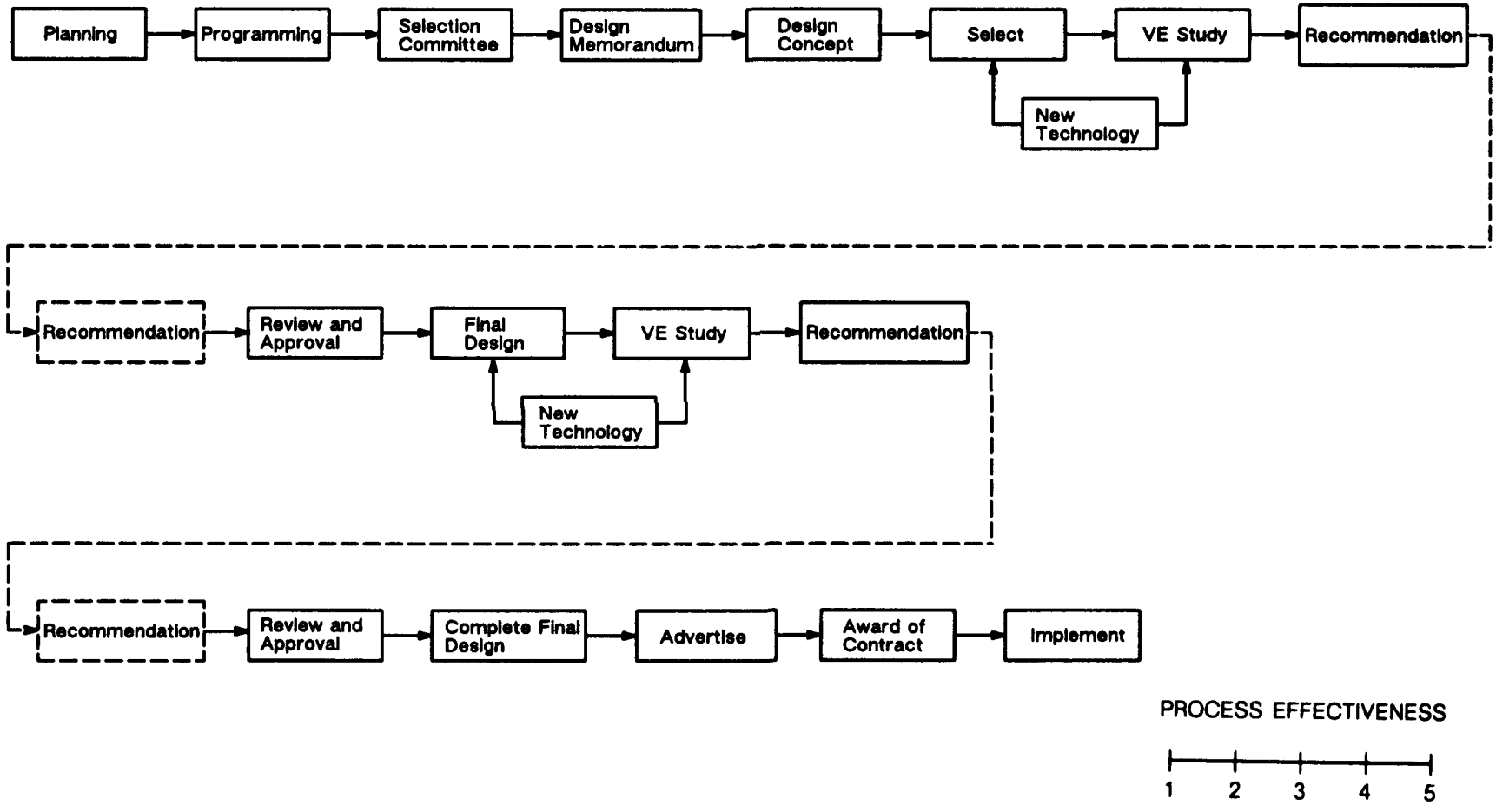

Figure B1. Civil Works Design VE Process.

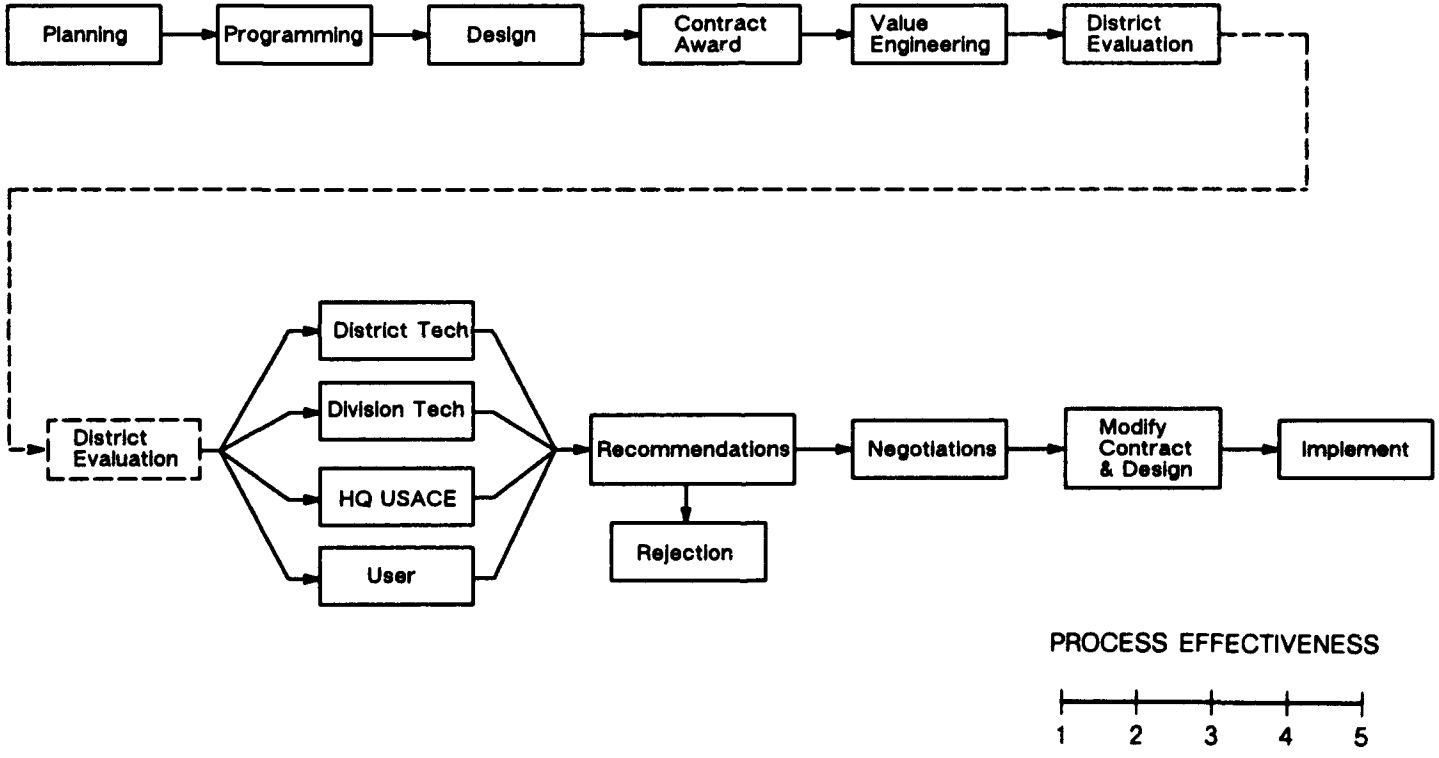

Figure B2. Civil Works Construction VE Process.

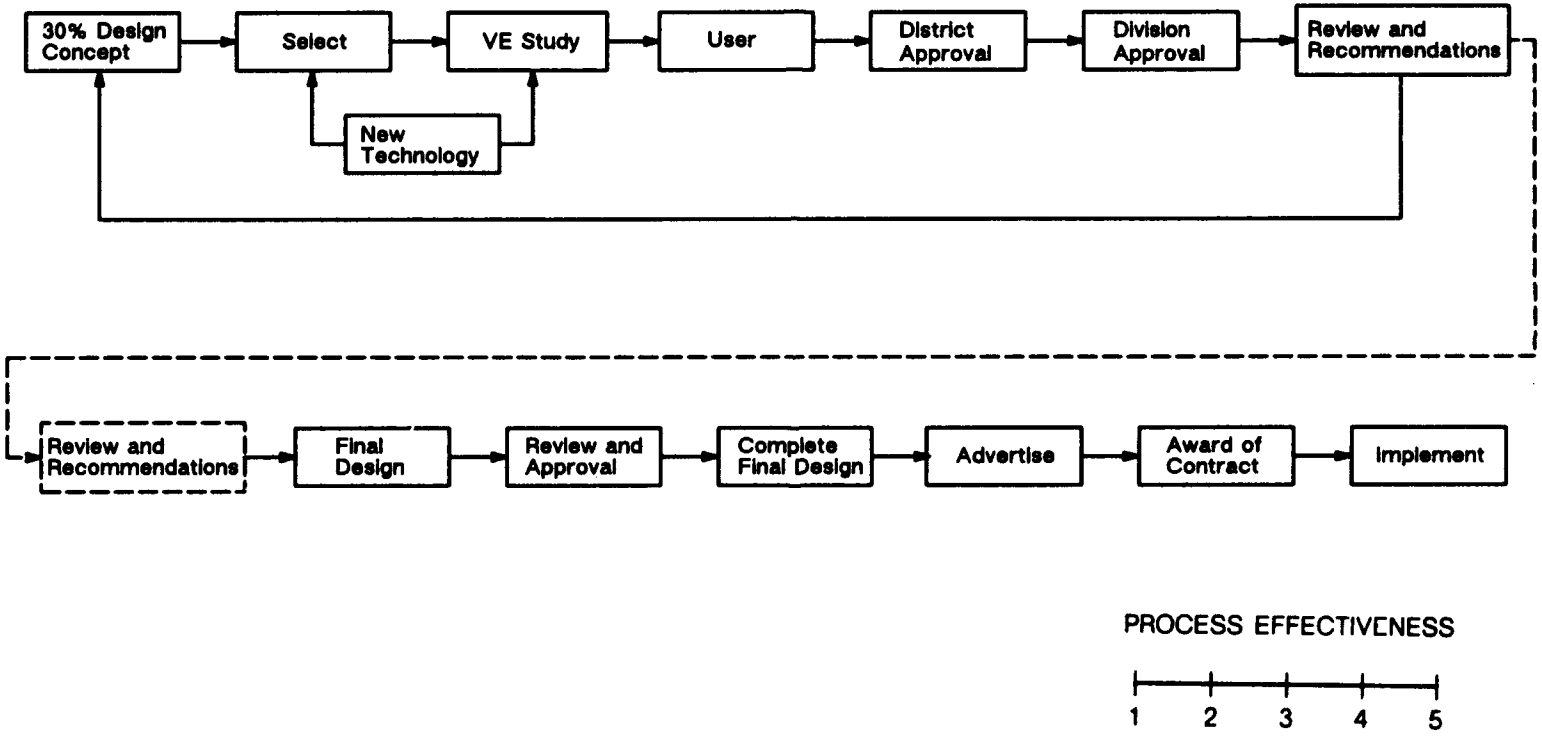

Figure B3. MCA Design VE Process.

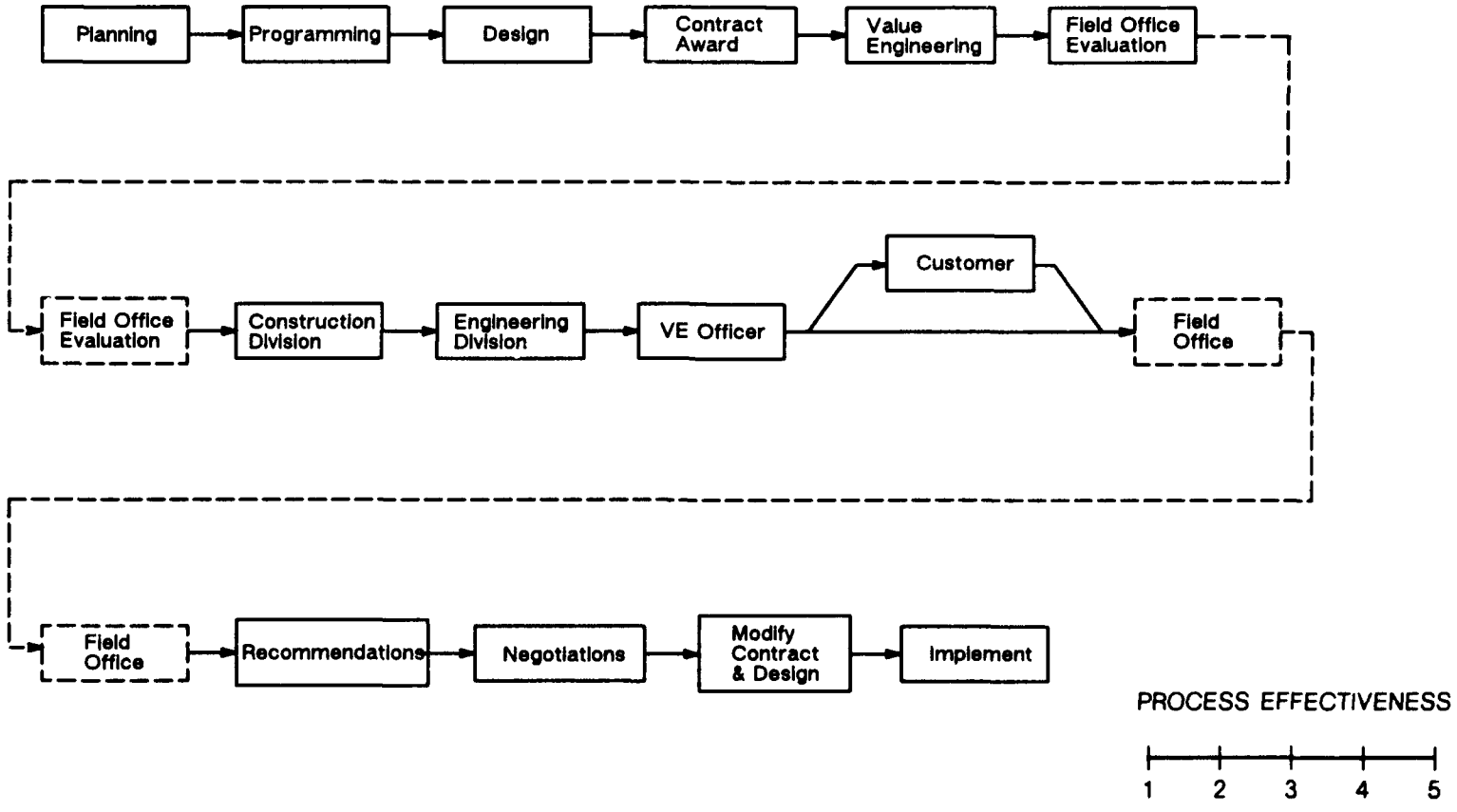

Figure B4. MCA Construction VE Process.

APPENDIX C: SUMMARY OF USACE POLICIES AND PROCEDURES AFFECTING THE ADOPTION OF INNOVATIVE TECHNOLOGIES

This appendix comprises key findings of a literature search performed in support of the Corps of Engineers Technology Adoption Processes study. It refers to all major regulations and guidance pertaining to the Corps' use of innovative technologies. The text is verbatim excerpts taken from the various documents comprising a representative summary of the rules, regulations, and practices governing the Corps' adoption of innovative technologies.

This material was, essentially, a working paper for the research team conducting the CETAP study. It is presented here for the convenience of Headquarters personnel and others needing this level of detail on the subject. The authors do not intend for this compilation itself to be viewed as guidance, however, and do not claim that it is completely current at the time of publication. The body of Corps regulations and publications pertaining to innovative technologies is updated virtually on a continuing basis. The material collected here does not necessarily represent the most recent version of every regulation and publication; also, some of these items may have been superseded or rescinded since this literature search was conducted. All of them, however, were in effect at some time during the execution and publication of this study.

Architectural and Engineering Instructions (AEI)
DESIGN CRITERIA

CHAPTER 1--GENERAL

1. GENERAL.

a. Purpose. The prupose of these Architectural and Engineering instructions (AEI) is to:

(1) Establish current and uniform criteria and standards for the design development of buildings and facilities at Army installations.

(3) Direct users to applicable reference materials to be used in the design process.

(5) Implement a system for managing criteria information.

(6) Promote standardization of buildings and facilities world-wode in the Army, including host nation construction programs.

d. DoD 4270.1-M, Construction Criteria.

(1) DoD 4270.1-M, Construction Criteria, dated December 15, 1983 was implemented in the Army by Department of the Army (DA) Circular 415-84-1, Department of Defense Construction Criteria, dated 15 September 1984. This DA circular expired on 30 December 1986 and will not be reissued.

(2) On 11 February 1987, the Office of the Deputy Assistant Secretary of Defense (Installations) published a new DoD 4270.1-M, Construction Criteria (a little yellow book), which replaced DoD 4270.1-M, dated December 1983. Subsequently, the same office published a new DoD 4270.1-M, dated September 1987, entitled: Department of Defense Policy Guidelines for Installation Planning, Design, Construction and Upkeep. This edition of DoD 4270.1-M supersedes all previous editions of DoD 4270.1-M and contains no technical criteria. Neither editions have been authorized for Army use.

(3) Therefore, all references to DoD 4270.1-M should be deleted from Corps of Engineers technical and contract documents. In addition, DoD 4270.1-M (any edition should no longer be used as a source for technical design criteria.

e. MIL-HDBK-1190, Facility Planning and Design Guide. MIL-HDBK-1190, dated 1 September 1987, was developed primarily at the request of the US Navy for their use. The proponent for the military handbook is the Naval Facilities Engineering Command. The Army Secretariat has not authorized the use of this military handbook within the Army; therefore, it will not be used as a source for technical design criteria.

f. TM 5-800-1, Construction Criteria for Army Facilities. TM 5-800-1, dated 10 September 1974, had been canceled by DA Pamphlet 25-30, dated March 1987; therefore, TM 5-800-1 should no longer be used as a source for criteria and standards.

h. Responsible office and Feedback. Users of this document are encouraged to submit suggestions for criteria Washington, D.C. 20314-1000. Users are requested, however, to be specific in their suggestions, furnish the rationale for their suggestions, and not submit questions.

i. Design Criteria Information System (DCIS). The Army's Programming, Administration, and Execution (PAX) computer system contains DCIS. Using DCIS provides a means to display or copy official design criteria such as this AEI and other designs criteria documents from a computer or computer terminal. Documents in DCIS are official and the most current versions.

(1) DCIS will be activated to PAX users upon request to the PAX system manager, PAX ID: V3MEMORY; or by telephone to AUTOVON 285-0578 to have the DCIS system added to their PAX menu. There is a nominal charge for access to DCIS.

(2) Authority to access documents in DCIS will be activated to users upon request to the DCIS manager, PAX ID: DCIS1 with a copy furnished to PAX ID CAP013.

(3) Requests for the DCIS menu items and for access authority may be made with one message to V3MEMORY with a copy furnished to DCIS1 and CAP013 in the following format:

(a) The name of the requesting individual.

(b) The name of the individual who will be using the user ID.

(c) The office address and symbol of the requesting individual, as well as the using individual.

(d) Telephone numbers (FTS, AUTOVON, Commercial) of the requesting individual, as well as the using individual.

(4) DCIS has a "Suggestion Box" feature that provides a means of providing feedback, comments and questions relating to the criteria contained in this document. The "Suggestion Box" feature affords users an opportunity to become involved in the improvement of the system, as well as the development of new and revised design criteria.

j. Construction Criteria Base (CCB). CCB resides on Compact Disk/Read Only Memory (CD/ROM) distributed by the National Institute of Building Sciences (NIBS). The CCB contains Army, Navy, National Aeronatical Space Administration (NASA), Veterans Administration (VA), and other agency guide specifications, Corps of Engineers technical manuals, Architectural and Engineering Instructions (AEI), and most industry and government standards.

(1) CCB is updated and distributed on a quarterly basis by NIBS.

(2) CCB is available by subscription from NIBS. Information on the subscription of CCB can be obtained from NIBS by calling (202) 289-7800.

k. SPECSINTACT Specification Preparation. SPECSINTACT, which is part CCB, is a system that assists in the preparation of project specifications. SPECSINTACT has been adopted by the Corps of Engineers and various military and civil federal agencies as the official automated system for maintaining their guide specifications, and for preparation of their construction project specifications.

l. SPECINFO Bulletin Board. SPECINFO is an automated bulletin board service that provides access to the Corps of Engineers Guide Specifications that have changed since the last quarterly issue of the CCB. SPEDINFO also contains additional information of interest to specification writers, and provides message exchange between SPECINFO users.

(1) SPECINFO is accessible by telephone via a 1200-2400 baud modem through a personal computer (PC) or computer terminal with no access or usage fees. The only cost to users is the Cost of the telephone call.

(2) SPECINFO is a service provided by HQUSACE (CEMP-EA) through the Huntsville Division Engineer Office, and can be calling (205) 955-5436, and information provided by calling (205) 955-5270.

2. DESIGN CONSIDERATIONS.

(2) Life Cycle Costs. Design decisions for types of construction projects will be based on life cycle cost considerations and the impact on productivity and operating efficiency of the functions within the facility. Studies will be made that consider the life cycle cost of the facility so as to arrive at an economical cost that takes into consideration not only the initial construction cost, but also the operating and maintenance costs of the building and associated impact on the mission performed within it over the anticipated life of the facility. However, the requirements of Federal Energy Management Improvement Act (reference 1-2) that specify that federal agencies reduce energy consumption 10 percent by 1995 compared to 1985 will also be paramount in decisions involving the architectural and engineering design and life cycle cost studies.

d. Construction Qualities. In no case will the quality of construction be higher than is necessary to provide construction suitable for the actual needs of the intended occupancy. For industrial and service facilities, such as shops and storage facilities, an austere quality of construction with reduced finishes will be provided. For buildings of more sophisticated occupancy, such as laboratories and major headquarters buildings, a higher quality of construction with better finishes may be provided. Specific criteria for many individual facilities are stated in this document.

e. Use of Local Construction Methods, Materials, and skills. Designs will consider economies that can be effected by the use of suitable local construction methods, materials, and skills that are consistent with the intent of these criteria.

f. Use of Standard or Stock Products. Commercially available standard or stock equipment, fixtures, and materials will be used when practicable.

3. CONSTRUCTION LEVELS AND BUILDING TYPES

b. Criteria for Building Systems Construction.

(1) Standards and Quality. The standards and level of quality indicated in this document apply to industrializes, manufactured, pre-engineered, and other types of building systems construction.

(2) Component Parts. The component parts will be readily available and be able to be procured competitively. In other words, it is not intended that designs, or availability of specified or offered component parts, be subject to further research or development, or both, but rather that the component parts be standard and off-the-shelf stock item.

(3) Manufactured and Pre-Engineered Buildings. These types of construction may be used for buildings when such use is indicated by life cycle costs to be economical; when they will meet the functional and performance requirements of the project; and when they can be architecturally compatible with the environment in which they will be erected. Because of the great variance in the cost and quality of such structures on the market, extreme care must be used in selection to ensure that the quality of the

facility to be provided is commensurate with the project requirements and expected longevity of the mission to be served.

CHAPTER 6--ARCHITECTURAL CRITERIA

1. GENERAL DESIGN PROVISIONS.

c. Functional Design. All facility planning will employ economical, functional architectural and engineering design, closely tailored to the actual requirements of the project, with particular attention to the selection of exterior and interior finishes, and to the extent and type of equipment and services to be provided. Special studies will be made for specific projects when necessary to determine the most economical equipment, finishes, materials, methods of construction, services, and practical structure to be provided. Designs will be governed by functional requirements, conform to existing criteria and standards, and be consistent with applicable congressional cost limitations. Facilities will be provided at the lowest reasonable construction cost while achieving the optimum life cycle cost.

d. Design for Flexibility. Flexibility in architectural design is the ability of an existing structure to accommodate a change in use with a minimum expenditure of resources. The Army usually operates and owns its facilities form the time of construction until the end of the useful life of the structure. During this long tenure of use, it is inevitable that the functional requirements of a building will change and often drastically. For example., under mobilization conditions, potential modifications that would have to be accomplished quickly should be considered. For this reason, flexibility is a major design requirement for all buildings, except for those with highly specialized functions that are prevented for economic reasons.

e. Design Management. The necessary procedure to effect architectural design excellence, as well as to ensure compliance with established criteria, policies, and standards, will be established by the design agencies. The design of all projects will be reviewed by the design agencies for conformance to functional requirements, HQUSACE criteria and standards, and this document. This review will also include careful examination of cost estimates.

f. Design Criteria and Standards. Designs for Army facilities should follow normal industry practice and standards for similar facilities except when specific requirements are stipulated in this document. HQUSACE will provide appropriate design criteria to supplement the criteria included in this document. Definitive design drawings, modular designs, and site adaption of previous project designs should be used for projects involving repetitive-type facilities.

APPENDIX F--FAMILY HOUSING FACILITIES CRITERIA

3. PROJECT DEVELOPMENT.

c. Contractor Options. Maximum flexibility will be offered bidders in the contract documents for provisions of optional materials and methods of fabrication.

d. Conventional and Industrialized Methods. Military family housing projects will permit construction by conventional (stick-built) or industrialized (prefabricated or compartmentized) methods.

DIVISION AND DISTRICTS

ENGINEERING DIVISION

1. Division Functions

b. Performs engineering research projects assigned to the division.

f. Performs technical engineering review of survey reports. Reviews and approves proposals, design memoranda, government estimates, and plans and specifications submitted by district commanders, and prepares recommendations on those for which approval authority is retained by the commander, USACE.

k. Prepares or supervises preparation of regional standard designs for military construction and coordinates repetitive use of suitable design for projects within the division.

m. Operates a division laboratory for the purpose of testing materials in accordance with ER 1110-1-8100.

3. District Functions

i. Provides general engineering services in support of military construction activities of the Department of Defense as requested.

k. Plans and designs authorized Civil Works and military construction projects.

l. Supervises contracts for services of architect-engineers, engineering consultants, and experts engaged for work in connection with both Civil Works and military construction activities.

m. Provides technical direction and assistance in construction of military and Civil Works projects and in operation and maintenance of Civil Works projects.

o. Prepares as-built drawings for completed construction projects.

p. Furnishes the Contracting Division forcasts and instructions on general supply requirements.

CONSTRUCTION-OPERATIONS DIVISION

1. Interprets and inforces construction policies of higher authority for military and civil construction and formulates local implementation.

5. Analyzes reports pertaining to construction and operations required by higher authority and develops other reports as may be necessary.

7. Develops improvements in construction practices, procedures, methods, and policies, and conducts inspector development and improvement programs.

8. Reviews and analyzes construction and operational features of plans and specifications for new construction, maintenance, repairs, dredging operations, new plant, equipment, and improvement thereto, and processes request for authority to repair existing plant and equipment.

13. Furnishes the Contracting Division with forecasts of general supply requirements, including recommendations for procurement, redistribution, or disposal of equipment, materials, and supplies based on plans and programs of the Construction-Operations Division.

15. Provides staff supervision of district shop inspection activities involving materials and equipment to be incorporated into construction projects.

17. Routinely visits projects under construction to assure that all features of the project are being designed and constructed compatable with operating requirments. Discusses operational deficiencies and recommendations with district elements and monitors appropriateness of action taken.

U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

4.a.(1) Conceives, plans, and executes engineering and scientific investigations, and research and development studies, and provides consulting services in support of the civil and military missions of the Chief of Engineers, other Federal agencies, state and local governments, foreign governments, and private firms. The broad fields of work include hydraulics, soil and rock mechanics, earthquake engineering, coastal engineering and nearshore oceanography, concrete, expedient construction, nuclear and conventional weapons effects, nuclear and chemical explosives, excavation, vehicle mobility, environmental relationships, engineering geology, pavements, protective structures, camouflage, aquatic plants, water quality, dredging material, mine/countermine technology, and military related combat and logistical engineering studies.

U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY

4.a. Conducts and coordinates research on the cold regions of the world and the effects of low temperatures on materials, materiel, and operations in support of the civil works and military missions of the Chief of Engineers, and other DOD and Federal agencies.

b. Conducts research, investigations, and engineering studies pertaining to development of new and improved techniques, materials, and criteria for planning, design, construction, operation, and maintenance of permanent and expedient military and civil works facilities in cold environments.

c. Conducts research and engineering studies to characterize the environment and its impact on performance requirements of civil works activities.

d. Conducts research and test programs necessary to characterize the cold regions environment to permit the development of effective Electo-Optical sensors control systems and other weapon systems hardware.

e. Conducts research and engineering studies to provide technology/support to the civil works program and to influence Army doctrine and operations in cold regions to enhance mobility, survivability and operational readiness.

f. Performs studies and research as required by agreements between OCE and other Army and government agencies.

g. Provides, upon request, support to the program for updating CE guide specifications, technical manuals and other criteria documents within assigned areas.

h. Conceives, plans, and conducts training courses in assigned technical fields for Corps personnel as directed by the Chief of Engineers.

U.S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY

4.a. Plans and executes, research and disseminates results for the purpose of reducing cost, allocating resources more effectively, and improving the functional characteristics of the Real Property Maintenance Activities (RPMA) System.

b. Conducts research and engineering studies in the materials, utilities, energy, foundations, structural and construction requirements for all buildings to function in all environments except cold regions.

c. Conducts systems oriented R&D in the process of engineering, design, management, operation, maintenance, replacement and life-cycle requirements of CE facilities; and development of a central data-bank of construction industry information.

d. Conducts systems oriented R&D on procedures and organizations responsible for the life-cycle of constructed facilities.

e. Conducts research and investigations to provide environmental quality and conservation of natural resources throughout the life-cycle of existing and planned military construction.

f. Conducts research and development in Theater of Operations construction and the use of combat engineers resources in the accomplishment of combat mission.

g. Conducts exploratory R&D for integrating advanced technological developments into Army Construction.

h. Provides Corps-wide support and consulting services in matters relating to paint, protective coatings, cathodic protection and other methods of mitigating corrosion for civil works and military construction and maintenance, including the research, development, formulation and testing of protective coatings and corrosion control, and testing paint for compliance with specifications CE-1409 for CE field operating activities not equipped to perform such tests.

i. Provides support to the Huntsville Division by conducting educational programs for Corps personnel and others for continuing education on systems engineering applied to the design, construction, operation, maintenance, and assessment on life-cycle requirements of military facilities and in paint coatings and corrosion control.

j. Provides technical support to the Rock Island District in the procurement of paint for all CE field operating activities (ER 1180-1-1, Para 4-7102.7).

k. Provides, upon request, support to the program for updating CE guide Specifications, technical manuals and other criteria documents within assigned areas.

U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES

4.a. Accomplishes research and development in support of civil works and military missions of the Chief of Engineers and other Federal agencies in the topographic sciences including mapping, point positioning, survey, land navigation, military geographic information, and remote sensing.

b. Performs research and development to support the Chief of Engineers' responsibilities to Defense Mapping Agency and U.S. Army Materiel Development and Readiness Command in the topographic sciences in accordance with separate memorandum of understanding.

c. Performs research in climatology to provide scientific and technical advisory services to assess the effects of the environment on the design, testing, and operation of materiel, updates technical manuals on environmental effects on materiel, and updates environmental criteria documents.

d. Provides an operational terrain analysis service for Army elements to include maintaining a terrain and hydrology data base, production of terrain and hydrology products in support of Army planning, training and operations.

e. Provides support to the Huntsville Division by conducting training courses in assigned technical fields for the Corps personnel.

CONFERENCES AND WORKSHOPS

3. The Corps of Engineers policy is to minimize the number of OCE sponsored conferences and workshops, to minimize the number of participants, and to select locations which require minimum travel and per diem cost consistent with needs to assure mission accomplishment.

5.a. Proposed conferences must meet the criteria of actual need as determined by the proponent. Multiple needs, whenever appropriate, will be consolidated into one conference per year at which all issues may be addressed and workshops conducted if practicable.

b. Conferences and workshops will be limited to the approved program.

c. Conferences called by OCE elements should emphasize the normal chain of command and should target FOA participation at Division level. District office participation will be minimized whenever possible and will be arranged through Division offices.

d. While not specifically subject to these procurements, small meetings to export new procedures and staff visits to conduct normal day-to-day business will be conducted within the spirit and guidelines established for conferences and workshops.

8. Participation in conferences called by other agencies outside the Corps of Engineers is left to the discretion of OCE elements and field commanders.

7. Policy

e. Direct communication and a full and free dialogue will be established between all members of the Army family during the three stages of R&D program: program development, execution, and technology transfer. Proponents, Laboratories, FOAs will make use of Corps wide and Army wide Groups and Teams established to coordinate the insertion of technology into Army Operations.

(1) During program development, communications will be maintained to assure a closer understanding of the requirements and to insure that the R&D is responsive to the requirements particularly with regard to the timeliness of technology transfer. Unresolved issues raised with regard to requirements, timeliness and products will be resolved by the Proponent in coordination with the Laboratory and DOD. Unresolved by DOD in coordination with the Proponent and the Laboratory.

(2) During program execution, communication will be maintained to assure that the R&D being performed is in accordance with the approved program plan. Unresolved issues raised in this stage will be resolved by DAD in coordination with the Proponent and the Laboratory.

(3) During technology transfer, communication will be maintained to facilitate the appropriate application of R&D results. Unresolved issues raised in this stage will be resolved by the Proponent in coordination with DAD and the Laboratory.

f. The USACE R&D technology transfer program will include the active participation of all members of the Army family to assure that the products of the Corps R&D program are usable, appropriate for transfer, and transferred in a timely manner. The procedures for executing technology transfer are described in ER 70-3-9 for the Military RDT&E Programs, ER 70-1-11 and ER 70-2-6 for the Civil Works Program, and in Appendix B for the reimbursable R&D program.

(1) Within the Army, the Proponent for a particular R&D product is responsible for insuring that technology transfer is adequate. Proponents within USACE/OCE are responsible for managing the technology transfer process, including the extent of technology transfer.

(2) Technology developed through the Corps R&D program shall be considered for transfer to other DOD and Federal Agencies, State and local governments and private enterprise as authorized by security regulations, the Stevensen-Wydler Act and the Technology Transfer Act of 1986. It is the joint responsibility of the Proponents and DAD to bring to the attention of these organizations the possible utilization of USACE developed technologies and assist them in the transfer of this technology to the maximum extent possible.

(3) Technology developed through the USACE R&D program shall be considered for transfer to foreign governments on a case-by-case basis. DAD will decide each case after discussion with appropriate officials.

g. The reimbursable R&D program is a critical adjunct to the direct funded R&D program. The reimbursable program has two major functions. First, it provides R&D customers with access to the USACE R&D capabilities to assist them in executing their mission. Second, the reimbursable program directly supports the direct funded program by: 1) filling in gaps in the Military RDT&E, and Civil Works R&D program; 2) supplementing direct demonstration funding such as Military RDT&E 6.3A and Civil

Works general investigation (GI) funding, 3) facilitating technology transfer, and 4) providing physical and numerical modeling and analysis capabilities to support Corps Division and Districts. Because of its importance, the reimbursable program requires oversight and management equivalent to the direct funded program.

(2) R&D performing elements will notify USACE Directorates and Separate Offices and OACE of technology under development for another customer which may be applicable to their responsibilities. The Directorate will inform DAD as to the applicability of the new technology and will take appropriate actions to transfer the technology.

IDENTIFICATION OF CIVIL WORKS RESEARCH NEEDS

4. It is the policy of the Commander USACE that the Civil Works R&D program addresses, and resolve, mission related problems which will allow FOA to apply knowledge gained through R&D to solve their specific problems. Accomplishment of the above requires that Districts and Divisions review their future programs to identify areas requiring research, and that R&D undertakings address those research needs. Research which is project specific will not be undertaken as part of this program unless it has a broader application. Project specific research will be funded with project funds.

7.a. Research Needs System. This system is the process by which FOA identify their future program needs. FOA may submit a narrative description, a Mission Problem Statement (MPS), or a problem associated with a Civil Works area at any time during the year to CDR USACE (DAEN-CWR-W) WASH DC 20314. These statements are forwarded to the appropriate R&D performing element for development of a work unit. Work units will address the mission problem to which they directly respond.

b. Future Trends. DAEN-CWR-W will prepare and maintain an analysis of Civil Works trends which will be the basis for the establishment of R&D priorities. This analysis will be accomplished in coordination with the Civil Works R&D Committee and distributed to technical monitors and R&D performing elements to aid them in prioritizing R&D within their programs.

8. Annually, DAEN-RD will schedule program reviews of the proposed R&D for the succeeding year. These meetings will be attended by the appropriate CW Technical Monitors, the User Representative, the R&D performing element representatives, and other interested parties (e.g. CW Division or Directorate and/or selected field representatives). Presentation for the meeting will include an R&D performing element prepared document that includes Research Program Summaries describing all ongoing Work Units and, as a minimum, proposed Work Units responsive to Mission Problems that have received a high rating by the technical monitor. This documentation will be distributed to Division R&D coordinators prior to the program review. Division coordinators should obtain comments from their technical experts regarding the priority of the work units and/or the need for modification of the work units to assist the Division in accomplishing its program. R&D coordinators should provide this information to the program Technical Monitor prior to the program review. The Technical Monitor will use this information to prioritize work units presented at the program review conference and to modify work units as deemed appropriate.

9. Program Responsiveness. If at any time the FOA believes a program is unresponsive to their needs, those views should be documented and provided to CDR USACE (DAEN-CWR-W) WASH DC 20314. DAEN-CWR-W will investigate the charge with other FOA offices and the program Technical Monitor and provide its finding to DAEN-RDC and/or the Civil Works R&D Committee for resolution.

RESEARCH AND DEVELOPMENT
Military Construction Research Requirements and Research and Investigations Coordination in Field Activities

6. Responsibilities.

a. The Director of Military Construction, OCE, will supervise the program for obtaining problem statements covering qualitative needs in the field, and formally stating these requirements for publication in DA Pamphlet 415-1, Qualitative Construction Requirements (QCR) with Qualitative Construction Development Objectives (QCDO). The Office of Plans, Research and Systems (OPRS) performs these functions for the Director.

b. Heads of Division, District and specified separate field offices will:

(1) Identify and state qualitative construction problems in their management, planning, design, construction, operation and maintenance operations supporting the overall military construction (MCA, minor new construction, et. al.) programs. (See paragraph 8a.)

(2) Determine the degree of need or priority for solution of problems perceived both within and outside their respective activities. (See paragraph 9.)

(3) Disseminate research and investigation (R&I) results pertinent to their activity, and apply technology and exploit capabilities developed within the military construction R&I program in the Corps laboratories.

(4) Designate a special assistant as the R&I coordinator within their respective office activities who will be the point of contact for all functions noted above. Individuals selected as R&I Coordinators should have as wide a range of contact throughout their office activities as possible in their primary duty assignments. Contact between Division and District R&I Coordinators should avoid insofar as possible special travel for this purpose, but advantage should be taken of visits necessitated in direct support of their respective primary duty assignments (as opposed to the secondary duty assignments as the R&I Coordinators).

7. Management Responsibilities. The responsibility for the management of the R&D program rests with the Directorate of Research and Development (DRD), with support from the Proponents, and the performing Laboratories. For management purposes, the R&D program cycle is broken into three major R&D stages: 1) program development, 2) program execution, and 3) technology transfer. The actual responsibilities depend on the stage of the R&D cycle and the RDT&E program as discussed below.

a. Program Development. Program development is subdivided into six steps: 1) Deficiency identification, 2) Deficiency validation, 3) Development of the Long Range Science and Technology (LRS&T) Plan and Execution Year Program, 4) Proponent review and prioritization, 5) Program Guidance and Approval, and 6) Program Objective Memorandum (POM) submission and budget . defense. The management responsibilities for these six steps are defined below.

(1) Problem Definition. Any member of the Army family, including the USACE Laboratories, can identify and submit problems or deficiencies for potential inclusion into the RDT&E requirements system. Problems or deficiencies are submitted to the appropriate Proponent or to CERD-M who will submit it to the appropriate Proponent. Military engineering deficiencies, for which TRADOC HQ is the Proponent, will be submitted to the applicable TRADOC school for validation and prioritization. Deficiencies in the Base Support and Environmental Quality mission area and the Military Engineering mission area not addressed by TRADOC Concept Based Requirement System (CBRS) are validated through mission Area Deficiency Statements (MADS). MADS can be submitted at any time to either the Proponent or to CERD-M in the format shown in Appendix C.

(2) Deficiency Validation. Although problems or deficiencies can be submitted by anyone, they can only be validated by the Proponent. only validated deficiencies can be used as a requirement for the Military RDT&E program. For the Base Support and Environmental Quality programs, the approved deficiencies are published as MADS. For the Military Engineering R&D program, the deficiencies are published in Mission Area Development Plans (MADP), Battlefield Development Plans (BDPs), or as MADS. CERD-M notifies the Laboratories of new MADS as they are validated and publishes the complete book of validated MADS in June of each year. Approved and prioritized MADPs and BDP deficiencies are published by TRADOC.

(3) Development of LRS&T Plan and Execution Year Program. DRD and the Corps Laboratories are responsible for developing an R&D program to provide the products and systems which will assist in eliminating the validated deficiencies. During the fourth quarter of the fiscal year, the Laboratories develop their Military RDT&E program, which consists of the execution year program for the next fiscal year and the Long Range Science and Technology (LRS&T) Plan, which covers the next iteration of the Program Objective Memorandum (POM) Cycle. The Laboratories develop their program in response to CERD-M guidance, which includes the program priorities, and the validated deficiencies. In developing their program they work closely with the Proponents to insure that the proposed work is responsive to the deficiencies and the output is appropriate for technology transfer. The 6.2 and 6.3A Military RDT&E Programs must be supported by validated deficiencies with the exception of the portion of the 6.2 program funded under the Laboratory Commander's initiative. Commander's initiative supports high priority but previously unidentified deficiencies. The portion of the program which can be funded under Commander's initiative is established each year by the Director of DRD and is included in the guidance letter for

assembling the program. The 6.1 program is developed to produce those basic R&D capabilities needed to support the 6.2 and 6.3A RDT&E programs as opposed to solving specific deficiencies. Documentation requirements for the Military R&D program are described in paragraph 8.

(4) Proponent Review and Prioritization. In the spring of each year, the Proponents for the R&D programs review. the LRS&T Plan for responsiveness to the validated deficiencies, and for applicability of the proposed products. Based on this review and the mission requirements, the Proponents give their criticality ratings and work unit priorities for the portions of the R&D program for which they are the Proponent.

(5) Program Guidance and Approval. The Proponents' comments and ratings are used by DRD to develop the guidance letter to the Laboratories for the development of the next year's execution program and the next iteration of the Long Range Science & Technology (LRS&T) Plan (see 7a(3) above). The Director of DRD, with advice from the Proponents, is the final approval authority for the execution year program. The Director of DRD also approves the new LRS&T Plan, which is reviewed at the next spring's Proponent review meeting.

(6) POM Submission and Budget Defense. DRD, with support from the Proponents, is responsible for submitting the USACE Military RDT&E program to the Office of the Assistant Secretary of the Army for Research, Development, and Acquisition (ASARDA). DRD is also responsible for supporting ASARDA in defense of these programs in the Army Planning, Programming, Budgeting, and Execution System (PPBES) process.

b. Program Execution. DRD has management responsibility for the execution of the approved R&D program. The performing Laboratories have responsibility for the execution of the RDT&E program. The Proponent is responsible for monitoring the RDT&E program during execution to assure conformance to the approved R&D plan, coordinating product completion with tech transfer activities, and assuring that the final research product can be transferred. The program execution stage ends with the development and pilot testing of the approved R&D-products.

(1) R&D Products. The R&D product is the new or improved capability the Army is getting by funding this work and not the technical report documenting the research. It is the R&D performing element's responsibility to insure that the final product is in a form which can be easily transferred to the user. The Proponents are responsible for approval of the form of the final product. The form of the final product will be described in the Technology Transfer Plan (TTP).

(2) Pilot Test. It is critical that R&D products be tested under actual applications. The completion of the program execution stage is the pilot test conducted by the performing Laboratory in an actual or closely simulated application. Pilot tests will be funded by the R&D program and monitored by the Proponent. The Laboratories will submit a list of pilot tests for the coming year as part of their input to the Research and Development Management Information System (RDMIS). Pilot test plans will be developed in conjunction with the Proponent and a copy sent to CERD-M. Planning for the pilot test will be included in the TTP.

c. Technology Transfer. The Proponent has management responsibility for technology transfer. Although technology transfer is formally the final stage of the R&D process, planning for technology transfer must be integrated throughout the R&D process. This planning is jointly the responsibility of the Laboratory and the Proponent. Technology transfer consists of the operational tests of the R&D products, the development of Technology Transfer Documentation, and the final implementation of the products. The planning for Technology Transfer is documented in the Technology Transfer Plan (TTP) as described in paragraph 8.

(1) Operational Tests. It is critical that R&D products be tested under actual application by the ultimate users of the technology. Operational tests will be conducted in accordance with a test procedure approved by the Proponent to insure suitability of the product/system for technology transfer. These tests can be conducted under 6.3A funding or funds supplied by the Proponent. Planning for the operational test will be included in the TTP.

(2) Technology Transfer Documentation and Implementation. In general, in order to implement the final product from an R&D effort, documentation such as technical manuals, guide specs, users manuals are required for technology transfer. Technical reports and test reports are generally not considered technology transfer documents. The technology transfer documentation will-be specified in the TTP. The production of the technology transfer documentation is the responsibility of the Proponent. In addition to documentation, user support, training, and feedback evaluation may be needed to complete full implementation. User support, training and evaluation of products is the responsibility of the Proponent. The Laboratories however will fully support the Proponents in these activities. Planning for technology transfer documentation and implementation will be included in the TTP.

8. (f) Technology Transfer Plan (TTP). At the initiation of an RDT&E effort, a Technology Transfer Plan (TTP) will be formulated by the R&D Performing Element in coordination with the Proponent to document the technology transfer planning described in paragraph 7c. TTPs can be prepared for an individual product/systems or for a group of mutually supporting product/systems. The TTPs are product or product system oriented and may include the results of mutually supporting work units. Each work unit must reference a TTP. Each work unit in the RDMIS system will reference an existing or proposed TTP. The details for developing the TTP will be included in the LOI for the RDMIS input. The TTP will be updated at appropriate milestones and/or In-Process Reviews (IPRs) . Projected Pilot Tests (PT) and Operational Tests (OT) must be included as part of the TTP, and budgeted for by both the R&D Performing Element and the Proponent.

APPENDIX D

6. Executive Agent Procedures. Upon notification that a Laboratory is selected to serve as EA the Laboratory Commander/Director will-insure that the following actions are accomplished.

b. Development and Implementation Plan - The EA will prepare a Development and Implementation Plan in coordination with the Supporting Agents based on the TOR. The Development and Implementation Plan is to be prepared not later than 60 days after approval of the TOR. This Plan will be submitted to CERD-M for approval. It will be used as both a planning and management document. It must be consistent with existing documentation requirements and make maximum use of information in existing DRD data bases. It will be updated on an annual basis in conjunction with the development of the LRS&T plan. The updated plan will be submitted to CERD-M for approval on 30 September of each year. The plan will include as a minimum, but not be limited to:

(1) Background Information.

(2) Product/Milestone Master Plan.

(3) Technology Transfer Targets.

(4) Inter-Laboratory/Interagency Execution Agreements.

(5) Meeting and Reporting Schedules.

DESIGN AND CONSTRUCTION EVALUATION (DCE)

3. Policy. The design and Construction Evaluation (DCE) effort, under the overall direction of the Director of Engineering and Construction, Chief, Construction Division and executed by CEEC-CE, shall encompass all phases of the project, identify quality management failures, and provide the basis for improvements through feedback and distribution of evaluation information. The process is based on project construction evaluation during any stage of construction. Problem areas will be analyzed by the DCE team to determine the reasons and/or source of the problem. Determination will be made whether it is due to construction practice, error in design, or major changes in criteria requirements. A letter and trip report will be prepared for dispatch to the FOA division commander for action. The FOA will advise CEEC-CE of the appropriate corrective action to be taken by the responsible office on the DCE team findings. In making the analysis the DCE team will specifically consider the following aspects of construction projects:

b. Design. Problems discovered which are considered to be design oriented will be investigated by the office responsible for design, determining where in the process the problem originated. The contract documents will be examined to determine the need for revised or additional guidance. The specific areas of interest include basic design judgment and practice; suitability of the design, materials and equipment for application and geographic location; design adequacy, thoroughness and clarity; cost-effectiveness; energy conservation, safety, environmental considerations; and conformance with user functional requirements.

c. Criteria Requirements. Contract documents will be reviewed for conformance with established OCE guidance. Unauthorized deviations from the requirements of the various design manuals, guide specifications, design standards, Engineer Technical Letters (ETLs), Engineer Regulations (ERs), Army Regulations (ARs), etc., should be noted. An authorized deviation should always be noted. Items of a proprietary nature or items unsuitable for the intended application are expressly of interest and should be reported. Instances of repetitive misuse of criteria will be analyzed by the appropriate team members for adequate requirements and for recommendation of directive action.

5. Feedback. Upon completion of each field evaluation visit, the evaluation findings will be reviewed and necessary technical and editorial changes will be made to each record observation card to ensure accurate information in entry format for the Construction Evaluation Retrieval System (CERS). The system's file will be utilized for feedback, including printouts of previous findings for follow-up by team members and periodic distribution of common problems to the field. Card comments on design and criteria items are distributed to the appropriate individuals in the engineering division for necessary revision and addition to technical manuals and guide specifications. Action on feedback related to standard plans is initiated at appropriate level in HQUSACE.

4. The Engineering Improvement Recommendation System (EIRS) will be used to assure appropriate and timely processing and dissemination of information derived from all feedback sources. Action officers are responsible for assuring that feedback information is appropriately processed through EIRS channels for dissemination to the field. Feedback information which results in changed requirements or guidance will be incorporated into applicable publication media and disseminated to the appropriate levels of command as outlined herein.

5. Feedback information from engineering and construction sources is derived through various channels, including formal and informal reviews, inspections, reports and programs. Post inspections, engineering and design coordination team visits, and the design criteria feedback program are essential elements in the collection of feedback information. Other important sources include construction evaluation reports, command inspection reports, deficiency reports, warranty inspection findings and suggestions.

6. EIRS is the formalized means of assuring the evaluation of recommendations resulting from information feedback sources and timely implementation of valid engineering improvement recommendations.

a. DAEN-MPE-S has been delegated responsibility for management of the EIRS program, and will coordinate with other elements of the Corps in fulfillment of this responsibility. The final changes in criteria or procedural guidance from the EIRS program will be issues through formal publication media such as regulations, technical manuals, guide specifications, and engineer technical letters. EIRS Bulletins will be used to provide advance information regarding problems and their probable solutions.

(1) The probable solutions included in EIRS Bulletins will be solutions which have not been thoroughly explored or staffed. Since probable solutions will not represent a final OCE position, their use will not be mandatory. However, in the case of drafts of changes to guide specifications currently being processed for issuance, as included in the EIRS Bulletins, it is expected that the information furnished will remain firm. Therefore, changes to Guide Specifications are identified as solutions rather than as probable solutions, and they should be used in current design.

7.a. To detect deficiencies or incipient defects in construction, materials, equipment, design, maintainability or functional adequacy which are not discernable until projects have been subjected to usage, a Post Completion Inspection will be conducted approximately six months after occupancy of a facility. Each inspection will include detection of construction deficiencies and determination of design adequacy including design and functional changes which should be made in similar designs for future projects, detection of potential high maintenance and operating costs, and

d. need for revising guides or criteria. The report will be distributed to all team members for their information and appropriate action. A copy of the report will be provided to CDR USACE (DAEN-MPE-T)

8.a. A coordination team visit will be made at least once in any three-year period to each District or operating Division Office with design work in the MC program to discuss engineeering and design procedures. The visits will be scheduled by the Chief DAEN-MPE. The immediate objectives of each coordination team visit will be to obtain information and insight concerning the techniques used by the

Division and District in carrying out the engineering and design work relating to the MC Program. The ultimate objective will be to use the information obtained and insight gained to help improve future operations relating to MC throughout the Corps. Upon completion of a visit, a trip report will be prepared and forwarded through the Chief, Engineering Division to the Director, Military Programs. The trip report will underscore follow-up action to be taken at OCE level.

9.a. The purpose of the Design Criteria Feedback Program is to keep OCE design guidance current. This is done by periodic OCE/HND/FOA inspections of military facilities which have been in use for about two years of for which design criteria problems have surfaced. The facilities will be user tested at this age, but normally will not have original features obscured by alterations or repairs. The functional performance of these facilities will be analyzed and reviewed to determine effectiveness.

e. The field on-site inspection and review will include discussions with the FE, the Resident Engineer, and the using agency service personnel, as appropriate. Pertinent comments, suggestions, recommendations, description of facility deficiencies, evidence of poor serviceability of materials, equipment, or systems will be recorded. The inspection team will be responsible for evaluation criteria deficiencies and for developing proposed solutions.

f. The HND team representative will prepare a written trip summary which will include specific recommendations for updating and improving design criteria. A copy will be provided to CDR USACE (DAEN-MPE-T).

10.a. The flow of feedback information should be such as to initiate improvements of all kinds, including improvement of the EIRS itself. Therefore, recommendations for improvement are encouraged, and these recommendations will be fed into the system for action.

b. Recommendations which are part of a report of a formal document shall continue to be reported as required by the regulation calling for such documents. Abstracts of such documents, or replies thereto, committing OCE to future engineering improvement effort shall be fed into the EIRS for monitoring to insure that follow-up action is taken. Recommendations which are not part of a report or a formal document should be transmitted by letter through channels to DAEN-MPE-S. Enclosures delineating recommendation(s) should be in the format used for enclosures to EIRS Bulletins. An information copy of each transmittal letter and the enclosed recommendation(s) should be submitted directly to CDR USACE (DAEN-MPE-S) by the initiator so that early staff action can be initiated.

11. In addition to these methods for gathering information, an Evaluation Retrieval System (ERS) has been established. The system's purpose is to provide timely information from a computer base file on subject matter derived from all feedback sources. Source information is input from Observation Card recordings of the afore mentioned inspection teams members. The storage and sorting process provides feedback in statistical format which specification writers, designers and QA personnel should use in determining weaknesses and strong points of the products they deliver.

4-303a. Conditions encountered in the field frequently will require construction to deviate to some extent from the approved plans and specifications. Some causes for this deviation are:

Unexpected foundation conditions

Conflicts with existing facilities

Non-availability of specified materials

Conflicts or errors in plans and specifications

Opportunities for reducing costs without sacrificing quality

Value engineering

Opportunities for improving quality without increasing costs

Changing requirements of the using service

b. The district engineer has authority to authorize small deviations from approved plans and specifications. He must assign responsibilities and delegate commensurate authorities to District field offices with respect to field changes.

CHANGES TO UNCOMPLETED AUTHORIZED PROJECTS

2-5a. Division commanders are delegated approval authority for changes to authorized projects if such changes meet all of the criteria listed below. Such changes will be reported to HQUSACE through the budget justification process.

a. Increase or decrease in scope no greater than 25% of the scope last authorized by Congress.

Changes in excess of 25% in any aspect must be approved by the commander USACE

b. Changes in location are determined to be insignificant

c. Changes do not exceed $3 million

d. Changes do not add to or delete from the project purpose

e. Addition of fish and wildlife mitigation measures do not require acquisition of additional lands

2-5b. The commander USACE is delegated approval authority for all other changes except those reserved by congress which are listed below.

a. Addition or deletion of a project purpose

b. Addition of fish and wild life mitigation measures requiring Federal acquisition of lands, where acquisition has not been specifically authorized by Congress. Changes in local cooperation requirements

c. Exceedence of $10 million Federal cost if project was authorized under section 201, prior to 22 October 1976; or $15 million Federal cost if authorized under Section 201 on or after that date.

CORPS-WIDE TECHNICAL CENTERS OF EXPERTISE ASSIGNED TO DIVISIONS AND DISTRICTS

4. Policy.

a. General. The successful engineering and construction of Corps of Engineers military and civil works projects requires a thorough working knowledge of a wide variety of highly specialized engineering, design, and operational activities. Many of these activities involve emerging or rapidly changing technologies, and since maintaining state-of-the-art awareness of these technologies is seen as basic to the successful execution of the Corps mission, they will be identified and supported by this regulation and periodic revisions thereto. Corps FOA identified as Technical Centers of Expertise are listed in Appendix A along with their assigned mission areas with applicable Mission and Function Statements given in Appendix B.

b. Technical Centers of Expertise. Technical Centers of Expertise are defined as a Division or District organization element which currently possesses a demonstrated, creditable, technical capability in a specialized subject area that can be of beneficial use to other Corps field offices. This capability can be resident in a single person or be the collective capability of an organizational unit and can be applicable to either civil works or military functions or a combination of both. The services to be rendered by a Technical Centers of Expertise to an FOA are advisory only unless specifically requested to be otherwise by the FOA seeking assistance.

5. Responsibilities.

a. HQUSACE/OCE. The Chief of Engineering Division, Directorate of Engineering and Construction, is assigned the overall responsibility for designation and oversight of the Technical Centers of Expertise program. A list of Technical Centers of Expertise mission areas, initially assigned FOA, and HQUSACE/OCE points of contact (POC) is shown in Appendix A. Overall technical monitorship of each Technical Center of Expertise is assigned to HQUSACE (DAEN-ECE). Although a future Technical Center of Expertise may be nominated by an FOA, the selection and the designation of a Technical Center of Expertise will be made by HQUSACE and implemented by revision to this regulation.

b. Divisions. The divisions in which Technical Centers of Expertise are located have the responsibility to establish and support the proposed Technical Centers of Expertise indicated in Appendix A, and any future Technical Center of Expertise established by HQUSACE (DAEN-ECE). Such support is to include the provision of sufficient training opportunity and funding to assist District Technical Center of Expertise personnel in maintaining state-of-the-art proficiency in their assigned mission area. Divisions with a need for advisory services of a Technical Center of Expertise will monitor and review those services to their using district in accordance with the provisions of ER 1110-2-1150 and ER 1110-345-100 as they would any other consulting design service.

c. Districts. All districts and operating divisions are expected to use the expertise and advisory service of Technical Centers of Expertise as they would any other consulting service to satisfactorily accomplish their design mission. The assisted activity is responsible for keeping its parent division or its next higher level of authority and the identified HQUSACE proponent organization informed regarding participation in the Technical Center of Expertise program.

d. Technical Center of Expertise. The responsibilities of a Technical Center of Expertise are threefold: to maintain, within its capability, state-of-the-art technical competence and awareness in its assigned specialty; to provide advisory assistance to other FOA; and to provide specific design services within its capabilities in their assigned specialty upon request.

B-17. Functions. In performing its assigned mission, the Center of Expertise will be capable of providing the following special functions:

a. Support HQUSACE (DAEN-ECE-A) in development of design and construction guidance and criteria.

b. Support HQUSACE (DAEN-ECE-A) in development of engineering standards, definitive drawings, and specifications.

c. Provide technical assistance to MACOMs and FOAs as follows:

(3) Prepare or review and assist with design memoranda and analyses.

(4) Prepare or review and assist with plans and specifications for construction contracts.

(5) Assist in the selection of architect-engineer firms.

(6) Monitor design services.

d. Assist and consult on technical matters during construction.

e. Attend and represent CE at technical specialty conferences when designated by HQUSACE (DAEN-ECE-A).

f. Support HQUSACE (DAEN-ECE-A) as point of contact for area of expertise.

g. Monitor technological advancements relative to tactical vehicle maintenance facilities through liaison with industry and appropriate research laboratories.

5.b. The HQ USACE (DAEN-ECE) has primary responsibility for overall technical management of the P & E program and for the E & D program and development of engineering and design criteria.

9.c.(3) Each feature design memorandum will clearly set fotth any proposed deviations from the project plan most recently approved that are pertinent to the subject matter covered. Full explanation of need for the deviation and their effects on the project will be included.

15.a. Division commanders, with the exception of the Commander, POD and NED, are delegated authority to approve the General Design Memorandum and Feature Design Memorandum except for those outlined below. The Commander, POD and NED shall submit all design memoranda to CDR USACE (DAEN-ECE) for approval. Those design memoranda to be submitted for the approval of HQ USACE (DAEN-ECE) are:

(1) General Design Memoranda.

a. For projects which include dams and/or hydroelectric power plants

b. For projects which include navigation locks with a lift of 10 feet or more

c. For local flood protection projects which include levees or floodwalls and pumping plants

d. For projects having substantial deviations from the authorizing document for which the division commander does not have approval authority (ER 1105-2-10, Chapter 2)

e. For projects having deviations from the authorizing document requiring approval by higher authority.

(2) Feature Design Memoranda.

a. For any design memorandum on which district and division are in major disagreement

b. For any design memorandum which proposes a change in project scope, purpose or requirements of local cooperation, compared to the authorizing document, which exceeds the criteria set forth in paragraph 2-4a of ER 1105-2-10, and for which approval authority has not been specifically delegated to the division commander

c. For any design memorandum because of unusual circumstances for which the division commander does not have technical expertise available

17. Any significant departure from an approved design memorandum, found necessary or advisable during the preparation of plans and specifications, will be incorporated in a supplement to the applicable design memorandum, which will be submitted for approval prior to completion of the plans and specifications. Plans and specifications will be prepared and approved only on the basis of approved design memoranda.

18. Except as provided in ER 1110-2-1200, plans and specifications will ordinarily be reviewed and approved by the division commander. All POD and NED prepared plans and specifications will be

submitted to HQ USACE for review and approval. When a design memorandum covering a specific project feature or phase of work is submitted to HQ USACE for approval, the division commander will recommend for which portion of the work, if any, plans and specifications should be reviewed and approved by HQ USACE, clearly delineating the work involved and the reasons for such recommendation. The return endorsement to the division commander will indicate for which portion of the work plans and specifications are to be submitted to HQ USACE for approval.

6. The criteria and design procedures set forth in engineer regulations and manuals will be utilized whenever applicable in the preparation of plans and specifications. In any case where use of criteria or procedures not covered in the regulations and manuals is proposed, full explanation and justification will be included in the appropriate design memoranda required by ER 1110-2-1150.

7. Guide specifications issued by the Chief of Engineers shall be utilized to the maximum practicable extent in the preparation of technical provisions for civil works projects.

a. Guide specifications for civil works construction will be utilized to the maximum extent practicable in preparation of all civil works specifications. Modifications will be held to the minimum necessary to provide for local conditions, special project requirements, and new developments and improvements in design or construction techniques.

c. Applicable technical provisions of guide specifications for military construction may be followed when the type of work is not covered by a guide specification designated for use for civil works construction.

d. For work not covered by guide specifications designated for use for civil works construction, recently approved project specifications or sections thereof may be used as guides to the extent that they are applicable.

8.a. Materials and equipment shall be described, where possible, by documents generally known to the industry. Nationally recognized industry and technical society specifications and standards shall be used to the maximum extent practicable to assure that requirements are compatible with current industrial practices and manufacturing resources. If industry documents are unsuitable, applicable Federal or Military specifications and standards shall be used to describe the requirements. Where use of nationally recognized industry standards or Federal and Military specifications is not practicable, contractors shall be required to use materials and equipment satisfying good commercial standards, available from local commercial sources.

b. The following general rules will be used in determining the applicability of Federal Specifications and other standards:

a. Specifications for supplies, materials, and articles, other equipment of standard manufacture, to be furnished for Government stock will always reference applicable Federal Specification

b. Specifications for equipment of standard manufacture whether intended for Government stock or for incorporation in the specific permanent structure need not make reference to standard specifications for materials of the component parts but rather will be prepared so as to base acceptability of the equipment upon capacity, performance or other requirements. When a standard specification covers the desired item of equipment in its entirety such a specification should be used.

c. Specifications for equipment of special design, not a standard manufactured product, will specify the quality of the materials for the major component parts by referencing those standard specifications which are considered necessary. For minor parts it will usually be advantageous to permit a manufacturer to use stock materials of acceptable quality.

d. In specifications for temporary construction or for small permanent structures, such as dwellings and service buildings, Federal specifications should not be used. A specification calling for commercially available products will be satisfactory for the components of these structures. When warranted by the quantities involved, recognized standards should be used for products, such as paint, which otherwise would be difficult to properly evaluate.

9.a. Changes in plans or specifications affecting work in progress and affecting contracts for which bids may have been received will be limited to cases of absolute necessity.
d. Unusual or unproven requirements will be avoided whenever possible.

e. Articles in specifications will not be designated by trade name unless it is impracticable to provide other identification for the article desired. Whenever possible, articles and materials will be identified by physical or chemical composition, by test qualifications, by performance conditions or by similar specifications.

13.f. Delegation of authority to approve plans and specifiations may be made to the district engineer as deemed advisable by the division engineer in cases of minor procurements, minor construction projects and projects for which standard or similar plans and/or specifications have been previously approved.

g. Significant revisions to approved plans and specifications may be made prior to advertising, or by amendment of an invitation for bids or by modification of an existing contract will be approved by the approving authority of the plans and specifications being revised prior to accomplishment. For this paragraph, significant revisions are those which modify the structural features, functional purpose or operational and maintenance characteristics of the equipment or work involved or have an appreciable effect on the bid price, competition for the work or administration of the contract. HQDA should be informed prior to implementation whenever such revisions constitute significant departures from the design concept as presented in the approved pertinent design memorandum.

16. To take full advantage of experience gained through construction and to avoid the repetition of mistakes, it is not necessary to refer to a standard in its entirety and any requirements which are too restrictive for the intended application or add unnecessarily to the cost.

4.b. In the contiguous U.S., all design will be accomplished in accordance with the policies outlined in this regulation and in accordance with the applicable Army and Engineer regulations and manuals, Engineer Technical Letters, multiple letters, all-division letters, drawings, and specifications subject to the specific provisions of the design directive; except that division engineers may, for a specific project, authorize deviations for criteria issued by OCE. Division engineers may not delegate this authority and will promptly report to HQUSACE (DAEN-ECE) each instance in which it is exercised. Such report will be made in a timely manner, to permit time for comment by OCE in case of objection and to permit time for any necessary corrective action by the district at least two weeks prior to bid opening. Districts will take the proper action to insure that any proposed deviation from criteria is specifically brought to the attention of the division engineer at the earliest design phase that it becomes known. In overseas areas where it has been determined that CONUS standards are not feasible, the division engineer may authorize deviation from such standards to reflect both the advantages and the limitations of available materials and local construction practices. In no area does authority to deviate extend to changes in criteria which will permit increase in fore or life safety hazards; to changes in planning and design standards for airfield pavements, airfields or heliports; or changes in criteria for diesel-engine generators. Any proposed deviations in these categories will be referred through CE channels to HQ USACE (DAEN-ECE) for approval.

c. In order to achieve uniformity throughout CONUS and to avoid unnecessary duplication of design effort, standard designs and definitive designs will be used as the basis for project design where directed or where shown on the DD Form 1391. For these projects for which OCE standards and definitives are not available, maximum advantage will be taken of field-prepared designs for site adaptation.

d. Pre-engineered structures will be considered for those projects where the type of facility and siting conditions permit.

5.b. Except for standard designs, the design responsibility of the Chief of Engineers is delegated to division and district engineers. Design may be accomplished through the use of architect-engineers. Project designs will be prepared in strict accordance with established criteria, design directives, and other written instructions applicable to the project. However, consideration may be given to reasonable and practical deviations from established design criteria, including DOD criteria, when deemed appropriate for the specific project involved and approved by the division engineer in accordance with paragraph 4. Deviation will not be made from approved scope and funding, as shown on each DD Form 1391.

(1) OCE has design responsibility for standard designs for repetitive facilities although the actual design may be assigned to field offices. The division or district engineer assigned responsibility for preparation of contract documents from standard designs will have design responsibility for site adaptation and modifications to delineate requirements for unusual foundation conditions and outside utilities. The division or district engineer will also have responsibility for incorporation current criteria issued by OCE in guide specifications and other media.

6.c. Implementation of New Criteria

There are three categories of implementation: routine, special, and immediate. Unless special or immediate application is specified, new or revised design criteria issued by the OCE will receive routine application.

(1) Routine application requires the use of new criteria in future projects and in current projects if received prior to initiation of site adaptation of standard drawings or initiation of preparation of project drawings and specifications.

(2) Special application requires the use of new criteria in future projects and integration into projects already designed, but not yet bid, by issuing amendments to bidding documents where necessary.

(3) Immediate application requires integration into all projects, except where immediate application would impact to cause one or more of the following conditions: (a) delay critical beneficial occupancy dates, (b) result in removal of more than an economic amount of construction already in place, (c) result in the loss of materials already delivered, or (d) require further funding which would require further apportionment or jeopardize funding of other items in the construction program.

9. Unusual or new Methods and Materials

Unusual or new methods and materials previously untried for military construction may be incorporated into the design when evidence shows that such use is in the best interest of the Government from the standpoint of economy, lower life cycle costs and quality of construction. It will be the responsibility of the manufacturer to prove the merit of the product by certified laboratory results and evidence of satisfactory installation under conditions similar to those anticipated for the proposed construction application. Such deviation must have approval of the division engineer and be reported to HQUSACE (DAEN-ECE).

11. Alternate Designs

Bidder initiated alternatives to the government-prepared design will not be accepted. Consideration of alternate designs for Air Force projects will be in accordance with AFM 88-15. For Army projects, prior approval of the division engineer will be obtained for the use of alternate designs.

12. Contractors' Options

Optional materials and methods of construction that are a type and quality acceptable for military construction are included in applicable guide specifications and standard designs as a means of increasing competition and reducing project costs. An additional option may be considered after a study of conditions affecting the project has shown that it is in consonance with good engineering practice in that locality, is economically justifiable, and is in the interest of the Government. Where such justification can be shown, division engineers may authorize additional options for specific projects. Where cumulative experience indicates that a change in the standard options may be advisable, division engineers will forward their recommendations to DAEC-MCE.

13.a. The manditory use of guide specifications and standard technical specifications is intended to provide the necessary uniformity of specifications used throughout the Corps to derive maximum competition benefits. This will enable manufacturers to produce materials and equipment with a reasonable assurance of acceptance for military construction.

b. Regardless of the merit of a material or product or its acceptability for military construction generally, only that which is in strict conformity with provisions of contract specifications will be accepted. Provisions of the specifications will be enforced strictly after the bid opening, and changes will be made only as necessary to correct errors or to meet changed conditions or new requirements. This practice will preclude acceptance of so-called "equal or better" items that do not conform fully to the contract requirements. Likewise, the fact that an item has been specified in previous jobs or may be considered on future projects will not be a basis for change order. These requirements make it necessary to carefully evaluate proposals and recommendations by prospective bidders during the advertising period and to correct the specifications by amendment, if necessary.

20.c. Division and district engineers are encouraged to inform DAEN-MCE of suggested changes to standard designs (both drawings and specifications) considered desirable to improve construction or functional use or to effect savings.

4.d. In accordance with ER 1110-345-100, paragraph 9, unusual or new materials or methods of construction may be specified if merit has been established and use has been approved by the division engineer. As an aid to proving merit, a handout is available for use in evaluation of new materials, equipment, and methods for military construction; the evaluation handout may be given to producers and suppliers who present their products for inclusion in specifications for military construction. Copies of the evaluation handout may be obtained from HQDA (DAEN-MCE-S) WASH DC 20314.

5.b. DEVIATIONS

(1) It recognized that the requirements in the guide specifications will not suit every project, and that the guide specifications will frequently need to be tailored to fit the specific project under design. Tailoring of an OCE guide specification either by a deletion or by an addition, is considered to be a deviation; therefore, the guidelines for deviations, as set forth below, will be applicable. Since deviations may prove costly or embarrassing to the Corps, only OCE-authorized deviations, or deviations reviewed and approved by the division engineers subject to the limitations below, will be permitted.

(2) AUTHORIZED DEVIATIONS

The following deviations are authorized without reporting to OCE:

a. Changes required by or permitted by DA publications, OCE publications, OCE design directives or letters, or the "Notes" section of the guide specifications.

b. Deletion of inapplicable test material, or insertion of additional needed test material (as necessary to tailor the specifications to fit a specific project) subject, however, to compliance with all regulations, procurement policies, criteria controls, and other explicit guidance established by official publications. Except when required to do so as a result of explicit guidance mentioned herein, additional text material will not be added unless it is absolutely necessary in order to construct the specific project involved.

c. Changes to make the format of each section consistent with that of the latest guides.

d. Tailoring Air Force projects to comply with AFM 88-15.

e. Changes to reduce requirements for submittals of technical data and samples in accordance with paragraph 4b.

f. Changes to make testing the contractors responsibility, in accordance with paragraph 4c.

g. Deletion of standard one-year guarantee in accordance with paragraph 4g.

(3) DEVIATIONS REVIEWED AND APPROVED BY DIVISION ENGINEERS

Except for OCE authorized deviations, changes will not be made unless appropriate to fit the specific project involved, and then only with the approval of the division engineer. Consideration may be given to reasonable and practical deviations from established design criteria, including DOD criteria, when deemed appropriate for the specific project involved and approved by the division engineer. Division engineer review prior to approval will ensure that the deviation reflects sound engineering logic and

complies with current regulations and procurement policies. Reporting to OCE in accordance with ER 1110-345-100, paragraph 4, will be required only the approved deviation is a deviation from criteria. Districts will take the necessary action to ensure that any proposed deviation from criteria is specifically brought to the attention of the division engineer at the earliest design phase that it becomes known, preferably at the time of submittal of concept design.

7. Where it is necessary to modify the requirements of a Federal or Military document by citing exceptions in the contract specifications and such modifications are repetitive, a request for a change in the referenced publication will be forwarded to DAEN-MCE-S.

9. The policies and procedures for review and approval of specifications by the using services, the necessity for and method of forwarding specifications to OCE for review and approval, and the authority of division and district engineers to make changes in specifications that have been approved by the using service and/or OCE are the same as for the drawings to which the specifications apply.

MAJOR REHABILITATION PROGRAM AND DAM SAFETY ASSURANCE PROGRAM

4.a. The purpose of the Major Rehabilitation Program is to permit construction of infrequent, costly structural rehabiliation or major replacement works that are intended to extend the useful life of a project or a principal feature thereof at projects operated and maintained by the Corps of Engineers. Projects approved for Major Rehabilitation will require budget justification and other supporting data similar to the budget information prepared for construction projects. The Major Rehabilitation Program is limited to the major repair or restoration or main structures such as dams, locks, powerhouses, and breakwaters, exclusive of electrical, mechanical, and other equipment, except that such equipment may be included where it is essential to and integral with the feature of the project being rehabilitated. As a further exception, the Major Rehabilitation Program may include the periodic replacement of large individual items of major equipment such as turbines and generators when they are part of a major replacement program. Division Engineers should make every effort to provide for regular maintenance of completed projects through normal Operation and Maintenance, General budget process. Major repairs to or replacement of boats, trucks, mobile cranes, and similar mobile equipment are excluded from this program.

b. The Dam Safety Assurance Program provides for modification of completed Corps of Engineers dam projects which are potential safety hazards in light of present day engineering standards and knowledge. The program is intended to facilitate upgrading of those project features which have design or construction deficiencies related to dam safety in order to permit the project to function effectively and as originally intended. In order to qualify, the modification must be within the Chief of Engineers' discretionary authority to rectify and also must be such that they cannot be accomplished under the routine maintenance or major rehabilitation programs. Projects approved for Dam Safety Assurance will require budget justification and other supporting data similar to the budget information prepared for construction projects. Project modifications requiring additional authorization may be identified under this program. However, these modifications would not be eligible for accomplishment until the requisite Congressional authorization is obtained in accordance with NEPA and Principles and Standards. Generally, existing authorities are considered sufficient to permit improvements to the project for safety purposes if such improvements do not alter the scope or function of the project or substantially change any of its specifically authorized purposes.

c. In addition, the Dam Safety Assurance Program is designed to upgrade dams built by the Corps of Engineers and turned over to local interests to operate and maintain. These upgrading projects may require additional authorization, but the studies will be funded under this program. The Major Rehabilitation Program is not applicable to local protection projects, dams or other works, turned over to local interests for operation, maintenance and major replacement.

5. Major rehabilitation or modification of dam safety assurance may be included in the Major Rehabilitation Program or Dam Safety Assurance Program if all of the following conditions exist:

a. The structural work does not include additions or betterments which constitute a change in project purpose, size, capacity or location. Modernization of operating equipment (except for mobile equipment) to meet current design standards may be incidentally included.

b. The estimated cost of the work is $5,000,000 or more. For multi-project systems that are budgeted as a single project, the $5,000,000 applies separately to each component project.

c. The structural work is required for continued operation of the project for its authorized purposes.

CORPS OF ENGINEERS LABORATORY, INVESTIGATIONAL RESEARCH AND TESTING FACILITIES

pg. 5 WES performs basic and applied research in the broad fields of hydraulics, beach erosion, mechanics, earthquake engineering, soil dynamics, concrete, expedient construction, nuclear and chemical explosives excavation, vehicle mobility, environmental relationships, engineering geology, pavements, protective structures, aquatic plants, water quality, and dredged material.

WES is the principal agent for the Corps of Engineers charged with the leadership role for research and development in the areas of countersurveillance, military hydrology, mine/countermine, Section 32 (streambank erosion), coastal engineering, and water conservation and supply.

pg. 7 WES also operates the Department of Defense Information Analysis Centers for Pavements and Soils Trafficability, Concrete Technology, Hydraulic Engineering, Soil Mechanics, and Coastal Engineering.

pg. 19 ETL is responsible for delivering high-precision positioning systems for the Field Artillery, target position equipment for tactical missile units, and systems for reproducing maps portraying specific military geography information needed by the Army in the field.

pg. 25 CRREL performs basic and applied research in support of the following broad mission areas: Winter Combat Operations, Winter Battlefield Environment, Cold Regions Facilities, Ice Engineering, River Ice Management, Civil Works Remote Sensing, and Cold Regions Hydrology.

pg. 28 The Construction Engineering Research Laboratory (CERL) conducts research and development to support Army programs in military construction, operations and maintenance, military engineering, and in civil works. Primary thrusts are to improve construction quality and energy efficiency while still safeguarding the environment. Communication and interchange of information with academic, engineering and construction activities within the Department of Defense, other Government agencies, and the private sector are emphasized.

pg. 32 The Facilities Engineering Support Agency manages the nontactical generator program and provides engineering and technical support to installation facilities engineers, major commands and to the Office of the Assistant Chief of Engineers.

pg. 36 The Hydrologic Engineering Center main forte in these specialties is the development and application of mathematical models used on planning, design, and operation of water resource projects. The major services provided to the Corps by the HEC are applied research, training, and project consulting.

pg. 37 Technology transfer to the Corps field offices is accomplished through Corps-sponsored training courses, special workshops, seminars, training manuals, and project assistance.

pg. 38 Research studies conducted by IWR focus on the water resources planning activities of the Corps. This includes efforts to improve methods for plan formulation and evaluation of the economic, social, and environmental effects of water resources projects as part of the Civil Works planning process.

Policy studies are conducted by IWR at the request of the Director of Civil Works. These studies evaluate existing policies, assess modifications, examine alternative policy options, and investigate issuance of new policy guidance.

pg. 39 The North Pacific Division Laboratory is the leading facility of the Corps for testing mass concrete placed in huge structures such as dams. It also conducts chemical and related physical tests on engineering materials, and soils tests related to foundations for structures and pavements. The lab performs materials testing work on request for any other Corps of Engineers office and for private industry when certain conditions are met.

The South Atlantic Division Laboratory have modern environmental exposure cabinets which are available for accelerated freeze-thaw, weathering, salt-spray corrosion, humidity corrosion, and mildew growth for paints and finished surfaces. Petrographic tests which analyze rock and sediment for foundations studies, concrete, aggregate investigations, riprap rock, and other construction materials are also performed by the South Atlantic Division Laboratory.

pg. 40 The Southwestern Division Laboratory has the distinction of being the sole purchasing and warehousing agent for all diamond tools used by the Corps of Engineers worldwide.

5. Records and Reports.

(3) Show that the VE effort generated an alternative, less-costly means of performing the required functions. Show that VE methodology was used, thereby preventing the conclusion that the action was the result of economic analysis or normal design review. Emphasize the functional analysis, that several alternatives were considered, and the attention paid to value versus cost. Refrain from the use of terminology such as **"through an economic analysis," "by a cost analysis,"** or other such phrases that might indicate that techniques other than Value Engineering had been practiced. (For civil works that recommended alternative is an innovation and not a standard that should have been used initially. Also, it is not a mandatory change required by unanticipated site conditions. Value Engineering is a voluntary effort to develop an alternative not an involuntary effort dictated by circumstances.)

6. Implementation

c. Standard Designs. When standard designs for military construction are studied under the guidance of the Office of the Chief of Engineers, resulting changes which are approved will be announced by Engineer Technical Letter as soon as possible. This will enable Districts to have the advantage of the changes before the revised standards are issued. For maximum savings, such changes should be implemented before opening of bids or, where practicable and when earlier revision is not possible, by contract modification.

APPENDIX B WORKBOOK

II. THE SPECULATION PHASE

OTHER QUESTIONS TO ANSWER

2. Can specification requirements be eliminated or modified?

3. Can a standard part or commercial product be used?

4. Would a modified standard part or commercial product reduce cost?

5. Have you considered newly developed materials?

III. THE DEVELOPMENT PHASE

OTHER QUESTIONS TO ANSWER

1. Are quality requirements met by each alternative?

2. Are reliability, and operational requirements met by each alternative?

3. Are safety requirements met by each alternative?

Technical Evaluation. (Detail for each selected alternative any required test or analytical procedures that may be necessary to verify that the basic function(s), can be performed without decrease in necessary quality, maintainability, reliability, performance, and compatibility. If any test or analyses have been performed, list results.)

APPENDIX E (Example of a division handout for contractors explaining the benefits of the VE incentive clause.)

Your Opportunity

You are often in a better position to keep up-to-date on advances in the state of the construction art than is the designer. In fact, you have the advantage of being in much more direct contact with the every day problems involved in construction. Therefore, you can provide a fresh approach to construction that can not only reduce the cost of our facilities, but can also improve the construction sequence and time on the job.

You are also in a better position to get new and innovative ideas for improving construction and reducing costs from subcontractors and suppliers. Put a VE Incentive Clause in all contracts with them to broaden the base of your participation. VE activity by the subcontractor and supplier means added income for you with minimum effort and investment.

VALUE ENGINEERING BENEFITS AND THE CONSTRUCTION CONTRACTOR

pg. 3 Any contract that results in added performance cost is a potential opportunity of Value Engineering (VE) savings.

pg. 4 The Value Engineering incentive Clause permits you to propose changes to the contract requirements that will "get the job done" at least as well as the original design, but at a lower cost.

You are often in a better position to keep up to date on advances in the state of the construction art than is the designer. In fact, you have the advantage of being in much more direct contact with the every day problems involved in construction.

pg. 5 You are also in a better position to get new and innovative ideas for improving construction and reducing costs from subcontractors and suppliers.

Savings resulting from your change proposal are normally shared on a 55-45 basis between you and the Government after you are reimbursed for your cost of implementing the proposal. The more you are willing to invest your time and talent in developing a sound technical proposal, the better chance you have for quick approval action. You will lose this investment each time a VECP is disapproved. On the other hand, almost two-thirds of all proposals submitted to the Corps have been accepted.

Research and Development
INSTALLATION SUPPORT ONE-STOP R&D SERVICE

3. Guidance. The total range of technology addressed by the Corps R&D community has been divided into selected research areas. A specific individual has been designated as a point of contact (POC) for each of the research areas. This POC is expected to be familiar with the latest knowledge in the research area and to specialist. Requests for assistance in other than assigned research areas are expected to be referred to or coordinated with the designated POC.

a. To obtain assistance on a problem, it is necessary to identify the appropriate research area and call the POC. The POC will respond directly or will enlist the aid of those persons most qualified to respond. The POC will also maintain contact throughout any subsequent activity to insure that a satisfactory response has been made.

b. Requesting activities will be expected to provide funds for travel and for assistance that exceeds two work days of effort.

c. The list of research areas and the corresponding contact is attached at Appendix A*. If there are questions concerning the details of this service or about the classification of a problem, call the Directorate of Research and Development (CERD-L) area code (202) 272-0255.

* Of the subject EP.

AR 34-2

RATIONALIZATION, STANDARDIZATION, AND INTEROPERABILITY POLICY

2-2.a.(1) DA will actively seek the Rationalization, Standardization and Interoperability (RSI) of doctrine, weapons systems, logistics, equipment, and procedures within NATO and ABCA on a priority basis to conserve resources and increase the combined combat capability of US, NATO, and American, British, Canadian, Australian (ABCA) Alliance forces.

AR 70-1

SYSTEM AQUISITION POLICY AND PROCEDURE

3-1 The Army process for conceiving, developing, acquiring, and fielding new items of equipment is formalized in an **Life Cycle System Management Model (LCSMM).**

1. Key Decision Points
2. Long Range Planning
3. Program Initiation
4. Concept Exploration Phase
5. Demonstration and Validation Phase
6. Full Scale Development
7. Low Rate Initial Production Phase
8. Production and Deployment Phase

3-9 Army Research, Development, Test, and Evaluation Program

1. Research
2. Exploratory Development
3. Advanced Development
4. Engineering Development
5. Management and Support
6. Operational System Development

3-11 Army Scientific and Technical Information Program

STIP provides for effective access to, and distribution of, scientific and technical information required in support of management and execution of the Army RDA Program.

3-12 Prototype Programs

1. Experimental prototypes are used in technical feasibility, technical approach and operational evaluations. They are designed to reduce technological uncertainty, prove feasibility or provide realistic cost estimates.

2. Development prototypes are normally for the purpose of confirming that the design concept has military utility in response to a stated military requirement. They also may be fabricated for competitive evaluation to select the best approach for further development. When development prototypes are fabricated in the FSD Phase, the intent is to assure that engineering problems have been solved and to permit thorough evaluation of the system.

6-1 **Material Improvement Management**

Material improvement can be accomplished three ways: reconfiguring a type-classified item that is in production by a Class I engineering change proposal; reconfiguring a type classified fielded item via a product improvement proposal; or accomplish an evolutionary improvement to product improvement.

7-1 **Tailoring the Acquisition Process**

b. Tailoring an acquisition program provides the MATDEV with the flexibility to not only modify standard acquisition process as a reactive necessity but also to make proactive planning decisions to significantly alter, combine or eliminate phases in the process. Two basic approaches that can be used are NDI and Army Streamlined Acquisition Process (ASAP).

7-2.a. The ASAP approach should be a primary consideration in the acquisition strategy to assure that development and production are low risk and future capability needs can be achieved through P3I.

7-3 Non-developmental items (NDI) are systems available from a variety of sources requiring little or no development effort by the Army. There are two general categories of NDI, off-the-shelf items used in the same environment for which the items were designed, and off-the-shelf items to be used in an environment different than that for which it was designed. The latter requires modification to hardware or operational software.

c. There is a third level of effort. This approach emphasizes integration of existing componentry and essential engineering effort to accomplish systems integration. This strategy requires a dedicated R&D effort to allow for system engineering of existing component, for software modification/development, and to ensure the total system meets requirements.

d. For all types of NDI, the acquisition strategy will consider economic and time constraints and realities when determining needs and trade-offs.

7-4 **Logistic Support Considerations**

a. When the standard acquisition process is altered, time available to execute essential components of the program may be reduced. Particular attention must be given to the effects of compressed processes on the program's ILS component. During development, the MATDEV must identify actions taken to reduce support risks.

c. Decision authorities must carefully review AS for streamlined programs, this review will ensure that adequate logistic support will be provided when the system is fielded.

AR 70-15

THE PRODUCT IMPROVEMENT PROGRAM

The objective of product improvement is to extend the useful life of existing materiel rather than acquiring or developing entirely new equipment. PI will be used as the means by which materiel type-classified standard is recognized to:

Increase the safety of personnel or reduce the damage to equipment during use

Improve operational capability in response to user needs

Reduce the cost of production of operational support

Improve reliability, availability and maintainability

Correct performance deficiencies

Improve RSI, compatibility or simplification

Comply with legislative requirements

Conserve energy

d. All changes to Army and Army-managed multi-service materiel that qualify as PI will be processed as product improvement proposals (PIP).

1-5 **Program criteria**

a. A wide variety of equipment change are included under the Army PI program. Some of these are commonly called conversions, modernizations, and reconfigurations. Also included are computer software changes of battlefield automated systems.

b. If configuration change is to be made on existing standard items in the field under new development and manufacturing, that part of the program is considered to be PI. Decisions for such product improvement must identify the correct funding needed and must be made as early as feasible during new development.

c. A proposed change will be considered as a PI if it meets two basic criteria; (a) the change involves an engineering effort which requires a change in design and determines its effect on form, or (b) a retrofit change to an operational inventory is involved.

2-12 **Material Developers**

DARCOM, TSG, COE, and USACE are material developers. Material developers will program and budget funds to carry out product improvements. They will ensure that PI of existing materiel is always considered as an alternative to the new development of materiel.

a. Material developers will determine the need for PI, and will ensure that each proposed improvement is adequately reviewed and evaluated. They will include all functional elements in the evaluation to ensure that only essential and cost-effective improvements are approved.

w. Material developers will also choose a method to collect field data needed to evaluate the adequacy of the improvements.

x. They will ensure that needed changes to technical documents are published, and that this will be completed only after coordination with the combat developer and trainer.

3-2 Basis of material requirements

a. The material developer, in close coordination with the combat developer, continually assesses the technology base to determine which technologies have been proven and are available to support a system concept. The BDP helps to focus the technology base efforts and industry research and development efforts in the identification of near term materiel solutions.

12.b. Standard designs, if applicable, will be used as a guide for repetitive type structures. Standard designs will be site-adapted to adjust for local climate and the availability of building materials.

16. Military construction will be accomplished with drawings and specifications that have been prepared, reviewed and approved as prescribed in AR 290-5 and AR 415-20.

MILITARY CONSTRUCTION ARMY (MCA) PROGRAM DEVELOPMENT
Design and construction agency

2-5 All MCA projects are designed and constructed by the USACE. This does not apply to certain minor construction, or to projects assigned to the Naval Facilities Engineering Command or other construction agencies.

IX. Construction options

3-47 Use of manufactured or pre-engineered buildings

Many types of buildings can readily be constructed using totally manufactured or pre-engineered components and systems. These alternatives offer potential savings by reducing labor requirements at the construction site. However, an important factor in determining the degree of economy gained by using these alternatives is the number of the competing manufacturers and their proximity to the construction site. Economic analysis for this type of construction will not differ from that for permanent type construction.

8-6 Criteria for proposed construction

a. For repetitive facilities using standard plans, design guides or criteria from TM 5-800-1, TM 5-803-4 or DOD 4270.1-M cite the source. If exceptions to established criteria are requested, they must be fully justified.

b. Nonstandard special design projects require data to support their scope. State how size and capacity of the proposed facility well adequately support requirements.

AR 415-18

MILITARY CONSTRUCTION RESPONSIBILITIES

Appendix A

D.1. Acquisition of military facilities, including family housing construction and certain National Guard and reserve component facilities within the U.S. shall be accomplished as follows:

a. a. The Department of the Army shall use the services of the Corps of Engineers, and the Department of the Navy shall use the services of the Naval Facilities Engineering Command for the design and construction of military facilities for their respective Military Departments. Each may use the services of the other Department in the interest of efficiency and cost-effectiveness, or when otherwise considered appropriate.

b. b. The Department of the Air Force shall use the services of the Corps of Engineers of the Naval Facilities Engineering Command for design and construction of the annual military construction program. Another construction agent may be used when recommended to and approved by the ASD(MRA&L), or a designee.

In addition, the Department of the Air Force may design and construct under its own supervision selected projects subject to the prior approval of the ASD(MRA&L), of designee.

c. The reserve components shall normally use the services of the Corps of Engineers or the Naval Facilities Engineering Command for the design and construction of facilities.

5.e. Concept design

Concept design will be prepared by the district engineer upon receipt of direction from the Chief of Engineers. It will be based on detailed functional requirements supplied by the using service and on pre-concept control data prepared by the district engineer.

f. Final design

Final design will be prepared under the supervision of the district engineer upon receipt of direction from the Chief of Engineers. It will be based upon and be consistent with previously approved concept design. District engineer approval of final design is sufficient to permit the project to proceed to advertisement for bids and eventual construction contract award following receipt of appropriate directives from the Chief of Engineers.

1-3 **Responsibility**

Installation commanders, through their facilities engineers, are responsible for facilities engineering at their installations and activities.

2-1 **General**

Standards established herein apply to all of the general types of facilities engineering work and functions relating to buildings and structures. However, it is essential that guide specifications be adapted to local existing conditions which, in many instances, differ from modern construction. These standards apply regardless of the source of funds or approval authority for such funds. Materials used for maintenance and repair of inactive facilities or those scheduled for disposal, or for construction in connection with such facilities, will reflect the lowest overall cost consistent with minimal requirements for the planned use of the facilities.

DEVELOPMENT AND USE OF NON-GOVERNMENT SPECIFICATIONS AND STANDARDS

3.a. The Objectives of the Army are to-

(1) Use commercial products and common commercial items in military materiel as much as practical.

(2) Reduce overlapping, duplicating, and conflicting documents generated separately by the Army and industry groups.

(3) Move toward a national voluntary standards program.

b. The Army seeks to achieve these objectives through-

(1) The use of specifications and standards developed by nationally organized non-Government standards bodies as one method for achieving this objective.

(2) Close coordination and cooperation between the Army and non-Government groups to enhance the availability and applicability of non-Government standards to Army use.

4. The DOD Standardization Program directs that:

a. Non-Government specifications and standards be adopted and used when there is no substantial or demonstrable advantage to the DOD in the development of a new document. The advantage will be determined by comparison of costs, logistic support, performance requirements, QC, and usable life of the item under existing specifications versus the proposed new military specification or purchase description. Duplication of the military series and non-Government standards are to be avoided and eliminated to the maximum extent practical where such duplication now exists.

b. Adopted non-Government specifications or standards will be used in the design and development of material and referenced in the preparation of military specifications or standards for material to the maximum extent practicable.

c. DOD participation in the development and/or adoption of a non-Government document for items common to those available commercially is preferred to the development of a new or revision of, a Federal or Military specification, standard or purchase description. However, military or Federal series documents will be developed and used in the event that essential requirements are not included in the development of non-Government documents.

d. Army agencies will actively participate in the technical functions of bodies engaged in the promulgation of non-Government standards to the extent of the DOD interest involved and within the limits of prudent use of manpower and fiscal resources.

5. Responsibilities

a. The Commanding General, US Army Material Development and Readiness Command (DARCOM) has responsibility for Army-wide direction and implementation of the Defense Standardization Program.

b. Army Standardization Assignee Activities, in cooperation with the Preparing Activities and Military Coordination Activities, will develop and maintain a roster of DOD personnel engaged in the development of specifications and standards on non-Government task groups and committees for assigned Federal Supply Classes and Areas.

d. Military Coordination Activites will initiate action for adoption of non-Government documents simultaneously with the issuance of the document by its parent standards body.

4-1 **Technology Transfer**

m. The Industrial Base Engineering Activity (IBEA) will screen all technical reports received from manufacturing methods and technology funded projects and select those suitable for conversion to the National Technical Information Service (NTIS) tech notes. IBEA will provide NTIS or its contractor with the information required to produce a Tech Note. NTIS will publish and distribute the Tech Notes to all subscribers.

3-5 **Military adaptation of commercial items (MACI)**

a. MACI encompasses those projects undertaken by the materiel developer to explore the feasibility of adapting commercially available non-developmental end items and components to meet Army requirements. Its objective is to provide an alternative to the development of materiel to meet Army needs.

AIR FORCE DESIGN MANUAL - CRITERIA AND STANDARDS FOR AIR FORCE CONSTRUCTION

1-1.d. In foreign countries, suitable local materials, labor, and construction methods are used if they produce economical and fire safe facilities of adequate serviceability. However, current US Government policy concerning such matters must be observed.

1-2.a. HQ USAF, Director of Engineering and Services (HQ USAF/PRE) establishes policy, criteria, and standards for the type and character of materials or systems to be used in designing and construction of new facilities and reconstructing, rehabilitating, altering, modifying, maintaining, and repairing existing facilities; provides architectural and engineering consultant service to the Air Staff and Major Command HQ; develops necessary additions and changes to AFM 88-15.

1-5. These criteria and standards give a bisis for achieving a uniform character of construction and materials for Air Force facilities. The Air Force objective is to obtain structures which are consistent with those constructed under good commercial practices. The designs for facilities emphasize sound planning principles with stress placed on scale, balance of elements, simple functional layouts, and minimum life cycle cost with full consideration of operation and maintenance cost and energy conservation. The listing of structural elements, materials and other items is not in order of priority.

a. Air Force construction criteria and standards cannot adequately cover all conditions and material requirements for a worldwide construction program. Therefore, exercise good judgement in selecting construction practices and recognized engineering standards where Air Force guidance is not provided or where deviations are requested.

1-6 While definitive drawings normally portray the design of single buildings or facilities, it is not Air Force policy to build such facilities as separate entities if this practice would be contrary to good planning and economy. Therefore, consider the convenience, efficiency, and savings possible from combining compatible functions and facilities such as housing and dining community recreation, maintenance, base supply and warehouses, morale and welfare, unit supply and administration, and from grouping of facilities similar to "shopping centers" of compatible civilian standards.

1-8 Insure that the Air Force objective of standardization of structural, mechanical and electrical systems and equipment is being implemented consistently during design. For each structure, a concerted effort should be made to avoid a multiplicity of different components. Design should contemplate an energetic attempt to:

(1) Standardize on sizes of joists and other structural members which will simplify take off, delivery, handling on the job, and the number and kinds of fittings and attachments required.

(2) Standardize on pipe, wire, and conduit sizes and materials.

(3) Search for other areas of standardization and elimination of details which require introduction of additional trades and components for unusually small amounts of work.

1-9 Buildings and structures which constitute exceptions to these criteria and standards are:

a. Those requiring different standards of construction than normally would be required because of:

(1) Functional mission or structural peculiarity.

(2) Importance and strategic value of their contents or equipment. Hospitals and medical facilities are not exempted from the requirements of this manual.

b. Family housing.

c. Exceptions to these criteria and standards (other than family housing) will be submitted to HQ USAF for approval

1-10.a. Air Force policy requires an economical selection of materials based upon construction and maintenance costs. Also consider functional requirements, fire safety, expected tenure of use, energy conservation and suitable appearance before selecting a material. Both structural and finish materials will be consistent with simple functional design and will be appropriate for local climatic conditions.

b. Variations in local availability and economy require that some latitude in construction and finish be allowed. This places the final choice with those responsible for preparing contract working drawings and specifications. Contract specifications will be prepared according to paragraph 18-107 of the Armed Services Procurement Regulations (ASPR).

c. Local (native) materials will be used when suitable and practicable. Lumber will be grade marked. Each piece of lumber must bear the official grade mark of the appropriate inspection bureau or association; or in lieu thereof, each shipment will be accompanied by a certificate of inspection issued by the appropriate inspection bureau or other approved agency.

1-15. Plans and specifications should be examined to eliminate built-in heavy future maintenance costs. Untried or unauthorized materials, components, and methods should generally not be used in conventional Air Force construction. If it has been determined definitely by careful evaluation that new materials and methods will give good results for special requirements, they may be used on approval of HQ USAF/LEE.

2-3.a. (2) When the criteria permits latitude, the Air Force does not generally attempt to direct closely the designer's solution to the problem. It is preferable to use the technical skill and resourcefulness of a professional designer, uninhibited by excessive direction.

(3) Personal prejudices must not be permitted to influence judgement of a design. When a monitor at command or lower echelon feels that he or she cannot conscientiously approve a design, yet does not feel completely justified in rejecting it, he should present the problem to a higher echelon for resolution.

2-4.a. AFM 88-15 provides standards and criteria for design of Air Force facilities. Pay particular attention to the broad policy applications of design criteria in AFM 88-15.

b. The use of building systems which produce an essentially complete functional structure is encouraged. However, the magnitude of the procurement must warrant the economic production of the components, subsystems, and systems involved. Economic studies or market research data should be available to support the justification for using building systems in lieu of procured conventionally designed and constructed facilities.

(2) Criteria:

(a) The standards and quality inherent to building systems under consideration must be in full conformance with established Air Force design and construction criteria.

(b) The component parts must be readily available and must be able to be procured competitively. It is not the intent that designs or availability of specified or offered component parts be subject to further research or development but rather the component parts be standard "stock" or "on-the-shelf" items.

4-4.a. The Air Force Regional Civil Engineers (AFRCE) are responsible for timely, economical and functional design and contract award for assigned projects in the Military Construction Program (MCP). Subsequent to contract award, AFRCEs review all change requests during construction and provide technical and functional approval as necessary. The AFRCE also designates design deficiencies and determines disposition.

b. AFRCEs assigned management responsibilities for MCP construction projects coordinate design and contract award matters with design agents when the Air Force is not the design agent.

4-5. During the design phase major commands are responsible for:

e. Review project designs

(1) Review early preliminary design (30 % design complete) data for functional adequacy and responsiveness to Air Force requirements. Normally, written comments should reach AFRCE within 20 calendar days following receipt or the applicable documents, or at a time of joint reviews. AFRCEs will proceed with actions, if comments are not received within 25 calendar days from date design documents mailed to MAJCOM, unless the MAJCOM advises that the project's complexity necessitates additional time for the review.

(2) Review unchecked final plans and specifications (90 % design complete) within 10 calendar days following receipt of the applicable documents for functional adequacy, and assure that preliminary comments have been incorporated.

5-5.c. NAF projects approved by HQ USAF or higher are awarded within the time frame for which authorization remains valid as indicated on the AF Form 1241, Engineering and Service project approval. If this condition is not met, the authorization expires automatically. Therefore, the project should be placed under contract as early as possible, consistent with project priority and design workload. Where projects are not awarded within the time specified on AF Form 1241, the conclusion will be that the project does not have a high priority. Such situations may be the basis for the realignment of funds to other projects that can be accomplished. Requests for time extensions will receive critical review; approval of such requests will be on an exceptional basis.

5-6. Major commands manage design and contract award of operations and maintenance (O&M) projects, including those which require HQ USAF or higher approval.

5-7.a. There is a difference between "project approval" and "technical approval." Project approval deals with granting of authorization to proceed with a real property maintenance, repair, or construction project. Technical approval is the certification that design documents have been reviewed and are technically sufficient for contracting documents. The technical review should insure:

(1) Functional adequacy.

(2) Provisions of special technical requirements.

(3) Adherence to Air Force criteria.

(4) Identification and removal of design deficiencies before contract award.

b. Major commands are delegated final technical approval for all appropriated and nonappropriated fund projects unless specified otherwise by HQ USAF/PREE.

c. Major commands may selectively delegate technical approval authority to the lowest level where demonstrated professional capability exists.

d. Major commands establish procedures for design review. All project designs must be reviewed. Errors and omissions in working drawings and specifications result in wasted time, manpower, and money during construction and tend to negate the Air Force effort to produce timely, economical, and quality construction. A concerted attempt must be made to eliminate these errors and omissions to the maximum degree practicable. In essence, there are four distinct parts of the review process:

(1) Technical review includes a thorough check of the methods, materials, and calculations for proposed structural, mechanical, electrical, etc., systems to assure that design will achieve the desired results. The review assures that design conforms to Air Force criteria. In essence, the reviewer is tasked to identify and remove design errors or omissions which will require contract modification after contract award. The reviewer must also ensure that the design conform to the scope, cost and concept specified in the project approval.

(2) Constructability review by the construction manager to assure clarity of plans and specifications and to determine the construction of the facility and its features are practical. This review

must be completed before plans and specifications are produced and forwarded to the base procurement officer.

(3) Installation Review by appropriate support staff agencies:

(a) Communications.

(b) Safety.

(c) Bioenvironmental Engineering.

(d) Fire Protection.

(e) Security Police.

(f) Using agency to verify functional adequacy with specific emphasis on incorporating all later or incomplete requirements.

(g) BCE to remove conflict with recent or planned in-house or contract civil engineering efforts, maintainability and standardization with existing RPIE, building and utility system components.

(4) Base Procurement Review.

13-11.a. The CM and inspecting personnel do not have authority for final approval of materials and equipment. This is retained by the contracting officer. However, the CM and the inspecting staff are responsible for the technical evaluation of submissions and for advising the contracting officer of approval or disapproval. The contracting officer makes his decision on the basis of their advice.

c. An appropriate test program during construction and the proper approval of materials are two of the principal means of determining the compliance with plans and specifications and high quality work.

(1) The majority of the materials normally are approved by the submission of samples (rather than testing), with manufacturer's certificates of compliance with Federal specifications, the American Society of Testing Materials (ASTM), specifications or other standards stipulated in the contract. The majority of equipment items normally are approved on a similar basis, with the addition of an operating test and a manufacturer's warranty.

(a) The CM must insure that the certificates are submitted and approved by the contracting officer before use of any of the materials on the projects.

(b) The CM certifies material suitability to the contracting officer. All submissions, approvals, and disapprovals must be fully documented.

(2) All laboratory tests to be performed will be stipulated in the specifications. In-place tests, such as tests of installed utility systems, are performed by contractor personnel in the presence of the contracting officer or authorized representative. The CM or project engineer must observe and verify the test data reported by the contractor. He or she must assure that necessary corrections and adjustments are made to produce the specified conditions. Laboratory tests of field samples (such as soil compaction tests, and tests of concrete and flexible pavement materials) are performed by a Government laboratory, if one is locally available.

d. Where specifications require contractor submission of shop drawings, the contractor should submit the drawings as soon as possible after notice to proceed and before buying the material and equipment. Drawings submitted by the contractor should be turned over to the CM for review. The design engineer should review shop drawings with the CM. Where critical, technical considerations are involved, shop drawings also should be reviewed for functional sufficiency by the using agency. On medical facility projects, shop drawings with medical functional implications are submitted to the HFO for his review and approval. A list of equipment and medical systems to be reviewed by the HFO is presented to the construction agency at the preperformance conference. In some instances, it may be appropriate for ground safety or the fire chief to review shop drawings. CM certification to the contracting officer must be in writing, and any disapprovals fully documented.

AFR 93-8

APPLICATION ENGINEERING PROGRAM

This regulation sets up a program for evaluating and reporting new nonproprietary materials and methods, that are used to meet Air Force engineering and services requirements. It provides bases with the flexibility to use new items, compare their performance with other items, and report the results of the evaluations. Air Force-wide issuance of these results prevents duplication of effort and advises all bases of successful and unsuccessful evaluations. It applies to all Air Force civil engineering organizations.

5. Industry representatives often propose new materials, systems, and methods for Air Force use. Such a product may be used and evaluated at base level if authorized by the Air Force. HQ AFESC (Air Force Engineering and Services Center) must approve use of a product that is outside established criteria or considered proprietary.

6. The Base Civil Engineer (BCE) selects nonproprietary items for evaluation, programs the work, and sets up an evaluation schedule. When an evaluation is initiated, BCE sends a preliminary report to HQ AFESC/DEMM. When an evaluation is completed, BCE sends a final report summarizing the completed project, including the conclusions and recommendations, and attaches any significant data. The BCE sends a final report summarizing the completed project, including the conclusions and recommendations, and attaches any significant data. The BCE sends a copy of each locally approved Applications Engineering project and report to the major command.

7. HQ AFESC decides whether to accept or reject a new material, system, or method, ends a study when the results are not satisfactory, decides whether results are important enough to publish and approves all waivers to existing criteria.

APPENDIX D: CETAP SURVEY QUESTIONNAIRES

QUESTIONNAIRE - Q1 (FOA)

POLICIES AND PROCEDURES THAT IMPACT THE INTRODUCTION OF NEW AND ALTERNATE MATERIALS AND PROCESSES FOR THE CONSTRUCTION AND MAINTENANCE OF REAL PROPERTY IN USACE

BACKGROUND:

The identification, assessment and incorporation of cost effective, proven alternate technologies, applicable to the civil works (CW) and military construction (MC) missions of USACE is most important in assuring that USACE continues to provide cost effective quality facilities. However, the processes which USACE currently uses to achieve this are for the most part believed to be ad-hoc, non-specific in nature or generally not well understood. For this reason, when overall effectiveness of the USACE processes of incorporating new technology is questioned, it is difficult to establish the validity of the criticism and to provide specific changes to correct the problem. In order to accurately assess USACE performance in adopting new and alternate technologies, CECER has been tasked by OCE to conduct a study to determine what processes exist, what processes are being used, the effectiveness of those processes, obstacles which hinder adoption, and make recommendations on changes which will enhance USACE performance.

The final products of this study will be (1) a series of flow charts depicting the various mechanisms used by USACE for adopting new or alternate technologies, (2) a point-of-contact list of USACE organizations for incorporating new or alternate technologies, and (3) a white paper report assessing the current mechanism's performance and making recommendations for improving the system.

In order to accomplish this mission, the following questionnaire is presented to solicit your knowledge and suggestions on the subject.

INSTRUCTIONS:

Please answer each question as completely as possible. Some questions may ask things or reference items that you are not familiar with. If so, please indicate this, for such information is valuable to the complete understanding of the processes. Reference to "your organization" means your immediate field operating agency (e.g. Kansas City District or New England Division). Individual responses to the questionnaire will be kept confidential within CECER. No data will be published that would identify any particular individual or field operating agency.

DEFINITION:

The terms new or alternate technologies are used throughout this questionnaire. Since these terms can have a variety of meanings, the following definition is given for the purpose of this questionnaire: A new or alternate technology is defined as any construction material or method which is not explicitly referenced in any existing USACE guide specification or manual and/or is not commonly used or specified for USACE related construction and maintenance projects. Automated Data Processing hardware and software systems shall not be included in this definition of new or alternate technologies.

RESPONDENT'S BACKGROUND:

NAME:

Phone Number:

Grade:

Title:

Organization/Field Operating Agency:

Pertinent Responsibilities:

Topics for Discussion

A. Responsibilities/Attitude for Introducing new Technologies into Practice

1. Does your organization assume a responsibility or "mission" for identifying and introducing new technologies into USACE practice? Is this responsibility stated explicitly (by regulation or other document), or followed implicitly by informal policy or practice?

2. Does your supervisor (next higher level of signature authority) provide any guidance regarding the use of new materials and techniques in projects? If so, what type of guidance?

** 3. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statements:

a. There are individuals with signature authority within your organization who promote the introduction of new technologies into practice.

b. There are individuals within your organization (even thought they do not have signature authority) who feel they should actively promote the use of new technologies.

B. Procedures for Introducing New Technologies

4. What are the principal regulatory or guidance documents observed by your organization that govern the adoption of new technologies?

5. Briefly comment on your organization's interpretation/execution of the following regulations concerning use of new technologies in USACE projects:

ER 70-1-9, "Transfer of Corps of Engineers Research and Development Technology"

ER 1110-2-1200, "Plans and Specifications", re: designing and specifying new materials or techniques.

ER 110-345-1000, "Design Policy for Military Construction", re: Designing and specifying new materials or techniques.

ER 1110-345-720, "Specifications", re: specifying new materials and techniques.

Value Engineering Contract Proposal provisions.

6. Who is the approval authority for your use of new materials or products on an individual project? . . . For general application USACE-wide?

7. Approximately, how many requests to use a new technology were initiated within your organization during the past year?

8. What procedures are required in your organization to process and document initiatives to use a new material or product? How much time and effort is necessary to perform these tasks? Who performs these tasks?

** 9. Give at least one example of a new technology that was utilized on a given project within the last three years. Has the use of this technology proven to be successful or unsuccessful? Had the new technology not been utilized, what would have commonly been used instead? What was the deciding factor for employing the new technology? Please provide the names of the personnel involved for each case listed.

** 10. What influence does the existence (or non-existence) of a Corps of Engineers Guide Specification (or other engineering guidance document) have on the ability of your organization to adopt a new technology? . . . For an individual project? . . . For general application USACE-wide?

** 11. Do you know of any instance(s) where a material or method was used because it was allowed by an engineering guidance document, even though a new method was considered to be equal or superior? (If yes) For what reason(s) did this occur? Please provide examples.

** 12. Do you think the design and engineering guidance documents reflect current/state-of-the-art construction and maintenance materials and methods, or not? Please provide examples.

13. In your experience, who usually initiates efforts to introduce new technologies into USACE practice? Is it USACE customers? Industry? Design/Engineering Professions? Who do you think <u>should</u> initiate these activities?

14. What procedure is most often used in your organization to evaluate a new technology? What types of evaluation are done in-house; who performs those evaluations? How is cost/performance data obtained if evaluations cannot be conducted locally?

15. What criteria are used to determine whether a new technology is "acceptable" or "unacceptable": what role do existing specifications/criteria play in the evaluation process?

16. In your organization, who ultimately assumes the risks of adopting a new technology? What level of risk/uncertainty is acceptable? How is this determined?

17. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would your rate the following statement:

    Established procedures (whether formal or informal) are used within your organization to initiate new technologies into practice.

C. Disseminating Information on New Technologies

18. What channels (formal or informal) exist for exchanging information concerning new or alternate technologies (both successes and failures) within USACE? . . . Within other DOD or civilian agencies who are responsible for construction?

** 19. Briefly describe your organization's interpretation/observance of provisions contained in the following document?

    ER 415-3-11, "Feedback Information."

20. In general, do you think that the information received from feedback systems tends to encourage, or to discourage, the adoption of innovations? Why?

21. In your opinion, are the feedback systems more likely (or less likely) to convey information about failures in innovation than about successes? Please explain.

22. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

    The dissemination of information on new technologies is a strong contributing factor in enhancing their incorporation into practice.

D. 23. Attached are flow charts depicting four processes for adopting new and alternative technologies. How accurately do these diagrams describe the processes used by your organization? Please amend as necessary.

24. On a scale of 1 to 5 (where 1 = poor, and 5 = good) how would you rate the effectiveness of each of the processes (depicting in the flow charts) for incorporating new or alternative technologies? (Mark your answer using the scale provided on the lower righthand corner of each flow chart.)

25. At what points of each process (see flow charts) do bottlenecks and delays occur, or would they be most likely to occur?

26. Are there any other processes used by your organizations for adopting technologies that are not reflected in these flow charts? Please describe them.

27. On an average, how long does it take (from initiation to actual utilization) to incorporate a new technology for a specific project? For general application USACE-wide?

28. In your opinion, what are the most important factors which facilitate the incorporation of new an alternative technologies into an organization?

29. What incentives exist for using new technologies in USACE design, construction, maintenance, and repair procedures?

30. What deterrents exist to the use of new technologies in USACE design, construction, maintenance, and repair procedures?

31. Of initiatives within your organization to adopt a new technology, approximately what percentage are approved for actual utilization? Of those technologies that are accepted and used, approximately what percentage are considered successful from a performance stand point? Of those technologies accepted for general use? What procedure was needed to do this and how long did it take?

32. Does the level of risk (i.e. potential consequences of an in-service failure) have a significant influence on the adoption of new technologies for USACE design, construction, maintenance, and repair procedures? Is a low-risk item more likely to be utilized and vice-versa? To what extent are significant cost savings an overriding factor regarding the use of a new technology that could have major consequences if a failure occurred?

33. To what extent does the policy excluding use of proprietary materials, systems, and processes unless absolutely necessary (ref. ER 1110-2-1200 and -345-100) inhibit the adoption of new or alternate technologies?

34. On a scale of 1 to 5 (where 1 = highly negative influence, and 5 = highly positive influence) how would you rate each of the following for their influence on the introduction of new or alternate technologies into USACE practice?

    a. The specification process (i.e. development and maintenance of a system of guide specifications and manuals for design and procurement usage).

    b. The budgetary cycle; design, procurement, and durations.

    c. Acceptability of risk on the parts of individuals or the organization.

    d. Life expectancy of facilities and required safety margins.

    e. Tolerance for unsatisfactory results by USACE and their customers.

    f. Availability of funding for experimental buildings.

    g. Required time and effort for implementing new technologies; potential payoffs.

    h. Input from contracted design and engineering professionals.

35. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

The Corps effectively incorporates new materials and methods while still assuring the construction and maintenance of reliable facilities.

E. Recommended Changes

36. What changes would enhance your ability to incorporate new materials and methods, while assuring that you maintain your ability to design, specify, and construct sound, reliable facilities?

*This program is now named the Facilities Engineering Application Program (FEAP).

QUESTIONNAIRE - Q2 (External Government/Private Sector)

POLICIES AND PROCEDURES THAT IMPACT THE INTRODUCTION OF NEW AND ALTERNATE MATERIALS AND PROCESSES FOR THE CONSTRUCTION AND MAINTENANCE OF REAL PROPERTY IN THE U.S. ARMY CORPS OF ENGINEERS

BACKGROUND:

The identification, assessment and incorporation of cost effective, proven alternate technologies, applicable to the civil works and miltiatry construction missions of U.S. Army Corps of Engineers (USACE) is most important in assuring that USACE continues to provide cost effective quality facilities. However, the processes which USACE currently uses to achieve this are for the most part believed to be ad-hoc, non-specific in nature or generally not well understood. For this reason, when overall effectiveness of the USACE processes of incorporating new technology is questioned, it is difficult to establish the validity of the criticism and to provide specific changes to correct the problem. In order to accurately assess USACE performance in adapthing new and alternate technologies, the U.S. Army Construction Engineering Research Laboratory has been tasked by Headquarters U.S. Army Corps of Engineers to conduct a study to determine what processes, obstacles which hinder adoption, and make recommendation on changes which will enhance USACE performance.

In order to accomplish this mission, the following questionnair is presented to solicit your knowledge and suggestions on the subject.

INSTRUCTIONS:

Please answer each question as completely as possible. Some questions may ask things or reference items that you are not familiar with. If so, please state such, for such information is valuable to the complete understanding of the processes. Reference to "your organization" means your immediate field operating agency. Individual responses to the questionnaire will kept confidential within the Laboratory. No data will be published that would identify any particular individual, agency, or company.

DEFINITION:

The terms new or alternate technologies are used throughout this questionnaire. Since these terms can have a variety of meanings, the following definition is given for the purpose of this questionnaire: A new or alternate technology is defined as any construction material or method which is not explicitly referenced in any existing guide specification or manual used by your company or agency and/or is not commonly used or specified for company/agency related construction and maintenance projects. Automated Data Processing hardware and software systems shall not be included in this definition. of new or alternate technologies.

RESPONDENTS BACKGROUND:

Name:

Phone Number:

Title:

Organization/Field Operating Agency:

Pertinent Responsibilites:

Company/Agency Structure: Does your company/agency have multiple field operating agencies with design and construction responsibilities or is this responsibility localized in a central office?

Topics for Discussion

A. Responsibilities for Introducing new Technologies into Practice

1. Does your organization assume a responsibility or "mission" for identifying and introducing new technologies into company/agency practice? Is this responsibility stated explicitly by a formal document or followed implicitly by informal policy or practice?

2. Does your supervisor (next higher level of signature authority) provide any guidance regarding the use of new materials and techniques in projects? If so, what kind(s) of guidance?

3. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

a. There are individuals with signature authority within your organization who promote the introduction of new technologies into practice.

b. There are individuals in your organization (even though they do not have signature authority) who feel they should actively promote the use of new technologies.

B. Procedures for Introducing New Technologies

4. Are there guidance documents observed by your organization that govern the adoption of new technologies? If so, please give the names of these documents. Briefly, comment on your organiazation's interpretation/execution of the guidelines or regulations contained in the documents.

5. Who has approval authority in your company/agency for the use of new materials or products in an individual project? . . . For general application company or agency wide?

6. Approximately, how many requests to use a new technology were initiated within your organization during the past year?

7. What procedures are required in your organization to process and document initiatives to use a new material or product? How much time and effort is necessary to perform these tasks? Who performs these tasks?

8. What (engineering guidance) specifications do you routinely use in design, construction and maintenance? Indicate the source(s) of these specifications. In-house? (If so, are they based on industry, or other specifications?) Industry? Government? American Institute of Architects Guide Specifications?

9. Please describe at least one example of new technology used by your organization on a project during the past three years. Has this technology proven to be successful, or unsuccessful? Had the new technology not been used, which one would have been used instead? What factors (e.g. performance/cost/risk) were decisive for employing the new technology?

10. What influence does the existence (or non-existence) of a government or industry guide specification (or other engineering guidance document) . . . For an individual project? . . .For general application company/agecny-wide?

11. Do you know of any instance(s) where a material or method was used because it was allowed by an engineering guidance document, even though a new method was considered to be equal or superior? (If yes) For what reason(s) did this occur? Please provide examples.

12. Do you think the design and engineering guidance documents used by your company/agency reflect current/state-of-the-art construction and maintenance materials and methods, or not? Please provide examples.

13. In your experience, who usually initiates efforts to introduce new technologies into practice? Is if your customers/users? Industry? Design/engineering Professions? Who do you think should initiate these activities?

14. What procedure is most often used in your organization to evaluate a new technology? What types of evaluations are done in-house; who performs those evaluation? How is cost/performance data obtained if evaluations cannot be conducted locally?

15. What criteria are used to determine whether a new technology is "acceptable" or "unacceptable"; what role do existing specifications/criteria play in the evaluation process?

16. In your organization, who ultimately assumes the risk of adopting a new technology? What level of risk/uncertainty is acceptable? How is this determined?

17. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

    Established procedures (whether formal or informal) are used within your company/agency to effectively introduce new technologies into practice.

C. Disseminating Information on New Technologies

18. What channels (formal or informal) exist for exchangin information concerning new or alternate technologies (both successes and failures) within the company/agency? . . .Outside the company/agency?

19. Does your company/agency have provisions for evaluating new technologies through a feedback system? If so, do you think that information received from feedback systems tends to encourage, or to discourage, the adoption of innovations? Why???

20. In your opinion, are feedback systems more likely (or less likely) to convey information about failures in innovation than about successes? Please explain.

21. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

    The dissemination of information on new technologies is a strong contributing factor in enhancing their incorporation into practice.

D. Assessing the Effectiveness of Procedures to Introduce New Technologies

22. What are the processes your company/agency has for adopting new and alternate technologies? Please sketch a flow chart of each process showing as much detail as applicable. (Use separate sheets of paper if necessary.)

23. On a scale of 1 to 5 (where 1 = poor, and 5 = good) how would you rate the effectiveness of (each of) the process(es) depicted in the above flow chart(s) for incorporating new or alternative technologies?

24. At what points of each process (see above flow charts) do bottlenecks and delays occur, or would they be most likely to occur? Why?

25. In your opinion, what are the most important factors which facilitate the incorporation of new and alternative technologies into an organization?

26. On an average, how long does it take your company/agency (from initiation to actual utilization) to incorporate a new technology for a specific project? For general application company/agency-wide?

27. What incentives exist within your company/agency for using new technologies in design, construction, maintenance, and repair procedures?

28. What deterrents exist within your company/agency to the use of new technologies in design, construction, maintenance, and repair procedures?

29. Of initiatives within your organization to adopt a new technology, approximately what percentage are approved for actual utilization? Of those technologies that are accepted and used, approximately what percentage are considered to be successful from a performance point of view? Of those technologies accepted for a specific project (and considered successful), did they become acceptable for the general use? What procedure was needed to do this and how long did it take?

30. To what extent does level of risk (i.e. potential consequences of an in-service failure) influence adoption of new technologies by your organization for design, construction, maintenance and repair procedures? Is a low risk new technology item more likely to be used than a high risk new technology item? To what extent do cost savings motivate such new technologies that could have major consequences is a failure occurred?

31. Does your company/agency have any policy excuding or limiting the use of proprietary materials? If so, to what extent does this policy inhibit the adoption of new or alternate technologies?

32. On a scale of 1 to 5 (where 1 = highly negative influence, and 5 = highly positive influence) how would you rate the following for their influence to the introduction of new or alternate technologies into your company/agency practice?

a. The specification process (i.e. development and maintenance of a system of guide specifications and manuals for design and procurement usage).

b. The budgetary cycle; design, procurement, and durations.

c. Acceptability of risk on the parts of individuals or the organization.

d. Life expectancy of facilitates and required safety margins.

e. Tolerance for unsatisfactory results by company/agency and its customers.

f. Availability of funding for experimental buildings.

g. Required time and effort for implementing new technologies; potential payoffs.

h. Input from contracted design and engineering professionals.

33. On a scale of 1 to 5 (where 1= strongly disagree, and 5 = strongly agree), how would you rate the following statement:

This company/agency effectively incorporates new materials and methods while still assuring the construction and maintenance of reliable facilities.

E. Recommended Changes

34. What changes would enhance your company's/agency's ability to incorporate new materials and methods, while assuring that you maintain your ability to design, specify, and construct sound reliable facilities?

QUESTIONNAIRE - Q1 (DEH)

POLICIES AND PROCEDURES THAT IMPACT THE INTRODUCTION OF NEW AND ALTERNATE MATERIALS AND PROCESSES FOR THE CONSTRUCTION AND MAINTENANCE OF REAL PROPERTY IN USACE

BACKGROUND:

The identification, assessment and incorporation of cost effective, proven alternate technologies, applicable to the civil works (CW) and military construction (MC) missions of USACE is most important in assuring that USACE continues to provide cost effective quality facilities. However the processes which USACE currently uses to achieve this are for the most part understood. For this reason, when overall effectiveness of the USACE processes of incorporating new technology is questioned, it is difficult to establish the validity of the critism and to provide specific changes to adopting new and alternate technologies, CECER has been tasked by OCE to conduct a study to determine what processes, obstacles which adoption, and make recommendations on changes which will enhance USACE performance.

The final products of this study will be (1) a series of flow charts depicting the various mechanisms used by USACE for adopting new or alternate technologies, (2) a point-of-contact list of USACE organizations for incorporating new or alternate technologies, and (3) a white paper report assessing the current mechanism's performance and making recommendations for improving the system.

In order to accomplish this mission, the following questionnaire is presented to solicit your knowledge and suggestions on the subject.

INSTRUCTIONS:

Please answer each question as completely as possible. Some questions may ask things or reference items that you are not familiar with. If so, please indicate this, for such information is valuable to the complete understanding of the processes. Reference to "your organization" means your immediate field operating agency (e.g. Kansas City District, New England Division or Ft. Ord DEH) otherwise it refers to your section or branch, please indicate which. Individual responses to the questionnaire will be kept particular individual or field operating agency. Questions identified with a double asterisk (**) are considered especially important.

DEFINITION:

The terms new or alternate technologies are used throughout this questionnaire. since these terms can have a variety of meanings, the following definition is given for the purpose of this questionnaire: A new or alternate technology is defined as any construction material or method which is not explicitly referenced in any existing USACE guide specification or manual and/or is not commonly used or specified for USACE related construction and maintenance projects. Automated Data Processing hardware and software systems shall not be included in this definition of new or alternate technologies.

Topics for Discussion

A. Responsibility/Initiative for Introducing new Technologies into Practice

1. Does your organization assume a responsibility or "mission" for actively identifying and introducing new technologies into USACE practice? Is this responsibility stated explicitly (by regulation or other document), or followed implicitly by informal policy or practice?

2. Does your supervisor (next higher level of authority) provide any guidance regarding the use of new materials and techniques in projects? If so, what type of guidance?

** 3. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statements:

a. there are individuals with authority within your organization who actively promote the introduction of new technologies into practice.

b. There aer individuals within your organization (even though they do not have signature authority) who feel they should actively promote the use of new technologies.

B. Procedures for Introducing New Technologies

4. What are the principal regulartory or guidance documents observed by your organization that govern the adoption of new technologies?

5. Briefly comment on your organization's interpretation/execution of the following regulations concerning use of new technologies in USACE projects:

ER 70-1-9 Paragraphs 5a and 6f, "Transfer of Corps of Engineers Research and Development Technology", re: use/awareness by districts and divisions of USACE developed technology and assistance in field demos as directed by higher authority.

ER 1110-345-720 Paragraphs 9-13 and 21, "Design Policy for Military Construction", re: Designing and specifying new materials or techniques, proprietary items, alternate designs, contractor options and adherence to specifications; submittal of ENG Form 3078, "Design or Project Deficiency Report and Recommendation."

ER 1110-345-720 Paragraphs 4d and 5b, "Specifications", re: specifying new materials and techniques, deviations from standards and specifications in MCA projects and reporting procedures.

OCE Suppl 1 AR 5-4, Chapter 4, "Value Engineering Program", re: Value Engineering Contract Proposal provisions.

6. Who (position/level) is the approval authority for your use of new materials or products on an individual project?

7. Approximately, how many requests to use a new technology were initiated within your organization (or immediate section) during the past year?

8. What procedures are required in your organization to process and document initiatives to use a new material or product? How much time and effort is necessary to perform these tasks? Who (positoin/level) perfonn these tasks?

** 9. Give at least one example of a new technology that was utilized on a given project within the last three years. What were the results? Had the new technology not been utilized, what would have commonly been used instead? What was the deciding factor for employing the new technology?

** 10. What influence does the existence (or non-existence) of a Corps of Engineers Guide Specification (or other engineerin guidance document) have on the ability of your organization to adopt a new technolgoy?

** 11. Do you know of any instance(s) where a material or method was used becaues it was allowed by an engineering guidance document, even though a new method was considered to be equal or superior? (If yes) For what reason(s) did this occur? Please provide example.

** 12. Do you think the design and engineering guidance documents reflect current/state-of-the-art construction and maintenance materials and methods, or not? Please provide examples.

13. In your experience, who (e.g. USACE, Customers, Industry, Design/Engineering Professionals, etc.) usually initates efforts to introduce new technologies into USACE practice? Who do you think should initiate these activities? Why do you think they should?

14. What procedure is most often used in your organization to evaluate a new technology? What types of evaluation are done in-house; who (position/title) performs those evaluation? How is cost/performance data obtained if evaluations cannot be conducted locally?

15. What criteria are used to determine whether a new technology is "acceptable" or "unacceptable"; what role do existing specification/criteria play in the evaluation process?

16. In your organization, who (position/level) ultimately assume the risk of adopting a new technology? What level of risk/uncertainty is acceptable? How is this determined?

C. Disseminating Information on New Technologies

17. What channels (formal or informal) exist for exchanging information concerning new or alternate technologies (both successes and failures) within USACE? . . . Within other DOD civilian agencies who are responsible for construction?

18. Briefly describe your organization's interpretation/ovservance of provisions contained in the following document:

ER 415-3-11, "Feedback Information", re: EIRS, PCI, DCFP and CERS information feedback systems.

** 19. How often are ENG Form 3078s "Design or Project Deficiency Report and Recommendation: (ER 1110-345-100 Paragraph 21) submitted by your organization? Are they effective in incorporating changes?

20. In general, do you think that the information received from feedback systems tends to encourage, or to discourage, the adoption of innovations? Why?

21. In your opinion, are the feedback systems more likely to convey positive or negative experiences in innovation than about successes? Please explain.

** 22. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

The dissemination of information on new technologies by formal USACE channels is a strong contributing factor in enhancing their incorporation into practice.

D. Assessing the Effectiveness of Procedures to Introduce New Technologies

23. (FE) What support do you receive from USACE Districts and Divisions which assist you in your mission? What support do you feel should receive but don't? How could the support you receive be improved?

24. (FE) In general, does the installation user feel that the Corps is providing them with high quality built quality built facilities. Please comment on.

25. (FE) What formal procedures (e.g., Construction VE Program) are used by your organization to adopt new technologies? Are these procedures considered effective in this regard? If you had an opportunity to modify the procedures, how would you do so?

26. (FE) Are you familiar with USACE's Facilities Technology Application Test (FTAT)* or Technology Transfer Test Bed (TTTB)Programs? Have you participated in either of these two programs? If so, please describe.

*This program is now named the Facilities Engineering Application Program (FEAP).

27. On an average, how long does it take (from initiation to actual utilization) to incorporate a new technology for a specific project? How long do you think it should take?

28. In your opinion, what are the most important factors which facilitates the incorporation of new and alternative technologies into an organization?

** 29. What incentives exist for using new technologies in USACE design, construction, maintenance, and repair procedures?

** 30. What deterrents exist to the use of new technologies in USACE design, construction, maintenance, and repair procedures?

31. Of initiatives within your organization (or immediate section) to adopt a new technology, approximately what percentage are approved for actual utilization? Of those technologies that are accepted and used, approximately what percentage are considered successful from a performance stand point? Of those technologies accepted for a specific project (and considered successful), did they become acceptable for general use? Was there any follow-up? Formal feedback initiated? What procedure was needed to do this and how long did it take?

32. Does the level of risk (i.e. potential consequences of an in-service failure) have a significant influence on the adoption of new technologies for USACE design, construction, maintenance, and repair procedures? Is a low-risk item more likely to be utilized and vice-versa? To what extent are significant cost savings an overriding factor regarding the use of a new technology that could have major consequences if a failure occurred?

** 33. To what extent does the policy excluding use of proprietary materials, systems, and processes unless absolutely necessary (ref. ER 1110-2-1200 and -345-100) inhibit the adoption of new or alternate technologies?

34. (OPTIONAL) On a scale of 1 to 5 (where 1 = highly negative influence, and 5 = highly positive influence) how would you rate each of the following for their influence on the introduction of new or alternate technologies into USACE practice?

a. The specification process (i.e. submittal for consideration, development and maintenance of a guide specification and manuals for design and procurement usage, dissimination, utilization...)

b. The budgetary cycle; design, procurement, and durations.

c. Acceptability of risk on the parts of individuals or the organization.

d. Life expectancy of facilities required.

e. Safety margins required.

f. Tolerance for unsatisfactory results by USACE and their customers.

g. Availability of funding for experimental buildings.

h. Required time and effort for implementing new technologies vs. the potential payoffs.

i. Input from contracted design and engineering professionals.

** 35. On a scale of 1 to 5 (where 1 = strongly disagree, and 5 = strongly agree), how would you rate the following statement:

The Corps effectivelyincorporates new materials and methods while still assuring the construction and maintenance of reliable facilities.

E. Recommended Changes

36. What changes would enhance your ability to incorporate new materials and methods, while assuring that you mainta in your ability to design, specify, and construct sound, reliable facilities?

VENDOR QUESTIONNAIRE

1. Generally, what kind(s) of product(s) does your company manufacture for use in construction or facilities maintenance?

2. Do most of these products meet some form of Federal or military specification? If not, do any of them? For those that do, were they made/formulated especially to meet a particular specification or did they just happen to conform?

3. Do your products meet industry established specification? If so, which ones (e.g. ANSI, ASTM, AIA, etc.)?

4. Does your company require approval or licensed contractors to install or apply your products?

5. Does your company have a separate Division to deal with Government/Military sales?

6. Are your products used by the U.S. Army Corps of Engineers for their construction/maintenance projects? If so, does the Corps typically purchase them as Corps supplied/furnished materials or are they purchased by the contractors (who are working on a specific Corps project) to meet the job material requirements?

7. Typically is your company's total annual sales (either directly or indirectly) to the Corps of Engineers more or less than $250,000? Less than $25,000?

8. What are the major constraints to having your products/technologies used in U.S. Army Corps of Engineers construction and maintenance projects? In construction and maintenance projects of other Federal organizations? Of state or local agencies? Of large private industry firms which have large real estate holdings and/or construction responsibilities?

9. If when your company has a new product or technology that may be of interest to the Coprs of Engineers, what is the typical marketing strategy to let the Corps of Engineers know of this new product or technology?

10. If your company has been successful in getting a new project adopted into the Corps' specifications, how long did it take?

11. In your opinion, what could be done to improve new technology adoption from the private sector to the Corps of Engineers?

12. Does your company find it easier to sell to the government or to private companiers? Why?

13. Does the size of the company or the agency, public or private, affect the ease with which you can sell your new products or technologies?

14. Please list in order any drawbacks with selling new technologies to the Army Corps of Engineers.

15. What changes would enhance the ability of your company to introduce and sell new technologies to the Army Corps of Engineers?

16. Please compare the time it takes to sell your new technologies to government agencies versus private companies, based on your actual experience.

ACRONYMS

ACTS	Advanced Construction Technology System
A/E	architect/engineer
AFR	Air Force Regulation
AR	Army Regulation
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BTFE	Building Technology Forecast and Evaluation
CEGS	Corps of Engineers Guide Specifications
CENACTT	Corps of Engineers National Advanced Construction Technology Team
CENET	Corps of Engineers National Energy Team
CETAP	Corps of Engineers Technology Adoption Process
CETAS	Corps of Engineers Technology Adoption System
CII	Construction Industry Institute
CPAR	Construction Productivity Advancement Research
CRC	Construction Research Center
CW	civil works
DA	Department of the Army
DCFP	Design Criteria Feedback Program
DEH	Directorate of Engineering and Housing
DOD	U.S. Department of Defense
EC	Engineer Circular

ACRONYMS (Cont'd)

EIRS	Engineer Improvement Recommendation System
EM	Engineer Manual
EP	Engineer Pamphlet
ER	Engineer Regulations
ETL	Engineer Technical Letter
FARs	Federal Acquisition Regulations
FE	facilities engineers
FEAP	Facilities Engineering Program
FOA	field operating activity
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HQUSAF	Headquarters, U.S. Air Force
M&R	maintenance and repair
MCA	Military Construction, Army
NAVFAC	Naval Facilities Engineering Command
OCE	Office of the Chief of Engineers
O&M	operations and maintenance
PCI	post-completion inspection
POC	points of contact
R&D	research and development
RDTE	Research, Development, Test, and Evaluation
SOP	standing operating procedure
T^3B	Technology Transfer Test Bed
TM	Technical Manual

ACRONYMS (Cont'd)

TCX	Technical Centers of Expertise
USACE	U.S. Army Corps of Engineers
USACERL	U.S. Army Construction Engineering Research Laboratories
USACRREL	U.S. Army Cold Regions Research and Engineering Laboratory
USAETL	U.S. Army Engineer Topographic Laboratory
USAF	U.S. Air Force
USAWES	U.S. Army Waterways Experiment Station
VE	Value Engineering
RETRIEVAL	Value Engineering Retrieval

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