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Technical Report 529

TRAINING DEVICE OPERATIONAL READINESS ASSESSMENT CAPABILITY (DORAC): FEASIBILITY AND UTILITY

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U. S. Army
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This report presents the results of an investigation of the feasibility and utility of implementing the Training Device Operational Readiness Assessment Capability (DORAC) concept throughout the Army. The investigation addresses three separate aspects of feasibility: Acceptability to end-users, technical feasibility, and financial feasibility.

Another aspect of DORAC concept feasibility concerns the ability to select the most cost-effective proficiency assessment capability from among a range of alternatives. To this end, a Cost and Information Effectiveness Analysis (CIEA)

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Partial Utility	Performance Standard
Aggregate Utility	Standardization
Information Quality	Technical Feasibility
Feasibility	Financial Feasibility
DORAC	CIEA

20.

methodology based on multiattribute utility measurement (MAUM) was developed and is presented in a companion report. In this report, the MAUM-CIEA methodology is demonstrated using a set of hypothetical DORACs for the M16A1 rifle.

The final section of the report integrates the feasibility results into a series of recommendations for optimizing the payoff from a DORAC, and suggests a series of steps for further investigation of the concept and related technologies.

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Assessing Device Operational
Readiness Assessment Capability (DORAC)

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FOREWORD

The research reported here is part of a broader program on training for combat effectiveness being conducted by the US Army Research Institute for the Behavioral and Social Sciences. The availability of knowledge regarding current combat readiness of the troops and the existing skill deficiencies is critical to resource allocation and training management in units.

The ARI Field Unit at Fort Benning, Georgia is investigating the feasibility and utility of a partial answer to this need: the use of unit training devices for evaluation/qualification purposes as well as for training. This report describes findings regarding three aspects of feasibility: acceptability to end-users, technical feasibility, and financial feasibility. As a part of the technical feasibility question and also so as to address the utility question, the application of a Cost and Information Effectiveness Analysis method to alternative training devices and other evaluation methods for M16A1 rifle skills is described and the results are presented.

With regard to the three aspects of feasibility, the use of training devices to assess combat readiness appears to be a satisfactory technique. With regard to utility, the use of a training device for these purposes for M16A1 rifle skills is viewed as valuable by military personnel.

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Technical Director

TRAINING DEVICE OPERATIONAL READINESS ASSESSMENT CAPABILITY (DORAC): FEASIBILITY AND UTILITY

BRIEF

Requirement:

Up to date information on the combat readiness and skills deficiencies of troops is needed to report personnel readiness levels and to manage troop training. Meeting this need can be made difficult by frequent personnel turnover; infrequent testing; and unknowns regarding skill decay rates. A partial solution to this problem may reside in unit training devices that are currently fielded and/or under development. If a device is designed and used to satisfy training requirements, it may, in many cases, also be designed and used on a regular basis (e.g., quarterly) to provide information on personnel qualification status and skill deficiencies requiring training. Requirements in developing this solution include an examination of the operational unit environments within which it would be employed, and evaluation of methods needed to implement the solution in the context of selected training devices.

Procedure:

The investigation consisted of two parts: (1) a field survey of US Army Forces Command (FORSCOM) units located at three Army posts and (2) a trial application of a newly developed multiattribute utility measurement (MAUM) Cost and Information Effectiveness Analysis (CIEA) method to evaluation alternatives for M16A1 rifle marksmanship skills. The field survey consisted of interviews with and administration of questionnaires to command and staff personnel responsible for combat readiness status and status reporting, and for training management. The survey obtained information concerning current practices in reporting troop readiness and skill levels, deficiencies in the training evaluation and unit status reporting systems, perceived ways to improve the systems, and DORAC concept acceptability and perceived utility. The MAUM CIEA method was applied to combinations of M16A1 rifle marksmanship evaluation alternatives which included two training devices and the current field testing procedure, Record Fire. The combinations varied in terms of number of alternatives included (e.g., Record Fire alone vs. Record Fire and one or more of the training devices) and the frequency of use. Personnel involved in application of the CIEA method included Army officers from the FORSCOM and US Army Training and Doctrine Command (TRADOC), who made judgments regarding the information utility of each of the alternatives; and contractor personnel who compiled the cost data and produced the final values which reflected the tradeoff between the information utility and cost figures for each alternative. The MAUM CIEA method is described in detail in a companion report (Hawley & Dowdy, 1981).

Findings:

(1) Use of a DORAC is quite acceptable to, and considered desirable by, those FORSCOM officer and enlisted personnel who have had prior experience (e.g., in Air Defense trainees evaluate team proficiency/readiness). Those who have not are doubtful and need assurance regarding data validity and the adequacy of device maintenance.

(2) The needs expressed by FORSCOM officer and enlisted personnel for more standardized evaluation procedures and performance standards, and for more objective performance measures, are exactly the needs that implementation of DORAC would meet.

(3) The MAUM CIEA method is usable, with contractor assistance at least, by FORSCOM and TRADOC officer personnel. Of particular importance is that these personnel are able to make judgments of the information utility of data from a number of evaluation alternatives using MAUM CIEA procedures and to do this consistently in terms of judged relative importance of information about each of the skill components of rifle marksmanship.

(4) There is a need, however, to simplify and expedite the application of the CIEA method to the extent possible. This need will be explored in future research.

(5) Training devices, when analyzed carefully with respect to the value of having and using a DORAC in operational units, can be judged to be useful for evaluation purposes. The TRADOC and FORSCOM personnel applying the MAUM CIEA method to the M16A1 DORAC alternatives judged the combination of one of the training devices with Record Fire to have a considerably higher information utility than Record Fire alone.

Utilization of Findings:

Findings will be used as inputs to further work in developing the MAUM CIEA method, possible efforts to develop alternative CIEA methods, and work to develop a DORAC and use procedures in selected training devices. The ultimate users of the final CIEA methods will be TRADOC training developers who are device and system proponents, and device design engineers working with the materiel developer (PM TRADE). The ultimate users of information obtained from DORAC usage of any particular device will be unit personnel, ranging from the trainers to the commanders.

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SECTION 1

INTRODUCTION

Background

Most scenarios for a full-scale confrontation between the United States and any of its major potential adversaries indicate that the majority of Army units will have to be prepared to fight immediately without the luxury of a lengthy mobilization period, such as the first year of World War II. Studies of the comparative military strengths of the United States and the Warsaw Pact countries also indicate that U.S. forces are likely to be heavily outnumbered, often by a ratio of five to one or more. To have any hope of success in this "come as you are and win the first battle outnumbered" situation, the Army will have to maintain a high level of individual and unit combat readiness at all times. Maintaining a consistently high level of combat readiness will necessitate frequent evaluations of individual and unit proficiency, along with a means of quickly diagnosing and remediating performance deficiencies.

In simpler times, the assessment of individual and unit job proficiency presented no special difficulties. Recently, however, the complex nature of many weapons systems, increased personnel turbulence, rapid skill decay rates, and changes in training philosophy have led to an emphasis on performance-oriented training and criterion-referenced testing. Soldiers are required to demonstrate their individual or collective competency in a "hands on" environment using actual equipment. This change in training and evaluation methodology has increased the demand for training and evaluation uses of operational equipment and accompanying support resources requirements [e.g., ammunition, spare parts, POL (petroleum, oil, and lubricants), etc.] during a time of inflation and budgetary constraints. More frequent performance-oriented individual or collective readiness evaluations would thus tend to complicate an already tight situation.

A proposed solution to the problem of conducting more frequent readiness evaluations in the face of tight resource constraints is to use training devices (e.g., simulators, mockups, etc.) instead of actual equipment in the conduct of such evaluations (Finley, Gainer, & Muckler, 1974; Hopkins, 1975). In addition to their intended uses, training devices can often provide a vehicle for individual or collective proficiency evaluations (Fitzpatrick & Morrison, 1971; Glaser & Klaus, 1972; Crawford & Brock, 1977). Historically, the most extensive uses of training devices in proficiency assessment have been in the aviation community (Caro, 1973). The commercial airlines and the Federal Aviation Administration use flight simulators extensively in proficiency assessment. Follow-up studies have indicated that pilot performance in flight simulators is predictive of performance in actual aircraft (American Airlines, 1969; Weitzman, Fineberg, Gade, & Compton, 1979).

Within a military setting, the uses of training devices in performance evaluation have generally mirrored civilian uses and primarily involved aviation. There has been, however, an increasing use of training devices to assess individual and collective proficiency in other areas. Among the additional applications have been maintenance proficiency and anti-submarine warfare crew performance. In the Army, one long-standing, non-aviation program of individual and collective readiness assessment using a training device is found in the Air Defense branch. Here, the AN/TPQ-29 simulator (and before that the AN/MPQ-T1 simulator for the Nike-Hercules system) is used in the conduct of operation readiness evaluations for HAWK Air Defense units. The AN/TPQ-29 is an engagement simulator (i.e., signal generator) capable of producing a variety of simulated air defense combat situations [e.g., multiple targets, electronic countermeasures (ECM) of various kinds, etc.]. The simulator was designed primarily for use as a training device, but it can be (and is) used to evaluate individual and crew performance. When using the AN/TPQ-29 in performance assessment, an evaluation team loads a "raid tape" containing the parameters of an air defense engagement into the simulator. The HAWK crew is evaluated on its ability to defeat the simulated threat; performance checklists are used to evaluate individual crew member performances. Hardcopy printouts of some individual and crew performance measures (e.g., targets destroyed, numbers of penetrators, engagement times, operator reaction times, etc.) are also obtainable from the simulator.

The evaluation of HAWK personnel using the AN/TPQ-29 engagement simulator illustrates the concept of a Training Device Operational Readiness Assessment Capability, or DORAC. DORAC simply means that a proficiency assessment capability is included with the training devices for a materiel system. Once built into the training device system, the DORAC is used to assess the operational readiness of the individuals or crews that operate the materiel system. As an added feature, the measurement capability inherent in the DORAC can also provide information useful for other purposes such as training management, unit management, materiel system evaluation, and so forth.

A recent review of Army training device proficiency assessment capabilities indicated that the DORAC principle *can* be applied to the training devices for virtually any parent materiel system (Shelnutt, Smillie, & Bercos, 1978). At the present time, actual use as in the aviation community or in the HAWK system is somewhat rare, but the potential remains. There are, however, several issues that remain to be resolved before generally attempting to implement the DORAC principle Army-wide. Among these issues are: (1) the feasibility of the concept, and (2) its utility for providing desired and meaningful data concerning individual or collective performance. The objective of this report is to present the results of an analytical and empirical study carried out to explore these issues. Before addressing the issues of DORAC utility and feasibility, the next portion of the report presents a brief overview of the formal context for DORAC development and implementation: the Army's training evaluation (TE) system and the unit status reporting (USR) system.

The Context for DORAC Implementation

Given that the objective of a DORAC is to provide decision-makers with readiness status and training diagnostic information, the formal context for the collection and use of the data is the Army TE system and the USR system. Each of these systems is described briefly as follows.

The Army Training and Evaluation System. As currently structured (SofTech, Inc., 1977), the Army TE system is based upon the use of Skill Qualification Tests (SQTs) and Army Training and Evaluation Program (ARTEP) evaluations. SQTs are designed to assess *individual* performance on critical job tasks. Tasks identified as critical and subject to SQT evaluation are listed in Soldier's Manuals (SMs), which are prepared for each Military Occupational Specialty (MOS). Each job incumbent is provided with a personal copy of the SM for his/her MOS.

The SQT test usually consists of three portions: a *performance-oriented* or "hands-on" component (HOC), a *written* component, and a job site component (JSC). During the HOC, soldiers are assessed on their ability to perform selected job tasks using actual equipment. The written portion of the SQT is a paper-and-pencil evaluation of an MOS-holder's job knowledge. The JSC covers designated skills which the soldier's supervisor evaluates and certifies within the context of the job site (e.g., rifle qualification, physical training, etc.). Current doctrine calls for SQTs to be administered a minimum of every two years.

Collective tasks are assessed in ARTEP evaluations. Training and evaluation objectives for collectives (e.g., platoons, companies, battalions) are prescribed in ARTEP publications. These publications are usually developed by the proponent Training and Doctrine Command (TRADOC) schools (e.g., Infantry, Armor, Artillery, Air Defense, etc.) with the assistance of the Army Training Support Center (ATSC). The actual ARTEP evaluation is conducted within the framework of a field exercise. Current doctrine calls for ARTEPs to be administered yearly

It has generally been recognized that a formal evaluation every year or so is not sufficient to address individual or collective training problems or indicate readiness status. Accordingly, units are encouraged to conduct more frequent internal evaluations. The results of internal or "mini-SQTs" are to be recorded in a Job Book that lists individual proficiency on a task-by-task basis. In addition to more frequent individual evaluations, units are also encouraged to develop a Training and Evaluation Outline (T&EO) that prescribes the structure of an evaluation of their collective proficiency. Since the T&EO specifies *collective* evaluation procedures, it can be classified as a mini-ARTEP.

In theory, unit-level personnel use SQT, ARTEP, and internal evaluation results to identify individuals and collectives that have identifiable training deficiencies (i.e., tasks that are not performed to standard). Higher level commanders (e.g., battalion, brigade, division) review SQT and ARTEP results to pinpoint weaknesses in their unit and to identify areas where additional training emphasis or assistance may be required. At the highest level, TRADOC uses aggregated SQT and ARTEP results to identify training system, materiel system, or tactical deficiencies that require special emphasis to effect a solution. It is generally recognized, however, that SQTs, ARTEPs, and internal evaluations provide insufficient or too infrequent data to adequately serve these information needs.

The Unit Status Reporting System. Army Regulation (AR) 220-1 establishes the USR system for "reporting the readiness status of selected active and reserve component units." USR reports are prepared on a monthly basis. In the USRs, commanders are required to assess their unit along three specific dimensions, and then to combine the individual ratings into an overall unit readiness rating. The individual dimensions are:

1. Personnel strength (operating, MOS trained, and senior grade).

2. Logistics (actual vs. authorized equipment, equipment status).

3. Training status.

The overall unit readiness rating is reported as follows:

Rating	Description
C-1, Fully Ready:	A unit fully capable of performing the mission for which it is organized or designed. Unit may be deployed to a combat theater immediately.
C-2, Substantially Ready:	A unit has minor deficiencies which limit its capability to accomplish the mission for which it is organized or designed. Unit may be deployed to a combat theater immediately.
C-3, Marginally Ready:	A unit has major deficiencies of such magnitude as to limit severely its capability to accomplish the mission for which it is organized or designed. Unit will require a period of intensive preparation before combat deployment/employment except under conditions of grave emergency.

Rating	Description
C-4, Not Ready:	A unit not capable of performing the mission for which it is organized or designed. Unit will require extensive upgrading prior to combat deployment.

In developing the USR, personnel strength data are taken from the unit's SIDPERS (Standard Installation/Division Personnel System) report. Three components influence the personnel rating: operating strength, MOS trained strength, and senior grade NCO strength. Rating guidelines for each of these components are provided in the AR. Logistics data are obtained by comparing actual equipment on hand (EOH) with Modified Table of Organization and Equipment authorizations. Equipment status (ES) is directly obtainable from equipment deadline reports. Again, the AR provides specific guidelines for assigning a unit logistics rating on the basis of EOH and ES data.

Training status is handled differently from either personnel strength or logistics. According to AR 220-1, "The training rating is a *judgment* based on an *estimate* of the *time* required to overcome training shortfalls." In making this estimate, the unit commander is advised to consider SQT scores, ARTEP results, and the results of other individual and collective evaluations, [e.g., Emergency Readiness Deployment Exercises (ERDEs), Field Training Exercises (FTXs), etc.], but no objective guidelines for their consideration are provided.

As a final step, the commander selects an overall unit rating (C-1 through C-4) that "best describes his unit's capability to perform the mission for which organized or designed." In theory, the overall unit rating should not exceed the lowest rating in a resource area (e.g., personnel or logistics) or the training rating. For units with major equipment systems (e.g., tanks, missiles, artillery pieces, etc.), the percentage of total equipment systems manned by *trained* crews usually serves as a guide for assigning the overall unit rating. For example, a unit rating of C-1 *should* indicate that at least 85% of total systems are available; a rating of C-2 that at least 70% of total systems are available; a rating of C-3 that at least 60% of total systems are available; and a rating of C-4 that the unit has less than 60% of total systems available.

Overview of Approach

The previous paragraphs have presented an overview of the problem situation: obtaining more frequent, reliable, and valid data concerning individual or collective readiness, while avoiding the expense of using operational equipment to that end. A proposed solution involving the use of training devices as a proficiency measurement bed (i.e., DORAC) was also presented. Finally, the formal context for operational readiness reporting and training evaluation was discussed. The remainder of the report presents the results of an analytical and empirical investigation of the feasibility and utility of the DORAC concept as applied to the problem situation.

In developing the report, an orthodox structure for project feasibility analysis is employed (Clifton & Fyffe, 1977). Specifically, the study considers three classical determinants of project feasibility:

1. Acceptability. An evaluation of the DORAC concept's feasibility in terms of the end user, or "market". Obviously, in the current context, a market in the traditional usage of the term does not exist. An analogous situation does exist, however, in that there is a constituency that must accept the DORAC concept should it be implemented. Specific issues addressed under this topic included: What is the current field situation in terms of training evaluation and unit status reporting? Do field personnel perceive deficiencies in current practices? If so, what are they? Is the DORAC concept viewed as an acceptable solution to any of the reported deficiencies? The vehicle for the conduct of this portion of the study was a survey of field readiness assessment (i.e., TE and USR) practices. These results are presented and discussed in Section 2.

2. Technical Feasibility. An examination of the technical aspects (e.g., developmental considerations, available and potential vehicles, reporting practices, etc.) of DORAC implementation. Issues of interest under this topic include: Can DORACs be successfully developed and implemented? Are the results of an implementation of the concept likely to be useful? How will DORACs fit into the training evaluation and USR systems? Under what conditions is maximum payoff from DORAC implementation likely to occur? Conclusions relevant to these issues were derived rationally on the basis of review of: (1) existing and projected Army training devices, and (2) suggested improvements to the TE and USR systems provided by survey participants. These issues are addressed in Section 3, Implementation Issues.

   One additional aspect of Technical Feasibility involves the issue of identifying the most cost-effective capability; that is, being able to structure a DORAC in which the value of the readiness information provided offsets the costs entailed in obtaining the information. An analysis directed at determining the most cost-effective DORAC is termed Cost and Information Effectiveness Analysis, or CIEA (see Hawley & Dawdy, 1981). To empirically investigate this issue, a demonstration CIEA was performed on a set of potential DORAC alternatives for the M16A1 rifle. The results of this demonstration CIEA are reported separately in Section 4.

3. Financial Feasibility. An examination of the resources required to develop, implement, and sustain a system of DORACs Army-wide. This issue is not addressed at a detailed or specific level; rather it is addressed at the level of general resource requirements. Material relevant to the issue of financial feasibility is presented in Section 3.

The final section of the report (Section 5) briefly summarizes the results of the DORAC feasibility and utility evaluation. A list of conditions under which maximum payoff from a DORAC is likely to occur is also presented. Then, integrating these two sets of results, specific recommendations for continued DORAC developments are listed and discussed.

SECTION 2

FIELD READINESS ASSESSMENT PRACTICES

Introduction

The first step in establishing the feasibility and utility of the DORAC concept was to determine: (1) if the intended end-users of DORAC information (i.e., field commanders and trainers) perceive the need for improved performance assessment, and (2) whether or not the DORAC concept is judged to be an acceptable solution to perceived evaluation deficiencies. Since this first portion of the feasibility analysis concerns end-user *perceptions*, the preferred vehicle for obtaining data relevant to these two issues was a field survey of potentially affected units. The survey addressed four sequential aspects of DORAC feasibility, listed as follows:

1. A description of current field reporting practices. Considering a cross-section of Army units, how are the formal requirements of the TE and USR systems interpreted and carried out?

2. The identification of deficiencies in the way training evaluation and unit status reporting are carried out, or in the quality of the information obtained.

3. Suggested improvements to the training evaluation or status reporting systems. User perceptions regarding solutions to deficiencies in the TE or USR systems.

4. DORAC concept acceptability and perceived utility. End-user opinions concerning the acceptability of the DORAC concept, and their comments concerning the utility of obtaining more frequent or higher quality performance data.

As noted previously, a major component of DORAC feasibility is the reaction of the intended users of the information. Realistically speaking, any performance evaluation program, no matter how well intended, has the potential for being viewed as an assessment of unit commanders. Field-level rejection of the concept will lead to DORAC being viewed as just another, and perhaps more expensive, evaluation system that functions no better than the method it replaces or supplements. In order to reduce the likelihood of this outcome, it was judged necessary to gain some insight into the probable reception a DORAC would receive. End-user opinions regarding potential uses of data and the mode of application for DORAC can have a bearing on the eventual acceptance of the concept.

Approach

The vehicle for obtaining information concerning the four aspects of DORAC feasibility cited above was a field survey. The survey was conducted with personnel from a cross-section of units representative of those likely to be affected by a decision to implement DORAC Army-wide. Units selected for participation in the field survey were located at Ft. Benning, GA; Ft. Knox, KY; and Ft. Bliss, TX. At these posts, survey participants were selected from the following units:

	Unit	Location
1.	4/37 Armor	Ft. Knox
2.	4/51 Mech. Infantry	Ft. Knox
3.	3/3 Field Artillery	Ft. Knox
4.	2/10 Field Artillery	Ft. Benning
5.	1/58 Infantry	Ft. Benning
6.	2/55 Air Defense Artillery (ADA)	Ft. Bliss
7.	1/7 ADA	Ft. Bliss
8.	1/3 Armored Cavalry Regiment (ACR)	Ft. Bliss
9.	3/3 ACR	Ft. Bliss

Survey information was obtained in face-to-face interviews with personnel representing a cross-section of unit perspectives (e.g., command vs. staff, brigade vs. battalion vs. company).

The first step in describing field proficiency assessment and status reporting practices was to develop suitable survey instrumentation. Survey instrument construction was conducted in two steps:

1. Development and tryout of a preliminary interview guide.
2. Development of refined survey instruments appropriate for various categories of interviewees.

The initial interview guide (see Appendix A) consisted of a set of preliminary, general questions designed to establish the range and type of potential responses. This initial interview guide was used with personnel from 2/55 ADA at Ft. Bliss, TX.

Based on the preliminary survey results, the initial interview guide was refined into two separate and more detailed interview guides, one for staff level (e.g., brigade, battalion) personnel, and another for company/battery/troop level personnel. The resulting detailed interview guides are presented as Appendixes B and C. Following the development of the detailed interview guides, unit surveys were conducted in the time interval 20 February to 3 April 1980.

Relevant Field Survey Results

The most striking result of the unit survey was the *wide range* of evaluation activities conducted by field personnel. In addition to required SQT and ARTEP evaluations, units in the various branches conduct numerous formal and informal evaluations tailored to the specific demands of the materiel systems they employ. Many respondents indicated that a large amount of their training time is spent "peaking" for these evaluations. In this context, peaking refers to the practice of intensively tuning-up, or cramming, for an upcoming evaluation.

Both the SQT and the ARTEP generally are conducted much as formally prescribed. As one respondent noted, "the unit does what it has to do." The SQT drew mixed reviews from survey participants. Some respondents indicated that the SQT does a good job of evaluating necessary job skills; other respondents were less positive. A fairly widespread view was that the written portion of the SQT places too much emphasis on reading ability. Personnel who are judged to be adequate job performers often do not perform well on the written portion of SQT because they do not read well. Respondents were unanimous on the importance of having *competent* evaluators for the hands-on portions of the SQT. Also, survey participants universally favored the idea of hands-on, performance-oriented proficiency evaluation.

In terms of the internal or mini-SQT, most of the units visited conduct some type of informal proficiency evaluation. These evaluations are usually carried out by crew chiefs or squad leaders on what was referred to as a task sampling basis; that is, on a daily or weekly basis, a sample of tasks for evaluation are selected from the SM. Most respondents admitted that these internal evaluations are of limited utility because there are no standardized procedures for their conduct and performance standards are often not vigorously enforced. The Job Book scheme for recording the results of internal SQTs is apparently not working. For many MOSs, Job Books are not available. Where Job Books are available, they are often not used. None of the units contacted placed a high priority on keeping Job Books up-to-date. Several respondents attributed this situation to a lack of command interest. Job Books are considered to be "just another paper requirement" with little perceived utility.

Respondent comments concerning the ARTEP were also mixed. For example, the Armored personnel contacted thought their ARTEP was very good; the Air Defense units surveyed no longer conduct an ARTEP because theirs had proven unsatisfactory in practice. The Infantry units queried rated the quality of their ARTEP between these two extremes. The internal or mini-ARTEPs that had been developed and tried were characterized as loosely constructed and non-standardized. A primary criticism of both types of ARTEP evaluation concerned a general lack of combat-referenced performance standards. Respondents generally agreed that a well-conducted ARTEP would be the preferred method of assessing overall unit combat readiness. The ARTEP permits all portions of the unit to carry out all aspects of their mission. In addition, a well developed ARTEP would exercise the command, control, and communication elements that are missing from more piecemeal evaluation procedures.

The most important aspect of characterizing current proficiency assessment practices concerned how units determine their training readiness level for the USR. When asked to address this subject, survey respondents generally gave one quick reply: "very subjectively." The training status rating was judged to be the most subjective of the three component ratings (personnel, equipment, training). As one respondent phrased it: "we have no real way to tell what our proficiency level is." Another respondent stated that the overall rating is "primarily driven by equipment and personnel strength considerations"; this respondent also admitted that "the training rating never drives it (the overall rating) down."

In summary, the first and second issues, current field proficiency assessment practices and perceived deficiencies, are characterized by the following points:

1. Units carry out whatever evaluation requirements are placed on them from higher headquarters.

2. Formal, explicit evaluation requirements are met; suggested or recommended evaluation activities are usually given a lower priority.

3. Both the TE and the USR systems are plagued by a lack of standardization and performance standards.

4. Unit personnel believe that they are in the best position to judge their unit's proficiency. They admit, however, that internally developed or conducted evaluations are usually quite deficient.

5. The USR is acknowledged to be "subjectively distorted." The training rating portion of the USR is the most subjective component of the three factors considered.

In terms of suggestions regarding improvements to the current TE and USR systems, the survey results were again mixed. Some respondents judged the present systems to be adequate. Other respondents were of the opinion that the current system places too much emphasis on numbers, or quantitative results. These respondents stated that an emphasis on quantitative results produces a "we-they" situation in which a unit's emphasis is on "passing the test" rather than on identifying and correcting performance deficiencies. Specific recommendations for improving the TE and USR systems included the following:

- Conduct integrated unit evaluations (e.g., ARTEP, FTX, etc.). The current assessment system is too piecemeal.
- Provide more detail on evaluation requirements, down to the task level.
- Conduct more field exercises.
- Provide for more time on equipment.
- Provide more immediate feedback on SQT.
- Make training and evaluation activities more realistic.
- Provide for evaluation by outsiders.

An additional implementation issue was the acceptability and perceived utility of the DORAC concept. This issue was assessed by two questions on the interview guide:

Q. *What is your opinion of using trainers or simulators in training evaluation?*

Q. *For the training portion of your USR, could you use skills evaluation data which have been generated by trainers/ simulators? How could you use such information, and what is your attitude concerning its use?*

In reviewing the field survey results, some striking response disparities to these questions were apparent. The primary factor determining positive or negative responses appeared to be the respondents' previous experience with training devices. Air Defense personnel, through their experience with the AN/MPQ-T1 and AN/TPQ-29, were generally receptive to the idea of using training devices for evaluation purposes. One respondent stated: "In Air Defense, we could not do without them." Not surprisingly, Air Defense personnel also were not opposed to the idea of using training device derived performance data as a guide for the USR training status rating. In fact, one HAWK battalion commander stated that AN/TPQ-29 results <u>are</u>

considered in assigning the training rating. The only recurring complaint expressed by Air Defense personnel concerned equipment *density*; there simply are not enough devices available to accommodate all units.

Survey results from other units, particularly Armor, presented an entirely different viewpoint. Many of the Armor respondents characterized their training devices as "substandard" and "inferior to actual equipment". One respondent stated flatly: "the devices don't work." As a result of these negative views toward training devices in general, most of the non-Air Defense respondents also were opposed to the idea of using training device generated performance data in the training portion of the USR. Some typical comments on the issue included the following:

- Based on my experience with current devices, no.
- The current devices cannot be used.
- Not with present simulators. With adequate simulators, maybe.
- People don't get serious with simulators.
- Partial inclusion might be O.K.
- No, period.
- Perceptions of current devices would not allow the results to drive USR training ratings (comment of battalion commander).

Not surprisingly, the above results indicate that personnel who have had favorable experiences with training devices (e.g., the AN/TPQ-29) view them favorably and do not have a negative attitude toward using the devices for proficiency evaluation. On the other hand, the experiences of many of the respondents with training devices have been negative. Training devices were characterized as being inferior, sub-standard, and of limited utility. Accordingly, these personnel are also opposed to the use of training devices in performance evaluation.

Discussion

The results presented in the previous paragraphs indicate that field personnel do recognize deficiencies in the current TE and USR systems. Among the major reported deficiencies are the following:

1. A general lack of standardization in evaluation procedures for all but SQTs.

2. A general lack of combat-referenced performance standards.

3. For many materiel systems, there is no sure means for obtaining acceptable performance data.

4. There is a generally recognized lack of objectivity in the way USR ratings are assigned.

When queried concerning potential solutions to the deficiencies cited above, survey respondents listed the following suggestions:

1. Provide for realism in training and evaluation.
2. Conduct integrated unit evaluations.
3. Provide immediate performance feedback.
4. Provide for evaluation by (impartial) outsiders.

Obviously, some of these suggestions are solutions to other problems, rather than to the identified problems, and require a priori that: (1) evaluation procedures are standardized, (2) adequate performance standards exist, and (3) a vehicle for obtaining proficiency data is available.

The survey results also indicated that training devices are generally *not perceived* to fit into any of the proposed solutions. This attitude primarily resulted from previous bad experiences with training devices on the part of many respondents. Given the favorable response of the Air Defense personnel, an argument could be made to the effect that the DORAC concept <u>can</u> be made acceptable to field personnel, but much convincing would be required. Considerable "bad press" associated with training devices will have to be overcome. The results suggest that if the DORAC concept is adopted it should be implemented deliberately and where the likelihood of visible success is high. Then, after a successful evaluation program has been developed, the concept should be publicized throughout the Army.

A second issue relevant to the topic of DORAC acceptability concerns a general aversion to quantitative evaluation on the part of field personnel. During the field survey, some respondents indicated that they would readily accept and, in fact, welcome any information that might be provided by a DORAC if the data were not reported as a formal part of the USR. As noted previously, any performance assessment program has the potential for being viewed as an evaluation of unit commanders. The natural tendency of commanders in such cases will be to protect their careers by making the evaluation as non-threatening as possible (one of the survey respondents referred to this outcome as "going the way of the OER"--Officer Efficiency Report). It is doubtful that any objective performance evaluation program can be implemented successfully if field commanders view it as a potential threat. How this aversion to quantitative evaluation can be rationalized with the intent of DORAC remains an empirical issue.

In the final analysis, it is obvious that most field personnel will not greet the DORAC concept with enthusiasm. Previous bad experiences with training devices and an aversion to quantitative evaluation will likely combine to produce resistance, perhaps passive, to DORAC implementation. Assuming, however, that implementation is conducted properly and carefully, the question of whether or not DORAC will be accepted by field personnel can be answered with a qualified "yes". The current attitude of Air Defense personnel strongly supports this position. It should be noted, however, that this positive attitude is the result of more than 20 years of positive experiences with training devices in evaluation.

SECTION 3

IMPLEMENTATION ISSUES

Introduction

Given an affirmative answer to the issue of DORAC concept acceptability, the next two aspects of feasibility are Technical and Financial feasibility. Technical feasibility involves determining whether or not it is possible to provide required measurement capabilities using current or projected training devices. The output of the technical feasibility analysis then provides the structure necessary to outline the resource committment required to produce the technical capability. In this manner, the technical analysis provides the framework for the Financial feasibility analysis.

Under the heading of technical feasibility, three questions are at issue:

1. Do vehicles (i.e., training devices) currently exist to support the DORAC concept, and what are the prospects for the future?

2. What will be required to develop DORACs in present and future training devices?

3. What will be required to implement the DORAC concept Army-wide?

Once the above issues have been addressed, the resources required to develop the DORAC concept can be projected. At this stage of the concept study, resource requirements were considered at a very general level; that is, categories and types of resource requirements are identified and discussed. Later, in Section 4, the resource requirements associated with a specific DORAC are considered.

Technical Feasibility

The first issue under the topic of technical feasibility concerns whether or not vehicles for DORAC implementation currently exist. In addition, the prospects for the future are also reviewed. This issue can be addressed quite directly by referring to DA Pamphlet 310-12, Index and Description of Army Training Devices, and the ATSC publication Comprehensive Plan for Training Devices.

DA Pamphlet 310-12 lists all of the training devices currently in the Army inventory. The list runs literally into hundreds of devices. These devices range in complexity from simple artillery noise simulators to quite sophisticated items such as the Guided Missile System Radar Signal Simulator Station (AN/TPQ-29) and several aviation cockpit simulators. In addition to the fielded devices, the comprehensive plan for training devices presents a long list of training devices currently undergoing development. Again, the projected devices present a considerable range in complexity.

It would thus seem that there is no shortage of candidates for DORAC development. Available candidates, however, do not imply that DORACs can be developed and implemented. As Shelnutt et al (1978) note, the cost of retrofitting a measurement capability to an existing training device is likely to be quite high. Thus, for current training devices that do not already have some inherent performance assessment capability (i.e., the AN/TPQ-29) the only cost-effective course of action may be to employ a human-based evaluation system (i.e., checklist, rating scale, etc.), even though such a measurement system may not provide data of the highest quality. In the present context, these person-based, add-on systems are denoted as "quasi-DORACs". Quasi-DORACs can be developed for nearly any training device that permits a *simulation* of all or part of an individual/collective mission.

The most obvious candidates for the development of more sophisticated (i.e., "hard") DORACs are training devices that include some kind of information processing capability, or weapons systems that include an information processing capability that can accommodate a proficiency measurement add-on (e.g., many missile systems). A review of the inventory of current training devices reveals several such systems/devices. Most of them, however, do not have extensive proficiency assessment capabilities currently built in. Thus, some amount of retrofitting would be required. The list of future training devices reveals potentially more candidates for hard DORACs. This higher number reflects an increasing use of materiel systems having an inherent data processing capability. From the descriptions provided, it appears that many of these projected devices are well along in their developmental cycle and may also require extensive retrofitting or design modification in order to accommodate more than a quasi proficiency assessment capability.

The potential for hard DORAC development in developing training devices may not be as bleak as the previous paragraph seems to indicate. For example, the U.S. Army Research Institute Field Unit at Ft. Bliss is currently sponsoring a project titled Optimizing Operator Performance on Advanced Training Simulators. A portion of this effort involves developing an operator performance recording, play-back, and scoring capability for the PATRIOT Tactical Operations Simulator/Trainer (TOS/T). Although the TOS/T was not designed to accommodate a proficiency assessment capability, modifying the simulation software to record and score operator performance did not present a particularly difficult problem. The simulation software was modified to accommodate what could be termed a hard DORAC capability without modifying any of the system hardware and without interfering with on-going TOS/T research or evaluation activities.

In view of the above results, it appears safe to state that a large potential for DORAC implementation currently exists. Furthermore, the future looks even more promising in terms of the number of training devices having DORAC potential.

Although many training devices having DORAC potential currently exist and others will come on-line in the future, potential is not sufficient to ensure the successful application of the DORAC concept throughout the Army. In order to be useful and successful, the training devices with DORAC will have to be made available in sufficient quantities to meet field training and evaluation requirements. Also, drawing upon the results of the field survey, the training devices will have to be of high quality and will have to be supported. In this context, *support* refers to providing a sufficient number of operators and evaluators, and to insuring the availability of adequate maintenance and other peripheral support facilities.

In addition to the obvious support requirements (i.e., adequate numbers of devices, maintenance support, etc.), some additional background work will also be required. This will involve developing *standard operating procedures* (SOPs) for the conduct of DORAC evaluation and providing realistic, combat-referenced performance standards for DORAC evaluations. Judging from the field survey results, the dual issues of *standardization* and realistic *performance standards* are critical to the success of the DORAC concept.

Once the capability has been developed and adequately supported, the final technical issue concerns how the performance data should be used. It appears that the formal TE system is adequate to accommodate DORAC information. DORACs can provide a full or partial vehicle for the conduct of a wide variety of internal and external evaluation activities. The Unit Status Reporting (USR) system would, however, have to be modified to provide for the inclusion of standardized training status data. The use of standardization teams to promote objectivity in the USR process would also be desirable. Operational readiness evaluation procedures currently employed by the U.S. Air Force and in the Army aviation community (for example, see TC-1-134 or TC-1-135) provide some insight into the potential structure of such a modified USR system.

In summary, the DORAC concept is technically feasible. However, several actions on the part of the Army must be undertaken before attempting to implement the concept Army-wide. These actions are listed as follows:

1. The Army's deployment practices for training devices will have to be upgraded. This will involve increasing device density, increasing device availability, and insuring the availability of personnel trained to operate and repair the devices. In addition, it is essential that training device deployment not seriously lag that of the materiel system.

2. Standard operating procedures for DORAC evaluations must be developed and enforced.

3. Realistic, combat-referenced performance standards for DORAC evaluations must be provided. Units also must be provided with guidelines on how to use DORAC generated proficiency status information to increase training efficiency.

4. The USR system should be modified to accommodate standardized individual/unit proficiency information.

Financial Feasibility

The final aspect of DORAC concept feasibility concerns the resource commitment on the part of the Army that will be necessary to develop, implement, and support a capability. Many of the factors that will impact upon the eventual cost of a system of DORACs have already been noted. In the interest of completeness, however, these factors are listed again and elaborated upon. The individual resource factors considered are listed as follows:

1. Facilities and Equipment
2. Materials
3. Personnel

Overall, the additional costs of developing and implementing a DORAC, where the evaluation mission is additional to the basic training mission, are anticipated to be minimal. Of these costs, facilities and equipment will likely be the single most costly aspect of a decision to implement DORAC Army-wide. First of all, a density of equipment sufficient to accommodate all planned evaluations which need to be accomplished from the conduct of training, if any, must be provided. Judging from the survey results, this will, in some cases, require a higher density of training devices than has currently been provided. Along with an adequate device density, appropriate support equipment and facilities (i.e., land, buildings, etc.) will also be required. Higher equipment densities will mean more support facilities than are now provided.

A second aspect of DORAC support is training and evaluation materials. Material support will run the gamut from computer software, to films, to printed matter, to miscellaneous items such as paper and pencils. The potential cost of this aspect of DORAC support should not be underestimated. For example, computer software can cost thousands of dollars to develop; scenario films for use in the Air Defense's Moving Target Simulator (MTS) cost in the neighborhood of $3-to-400,000 to develop; scenarios for use with the PATRIOT TOS/T are very costly and time consuming to produce. Not all DORACs will impose resource demands at the levels cited above, but the potential for costly materials support exists.

The third aspect of financial feasibility is personnel. In this area, DORAC resource demands are likely to vary considerably. Some DORACs will require little more than a part-time evaluator/maintainer drawn from an affected unit. Other systems may require full-time evaluators, operators, and maintenance personnel. For example, the PATRIOT TOS/T, admittedly a very complex training device, requires a full-time complement of 3-to-4 operators and software maintenance personnel (both military and contractor) to keep it operational. In addition, hardware maintenance support is provided on a contractual basis.

No matter what level or type of support is required, one fact is apparent from the field survey results: if the DORAC concept is implemented, it must be given adequate support. Without adequate provisions for support, DORAC will be doomed to failure in terms of meeting the objectives for which it is intended.

SECTION 4

DEMONSTRATION OF ANALYSIS METHOD FEASIBILITY AND DORAC UTILITY

Introduction

Section 4 is concerned with the conduct of a demonstration Cost and Information Effectiveness Analysis (CIEA) performed on a set of hypothetical DORAC alternatives. CIEA is a cost-benefit trade-off analysis similar in nature to cost and training effectiveness analysis (CTEA) and to cost and operational effectiveness analysis (COEA). The objective of CIEA is to provide the framework for selecting a preferred DORAC alternative in terms of the value of the information provided (e.g., operational readiness, training status, etc.) versus the cost of developing, implementing, and operating the capability. CIEA is intended to serve as a guide to decision-makers in developing and evaluating alternative DORAC concepts for any parent materiel system.

As a methodology, CIEA (along with CTEA and COEA) is a member of a set of procedures generally known as cost-effectiveness analysis. The term cost-effectiveness analysis denotes a procedure in which alternative system concepts are evaluated using measures of cost (usually dollars) and separate measures of effectiveness (e.g., reliability, speed, probability of accomplishing a task, or a weighted index of a number of such factors) (Barish & Kaplan, 1978). Under this approach, cost and effectiveness values for each alternative are determined. The systems are then evaluated on the basis of whether the added benefits of the more effective alternatives are worth their added costs. The use of cost-effectiveness analysis is common in the evaluation of military materiel and training systems (for example, see TRADOC Pam 11-8 or TRADOC Pam 71-10).

The Statement of Work (SOW) for the current project calls for a preliminary CIEA methodology to be developed and then demonstrated using a training device system selected by the Army Research Institute (ARI) in conjunction with the Project Manager for Training Devices (PM TRADE) and the Army Training Support Center (ATSC). These devices were to serve as a research vehicle for CIEA development, a demonstration of method usability, and to provide an evaluation and possible demonstration of DORAC utility in the selected cases. The obj 'tive of Section 4 is to serve the last two purposes by presenting the ·ults of an application of the preliminary CIEA methodology (denoted MAUM-CIEA, MAUM standing for multiattribute utility measurement) (see Hawley & Dawdy, 1981) to the selected training device and a baseline readiness evaluation procedure.

The training devices selected for actual use in the demonstration CIEA are applicable to the Army's standard-issue rifle, the M16A1. These training devices are designated the Weaponeer and the Squad Weapons

Analytical Trainer, or SWAT. Each of the subject training devices is described in additional detail later in this section of the report. For evaluation purposes, the training devices are structured, alone and in combination, to constitute a set of feasible DORAC alternatives. The alternatives are to be evaluated with respect to the utility of the information they provide versus the cost required to obtain it. Alternatives are evaluated against each other and against a baseline condition defined as Record Fire (RF) conducted one time per year. RF is the vehicle presently used to assess individual marksmanship proficiency on the M16A1 rifle.

The following portions of this section carry a set of proposed M16A1 DORACs through the steps of a CIEA evaluation. As outlined in Hawley and Dawdy (1981), the phases, and nested steps, of the MAUM-CIEA methodology are listed as follows:

1. Assess needs and constraints.

2. Define system objectives
   a. Determine issues to which utility ratings are relevant.
   b. Determine relevant factors on which alternative system concepts are to be assessed.
   c. Identify perspective from which utility is to be assessed.

3. Identify operational requirements for the attainment of system objectives.

4. Develop alternative system concepts.

5. Establish system evaluation criteria.
   a. Derive importance weights for each factor identified in Step 2-b.
   b. Assess utility of each operational measure (the output of phase 3).

6. Generate systems-versus-criteria array.
   a. Obtain system effectiveness ratings.
   b. Determine partial utility scores for each factor.
   c. Aggregate partial utilities to produce a global utility score for each alternative.
   d. Estimate cost for each alternative.

7. Perform sensitivity analyses.

8. Select a preferred alternative.

Since the CIEA is a demonstration exercise, the needs/constraints assessment portion (Phase 1) was not formally addressed. For purposes of analysis, the following assumptions were made: (1) concern has been expressed regarding the current level of rifle marksmanship proficiency in the Army; (2) leadership concern has been formalized in a problem statement; and (3) no relevant constraints have been specified. Results from each of the remaining phases of the demonstration analysis are now presented and discussed in turn.

Demonstration CIEA

Define System Objectives

The objective of Phase 2, Define System Objectives, is to translate the general problem statement into a formal specification of the objectives of the proposed DORAC. This is accomplished through a process consisting of three steps, listed as follows:

1. Determine the issues to which DORAC information is relevant.
2. Determine information worth dimensions.
3. Identify the perspective from which information worth is to be assessed.

Again based on assumption, a list of information issues relevant to marksmanship proficiency is presented in Table 4-1. The issues listed in Table 4-1 represent the starting point for the demonstration CIEA.

The information issues presented in Table 4-1 primarily concern operational readiness. An additional area of interest is unit training management. Hence, the information worth dimensions (WDs) selected for the demonstration CIEA are listed and defined as follows:

1. Readiness Evaluation. The determination of whether or not individuals/units are capable of performance at an acceptable level/standard on the performances specific to the DORAC application.

2. Training Management. The use of performance status or diagnostic information in determining who, how often, when, and what to train for individual/unit performances related to the specific DORAC.

Other potential information applications such as unit management or fighting system evaluation/development were not considered in the demonstration analysis.

Table 4-1

Information Issues

1. Can soldiers prepare the M16A1 rifle for operation?
2. Can soldiers maintain the M16A1 rifle?
3. Can soldiers fire on probable targets from positions dictated by combat and under combat conditions?
4. Can soldiers detect and identify the types of targets probable in combat?
5. Can soldiers be used effectively in assault operations?
6. Can soldiers be used effectively in defense operations?
7. Can soldiers be expected to practice ammunition conservation?
8. Can soldiers be expected to engage hostile targets presenting the greatest threat?
9. Can soldiers be expected to maintain proper concealment under combat conditions?
10. Can fire teams be expected to maintain adequate weapon operation, and engagement procedures to enhance the probability that they can effectively operate in combat?

After defining information issues and WDs, the final step in Phase 2 involved specifying the perspective from which information worth was to be assessed. As noted in Hawley and Dawdy (1981), the issue of "utility to whom" is decided by referring to the WDs. In the present situation, the WDs indicate that subject matter experts in the areas of readiness evaluation, training evaluation, and unit training represent the necessary perspective. Within the Army, such expertise is found in personnel from affected operational units and from the proponent school for the parent materiel system. Accordingly, a decision was made to conduct the demonstration analysis using representatives from an Infantry unit and the U.S. Army Infantry School Directorate of Training Development (USAIS DTD).

Identify Operational Requirements

The next phase in CIEA was to translate the information issues into operational requirements for a DORAC; that is, to map information issues into specific individual/unit performances. In addition, the conditions under which performances are to be demonstrated and the standards by which performances are evaluated were also specified. Table 4-2 presents a list of the performances and standards specifically associated with Readiness Evaluation. Table 4-3 lists the performances and standards relevant to training management. Potential performance conditions for both sets of performances are given in Table 4-4.

Develop Alternative System Concepts

As noted previously, the training devices selected for use in the demonstration CIEA are relevant to the issue of marksmanship proficiency. The current method used to assess marksmanship proficiency is RF conducted one time per year. During RF, each soldier is taken to a firing range and assessed in a 40-round live-fire exercise. Prone and foxhole firing positions are employed; range and target exposure time also vary. A candidate is rated as "qualified" if he/she achieves 17 (23 at Ft. Benning) or more hits out of 40 possible. Figure 4-1 presents the firing positions, target ranges, and times used in RF.

Weaponeer (WP) is an M16A1 remedial marksmanship trainer designed to isolate individual performance deficiencies. A simulated M16A1 rifle is equipped with a target sensor and each target contains a light emitting diode (LED) which is sensed by the target sensor on the rifle. A predicted round impact point is determined by the LED-target sensor alinement. WP has a memory for recording up to 32 predicted shot impacts and a printer for providing a printout of all shots on selected targets. Rifle recoil is simulated with recoil energy being variable from no recoil to a recoil intensity 40 percent greater than the recoil of a standard M16A1 rifle.

Table 4-2

Performances and Standards Relevant to Readiness Evaluation

PERFORMANCE	STANDARD
I. Condition to operate	
A. calibrate (zero)	prescribed shot group and shot group location
B. load	proper weapon operation
II. Maintain operation	
A. reload	continued weapon operation
B. reduce a stoppage	return the weapon to proper operation
III. Operate	
A. aimed fire from: 1. prone 2. sitting 3. squatting 4. kneeling 5. standing 6. foxhole supported 7. foxhole unsupported	No standard established by position. Current standard: 17/40 (42%)† on record fire collapsed across the foxhole and prone position and confounded with target range and time of exposure. The initial standard can be set at the approximate 42% level used for record fire.
B. pointed fire from: 1. standing 2. crouching 3. moving	
IV. Engage	
A. detect and identify targets	No standard stated. The initial standard can be a minimum at 42% hits on hostile and a reduced score for hitting on a friend.
B. assault	No standard stated. The initial standard can be a minimum of 42%.
C. defense	No standard stated. The initial standard can be a minimum of 42%.
D. patrol operation	See 'assault' above.
E. ammunition rationing	No standard stated. The initial standard can consist of allocating a number of rounds based on the number of targets presented plus y%. y% based on prescribed firing modes for targets presented. Require the firer to fire on 90% of the targets presented and have an overall accuracy of 42%.

† At Ft. Benning the standard for qualification is 23/40 or 58%.

Table 4-2 (Cont'd)

PERFORMANCE	STANDARD
IV. Engage (Cont'd)	
F. threat evaluation	No standard stated.
G. concealment	No standard stated. The initial standard can be based on duration of exposure weighted by amount of exposure and target range.
V. Team fire	No standard stated. See appropriate comments under 'maintain operation' and 'engage' above.

Table 4-3

Performances and Standards Relevant to Training Management

PERFORMANCE	STANDARD
I. Condition to operate	
A. Calibration (zero)	prescribed shot group and shot group location
1. adjust for minute of angle	prescribed procedure
2. adjust for gravity effect	prescribed procedure
3. sight-weapon alinement	prescribed procedure
B. Load	proper weapon operation
1. inspect magazine top round alinement	prescribed procedure
2. apply proper intensity blow to seat magazine	prescribed procedure
3. insure the first round is seated in the chamber	prescribed procedure
II. Maintain operation	continued weapon operation
A. Reload	
1. remove the magazine	prescribed procedure
2. see 'load'	see 'load'
B. Reduce a stoppage	return the weapon to proper operation
1. perform immediate action procedure	prescribed procedure
2. inspect an M-16 and diagnose the stoppage	prescribed procedure
3. take the appropriate action for reducing a stoppage	identification of the correct procedure and a prescribed procedure

Table 4-3 (Cont'd)

PERFORMANCE	STANDARD
III. Operate	
A. Man-machine Interface (M-MI)	prescribed technique
1. trigger control (squeeze)	
2. grip on weapon	
3. breath control	
4. relax	
5. compensate for recoil	
6. change firing mode	
7. stock weld (if applicable)	
8. firing elbow (if applicable)	
B. Marksmanship	
1. compensate for range	No standard established by range. The initial standard can be a minimum of 42% hits.
2. compensate for wind	No standard established by wind velocity. The initial standard can be a minimum of 42% hits under wind conditions.
3. compensate for target movement	No standard established. The initial standard can be a minimum of 42% hits on moving targets.
4. transfer of fire	No standard established. The initial standard can be a minimum of 42% hits.
5. obtain a proper sight picture (aimed fire only)	prescribed procedure
6. obtain a proper aiming point (aimed fire only)	prescribed procedure
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	No standard established for pointed fire. Since pointed fire is appropriate only for targets at close range, an initial standard of 40% hits can be used.

Table 4-3 (Cont'd)

PERFORMANCE	STANDARD
III. Operate (Cont'd)	
B. Marksmanship (Cont'd)	
8. aimed fire from: a. prone b. sitting c. squatting d. kneeling e. standing f. foxhole supported g. foxhole unsupported	No standard established by position. Current standard: 17/40 on record fire collapsed across the foxhole and prone position and confounded with target range and time of exposure. The initial standard can be set at the approximate 42% level used for record fire.
9. pointed fire from: a. standing b. crouching c. moving	
IV. Engage	
A. Detect and identify targets	No standard stated. The initial standard can be a minimum at 42% hits on hostile with a reduced score for hitting a friend.
B. Assault	No standard stated. The initial standard can be a minimum of 42%.
C. Defense	No standard stated. The initial standard can be a minimum of 42%.
D. Patrol operation	See 'assault' above.
E. Ammunition rationing	No standard stated. The initial standard can be allocating a number of rounds based on the number of targets presented plus y%. y% based on prescribed firing modes for targets presented. Require the firer to fire on 90% of the targets presented and have an overall accuracy of 42%.
F. Threat evaluation	No standard stated.
G. Concealment	No standard stated. The initial standard can be based on duration of exposure weighted by amount of exposure and target range.
V. Team Fire	No standard stated. See appropriate comments under 'maintain operation' and 'engage' above.

Table 4-4

Potential Performance Conditions

1.	Motion (firer movement)
2.	Illumination
3.	Meteorological
4.	Clothing worn by firer
5.	Temperature
6.	Target-background contrast ratio
7.	Similarity between friend and enemy
8.	Terrain
9.	Field of fire
10.	Approach routes
11.	Concealment factors
12.	Force density ratio
13.	Fire sector
14.	Firer-target proximity

TABLE 1 FOXHOLE POSITION

RD	Range (M)	Time (Sec)	Hit	Miss	No Fire
1	50	5			
2	200	5			
3	100	5			
4	150	5			
5	300	10			
6	250	10			
7	50	5			
8	200	5			
9	150	5			
10	250	10			
		TOTAL			

TABLE 2 PRONE POSITION

RD	Range (M)	Time (Sec)	Hit	Miss	No Fire
1	100	15			
2	250				
3	300	10			
4	50	10			
5	200				
6	150	15			
7	300				
8	50	10			
9	200				
10	100	5			
		TOTAL			

TABLE 3 PRONE POSITION

RD	Range (M)	Time (Sec)	Hit	Miss	No Fire
1	150	5			
2	300	10			
3	100	10			
4	200				
5	150	15			
6	250				
7	100	15			
8	300				
9	200	15			
10	300				
		TOTAL			

TABLE 4 FOXHOLE POSITION

RD	Range (M)	Time (Sec)	Hit	Miss	No Fire
1	100	10			
2	200				
3	250	20			
4	300				
5	100	15			
6	250				
7	250	10			
8	300	10			
9	50	10			
10	100				
		TOTAL			

Figure 4-1. Record Fire Scoring Table

Three types of magazines are provided for use with the rifle: a 20-round (unlimited fire) magazine, a 30-round (unlimited fire) magazine, and a limited fire magazine that allows from 1 to 30 simulated rounds in the magazine. A headset is provided for simulating the firing sound of an M16A1 rifle. The WP also includes a selection for random misfire.

WP can present three targets: a scaled 25 meter zeroing target, a scaled 100 meter 'E' type silhouette target, and a 250 meter 'E' type silhouette target. Any target selected can be raised at random during a 1 to 9 second time frame and can remain in a raised position for a duration of 2, 3, 5, 10, 15, 20, 25 seconds, or continuous. The WP provides a target 'Kill' function: a selection that will cause a raised target to drop when it is hit. Firing pads used with the WP provide the capability for the firer to fire from the foxhole or prone position.

A video display allows an observer to monitor individual shots and replay the last 3 seconds of each of the first 3 shots. Scoring available with the WP video display includes: the target on display, the number of hits on the target, the number of misses, late shots (fired after target drops), the shot number, and the total number of shots fired (Spartanics, Inc., 1976).

The second training device was the SWAT. SWAT is an electrooptics-based, microcomputer-controlled, training device that permits tactical infantry weapons training under stimulated battlefield conditions in a classroom environment. In a short period of time, a user can be subjected to a wide range of combat situations where each user's performance is analyzed in real-time, and immediate feedback is given to both the users and the evaluator. Combat scenarios can be changed to fit any potential battlefield requirement. The trainer is configured for a maximum of five persons.

The SWAT has two motion picture projectors: a visual and an infrared (IR) projector. The visual projector displays the battle scene, including visual targets. The infrared projector provides invisible infrared target areas which the weapon must be aimed at in order to score a hit. Lead is programmed into the infrared target, which the weapon receiver detects, requiring the trainee to lead the target as necessary. Each user has a simulated M16A1 rifle with an attached IR detector consisting of a four-quadrant photo diode. The four-quadrant target information and micro-computer logic determine kills, eight areas of near misses, and total misses.

When the user fires the weapon, he/she hears a simulated bang and feels a recoil. Recoil is generated by a short pulse of air released near the front sight which drives the weapon high and to the right. An 8080-based micro-processor determines where the round would have hit and supplies this information to both a computer-generated voice unit and a cathode-ray tube (CRT) display on the evaluator's station. The computer voice unit drives both the user's and evaluator's headsets. When a target appears on the screen, the IR projector outputs a target present signal. This signal starts a clock in the microcomputer which measures the time until the user fires, thus assessing reaction time. The target present signal is also used to determine: (1) the number of targets that appeared, (2) targets ignored, (3) targets shot at, and (4) if the user fired when no target was present. User results are continuously displayed in five columns on a CRT display at the evaluator's station. At the completion of the exercise the results, analyses and response time are printed by a terminal at the evaluator's station.

Distribution of fire is monitored using an IR source located in the flash-hider part of the rifle. The projected IR laser spot is invisible to the user but is detected by an infrared television camera and displayed by a CRT located on the evaluator's console. When the rifle is fired, the IR spot projector illuminates the CRT with a small IR aim spot. If the evaluator wants to continuously monitor rifle motion, the IR aiming spot can be left on continuously. Data can also be recorded for playback during debriefing. A more complete description of SWAT is provided in Andrews (1979).

Training devices alone will not always constitute DORAC alternatives. In fact, DORAC alternatives will usually consist of sets of training devices/methods used in combination and a usage scenario. In the CIEA demonstration, the following devices/methods and usage scenarios constituted the DORAC alternatives:

1. Baseline. The present situation of RF conducted one time per year. [RF(1)]

2. RF twice per year (every six months). [RF(2)]

3. RF quarterly. [RF(4)]

4. WP once per year. [WP(1)]

5. RF once, WP once. [RF(1) + WP(1)]

6. RF once, WP three times. [RF(1) + WP(3)]

7. SWAT once per year. [SWAT(1)]

8. RF once, SWAT once. [RF(1) + SWAT(1)]

9. RF once, SWAT three times. [RF(1) + SWAT(3)]

10. RF, WP, and SWAT used in a rotating quarterly evaluation. [RF + WP + SWAT]

The alternatives were reviewed to identify which of the performances identified in Tables 4-2 and 4-3 could be assessed by each alternative. Table 4-5 presents the resulting Performance by Alternative Matrix for Training Management. Readiness Evaluation performance measures constitute a subset of the Training Management measures. These measures are shown separately in Table 4-6.

Because of the nature of the conditions for some of the M16A1 performances (i.e., many conditions are, in fact, "catch alls" that refer to a broad range of possible situations), a Performance by Conditions Matrix as discussed in Hawley and Dawdy (1981) was not developed. Rather, a description of the measurement potential of each of the training devices in terms of performance conditions and target variables is provided in Table 4-7.

Finally, Table 4-8 presents measurement method descriptions and judged data dependability ratings for each device/method on each performance. Information quality ratings were assigned using the 5-point scale given as follows:

1 - Very Low
2 - Low
3 - Moderate
4 - High
5 - Very High

Establish System Evaluation Criteria

The next step in the CIEA demonstration involved: (1) deriving importance weights for WDs, and (2) obtaining utility ratings for operational measures (OMs) (i.e., Performances) nested within WDs. In the demonstration exercise, these sets of parameters were obtained using two independent groups of decision-makers.

Since the WDs of interest were Readiness Evaluation and Training Management, the proper perspective for information worth assessment was unit readiness assessment, training development, training evaluation, and unit training. Accordingly, importance weights and utility ratings were elicited in a collective setting using independent groups consisting of personnel from 1/58 Infantry at Ft. Benning, GA, and from USAIS DTD. In both cases, consensus judgments were obtained.

The first task for the two groups of raters was to provide importance weights for the two WDs. Separate results from the two groups and averaged weights are presented as follows:

Table 4-5

Performance by Alternative Matrix for Training Management[1]

Performance	Individual Devices: RF	WP	SWAT	Device Combinations: RF + WP	RF + SWAT	RF + WP + SWAT
I. Condition to operate						
A. Calibration (zero)						
1. adjust for minute of angle	X	0	0	X	X	X
2. adjust for gravity effect	X	0	0	X	X	X
3. sight weapon alinement	X	0	0	X	X	X
B. Load						
1. inspect top round alinement	X	0	0	X	X	X
2. apply blow to seat magazine	X	X	X	X	X	X
3. insure the first round is seated in the chamber	X	0	0	X	X	X
II. Maintain operation						
A. Reload						
1. remove the magazine	X	X	X	X	X	X
2. see 'load'	X	0	0	X	X	X
B. Reduce a stoppage						
1. perform immediate action procedure	X	X	X	X	X	X
2. inspect an M-16 and diagnose the stoppage	X	0	0	X	X	X
3. take the appropriate action for reducing a stoppage	X	0	0	X	X	X

[1]Table entries are an "X" or an "O" indicating that the device/device combination does or does not, respectively, provide a vehicle for assessing a given performance.

Table 4-5 (Cont'd)

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Performance						
III. Operate						
A. Man-machine interface						
1. trigger control	X	X	X	X	X	X
2. grip on weapon	X	X	X	X	X	X
3. breath control	X	X	X	X	X	X
4. relax	X	X	X	X	X	X
5. compensate for recoil	X	X	X	X	X	X
6. change firing mode	X	X	X	X	X	X
7. stock weld	X	X	X	X	X	X
8. firing elbow	X	X	X	X	X	X
B. Marksmanship						
1. compensate for range	X	X	O	X	X	X
2. compensate for wind	X	O	O	X	X	X
3. compensate for target movement	O	O	X	O	X	X
4. transfer of fire	X	X	X	X	X	X
5. obtain a proper sight picture (aimed fire)	X	X	X	X	X	X
6. obtain a proper aiming point (aimed fire)	X	X	X	X	X	X
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	X	O	X	X	X	X

Table 4-5 (Cont'd)

Performance	Individual Devices: RF	WP	SWAT	Device Combinations: RF + WP	RF + SWAT	RF + WP + SWAT
III. Operate (cont'd)						
B. Marksmanship (cont'd)						
8. aimed fire from:						
a. prone	X	X	X	X	X	X
b. sitting	X	X	X	X	X	X
c. squatting	X	X	X	X	X	X
d. kneeling	X	X	X	X	X	X
e. standing	X	X	X	X	X	X
f. foxhole supported	X	X	X	X	X	X
g. foxhole unsupported	X	X	X	X	X	X
9. pointed fire from:						
a. standing	X	O	X	X	X	X
b. crouching	X	O	X	X	X	X
c. moving	O	O	O	O	O	O
IV. Engage						
A. Detect and identify targets	O	O	X	O	X	O
B. Assault	O	O	O	O	O	O
C. Defense	O	O	X	O	X	X
D. Patrol operation	O	O	O	O	O	O
E. Ammunition rationing	O	O	O	O	O	X
F. Threat evaluation	O	O	O	O	O	O
G. Concealment	O	O	O	O	O	O
V. Team fire	O	O	X	O	X	X

Table 4-6

Performance by Alternative Matrix for Readiness Evaluation

Performance	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
I. Condition to operate						
A. Calibrate (zero)	X	O	O	X	X	X
B. Load	X	O	O	X	X	X
II. Maintain operation						
A. Reload	O	O	O	O	O	O
B. Reduce a stoppage	O	O	O	O	O	O
III. Operate						
A. Aimed fire from:						
1. prone	X	X	X	X	X	X
2. sitting	X	X	X	X	X	X
3. squatting	X	X	X	X	X	X
4. kneeling	X	X	X	X	X	X
5. standing	X	X	X	X	X	X
6. foxhole supported	X	X	O	X	X	X
7. foxhole unsupported	X	X	O	X	X	X
B. Pointed fire from:						
1. standing	X	X	X	X	X	X
2. crouching	X	X	X	X	X	X
3. moving	O	O	O	O	O	O

Table 4-6 (Cont'd)

Performance	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
IV. Engage						
A. Detect and identify targets	O	O	X	O	X	O
B. Assault	O	O	O	O	O	O
C. Defense	O	O	X	O	X	X
D. Patrol	O	O	O	O	O	O
E. Ammunition rationing	O	O	O	O	O	O
F. Threat evaluation	O	O	O	O	O	O
G. Concealment	O	O	O	O	O	O
V. Team fire	O	O	X	O	O	O

Table 4-7

Training Device Capabilities in Terms of Performance Conditions and Target Variables

	RF	WP	SWAT
Target Variables:			
1. Multiple	0	0	X
2. Friendly and hostile	0	0	X
3. Range variable	X	0	X
4. Movement			
A. Direction	0	0	X
B. Distance	0	0	X
C. Rate	0	0	X
5. Exposure			
A. Amount	0	0	X
B. Duration	X	X	X
C. Frequency	X	X	X
6. Camouflage	0	0	X
7. Target termination when hit	X	X	0
Conditions:			
1. Motion (firer movement)	0	0	0
2. Illumination	X	X	X
3. Meteorological	0	0	0
4. Clothing worn by firer	X	X	X
5. Temperature	0	0	0
6. Target-background contrast ratio	0	0	X
7. Similarity between friend and enemy	0	0	X
8. Terrain	0	0	X
9. Field of fire	0	0	X

(Column group heading: Device/Method — RF, WP, SWAT)

Table 4-7 (Cont'd)

	Device/Method		
	RF	WP	SWAT
Conditions (Cont'd)			
10. Approach routes	O	O	X
11. Concealment facts	O	O	O
12. Force density ratio	O	O	O
13. Fire sector	O	O	O
14. Firer-target proximity	O	O	X

Table 4-8
Measurement Method Descriptions and Dependability[2] Ratings

	Device					
	RF		WP		SWAT	
PERFORMANCE	Method	Dependability	Method	Dependability	Method	Dependability
I. Condition to operate A. Calibration (zero) 1. adjust for minute of angle 2. adjust for gravity effect 3. sight-weapon alinement	Evaluator by recording the shot group and observing or recording the firer's behaviors.	High	N/A	---	N/A	---
B. Load 1. inspect magazine top round alinement 2. apply proper intensity blow to seat magazine 3. insure the first round is seated in the chamber	Evaluator by verification (i.e., Go-No-Go) or performance checklist.	High	Evaluator by verification or performance checklist. Measurement on B-2 only.	High	Evaluator by verification or performance checklist. Measurement on B-2 only.	High
II. Maintain operation A. Reload 1. remove the magazine 2. 'see load'	Evaluator by verification.	High	Evaluator by verification.	High	Evaluator by verification.	High
B. Reduce a stoppage 1. perform immediate action procedure 2. inspect an M-16 and diagnose the stoppage 3. take the appropriate action for reducing a stoppage	Evaluator by verification or performance checklist.	High	Immediate action only. Evaluator by verification.	High	Immediate action only. Evaluator by verification.	High

[2]Dependability ratings for human evaluators assume ideal conditions.

Table 4-8 (Cont'd)

PERFORMANCE	Device: RF Method	RF Dependability	WP Method	WP Dependability	SWAT Method	SWAT Dependability
III. Operate						
A. Man-machine Interface (M-MI) 1. trigger control (squeeze) 2. grip on weapon 3. breath control 4. relax 5. compensate for recoil 6. change firing mode 7. stock weld (if applicable) 8. firing elbow (if applicable)	Evaluator by verification or performance checklist	Moderate	Evaluator by verification or performance checklist. Machine has some capability to assist evaluator verification of some sub-performances.	High	Evaluator by verification or performance checklist.	Moderat
B. Marksmanship						
1. compensate for range	Evaluator by recording firer's score at various target ranges	High	Limited, but same procedure as RF except that machine can assist in scoring.	High	N/A	---
2. compensate for wind	Evaluator by observing firer's behavior and score on windy days. Inference.	Low	N/A	---	N/A	---
3. compensate for target movement	N/A	---	N/A	---	Machine record of firer's score on scenarios involving moving targets.	High
4. transfer of fire	Evaluator by observing firer's behavior and noting score.	Moderate	Same as RF	Moderate	Same as RF	Modera

Table 4-8 (Cont'd)

PERFORMANCE	RF Method	RF Dependability	WP Method	WP Dependability	SWAT Method	SWAT Dependability
III. Operate (cont'd)						
B. Marksmanship (cont'd)						
5. obtain a proper sight picture (aimed fire only)	Evaluator verification using M16 sighting device.	High	Evaluator verification using M16 sighting device. Machine also presents video display cf firer's aim point.	Very High	Machine presents video display of aim point. Sight picture verified by inference.	Moderat
6. obtain a proper aiming point (aimed fire only)	Verification of firer's hit distribution on target.	Low	Machine video display of aim points and round strike points.	Very High	Video display of aim point and round strike points.	Very High
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	Observer verification of technique. Subjective judgment.	Low	N/A	---	Observer verification of technique. Subjective judgment.	Very Low
8. aimed fire from: a. prone b. sitting c. squatting d. kneeling e. standing f. foxhole supported g. foxhole unsupported	Recording firer's score by position and composite. Assessed only in prone and foxhole supported position.	High	Machine recording of firer's scores by position.	Very High	Same as WP	Very High
9. pointed fire from: a. standing b. crouching c. moving	Recording firer's score by position and composite. Currently not assessed.	Moderate	N/A	---	Machine recording of firer's score by position. Firer movement not possible.	Moderat

Table 4-8 (Cont'd)

	Device					
	RF		WP		SWAT	
PERFORMANCE	Method	Dependability	Method	Dependability	Method	Dependabilit
IV. Engage						
A. Detect and identify targets	N/A	---	N/A	---	Record of number of friendly targets hit. Reports only hits, not misses.	Modera
B. Assault	N/A	---	N/A	---	N/A	---
C. Defense	N/A	---	N/A	---	Machine scoring of firer's score under defensive scenario.	Modera
D. Patrol operation	N/A	---	N/A	---	N/A	---
E. Ammunition rationing	N/A	---	N/A	---	N/A	---
F. Threat evaluation	N/A	---	N/A	---	N/A	---
G. Concealment	N/A	---	N/A	---	N/A	---
V. Team Fire	N/A	---	N/A	---	Partial measurement. Machine record of hits/misses/passes of team.	Low

Worth Dimension	1/58 Infantry	USAIS DTD	Combined
Readiness Evaluation	.80	.83	.815
Training Management	.20	.17	.185

The judged importance weights were quite consistent across the two groups of raters.

After assigning importance weights to the WDs, each group next assigned utility ratings to operational OMs nested within WDs. Each of the groups was assigned to rate one set of OMs: personnel from 1/58 Infantry rated the measures nested under Operational Readiness; the USAIS DTD participants rated the measures nested under Training Management.

The final utility ratings for Readiness Evaluation are presented in Table 4-9. Similar results for the measures nested under Training Management are listed in Table 4-10.

Generate Systems-Versus-Criteria Array

Following the generation of importance weights for WDs and utility scores for OMs nested within WDs, the next phase in MAUM-CIEA involved generating the systems-versus-criteria array. In CIEA, the systems-versus-criteria array is a matrix that presents each alternative and its associated evaluation criteria--Information Utility, Relative Information Utility, Information Cost, Relative Information Cost, and Relative Information Worth.

Developing the systems-versus-criteria array was a five step procedure, with the steps listed as follows:

1. Obtain System Effectiveness Ratings
2. Determine Partial Utilities for WDs
3. Aggregate Partial Utility Scores
4. Estimate Costs of Alternatives
5. Determine Relative Information Worth

Each of these steps is discussed in the following paragraphs.

Obtain Systems Effectiveness Ratings. Within the context of CIEA, system effectiveness is defined as the degree to which an alternative provides timely, quality information on the performances relevant to the DORAC implementation. Specifying system effectiveness was carried out in three substeps: First, information *quality* ratings were obtained for each device/device combination (d/dc) on each OM. Next, each d/dc was evaluated with respect to the utility of the *frequency* with which performance data are provided. Finally, the quality ratings and frequency utility scores were combined to produce a single measure of the *effectiveness* of each d/dc on each OM nested within each WD.

Table 4-9

Utility Ratings for Information Measures Nested Under Readiness Evaluation

I. Condition to operate	
A. Calibrate (zero)	.0265
B. Load	.0305
II. Maintain operation	
A. Reload	.0287
B. Reduce a stoppage	.0269
III. Operate	
A. Aimed fire from:	
1. prone	.0896
2. sitting	.0108
3. squatting	.0086
4. kneeling	.0090
5. standing	.0262
6. foxhole supported	.0802
7. foxhole unsupported	.0806
B. Pointed fire from:	
1. standing	.0179
2. crouching	.0609
3. moving	.0627
IV. Engage	
A. Detect and identify targets	.1075
B. Assault	.0717
C. Defense	.0860
D. Patrol	.0538
E. Ammunition rationing	.0079
F. Threat evaluation	.0358
G. Concealment	.0082
V. Team fire	.0699

Table 4-10

Utility Ratings for Information Measures
Nested Under Training Management

I. Condition to operate (zero)	
A. Calibration (zero)	
1. adjust for minute of angle	.0034
2. adjust for gravity effect	.0062
3. sight weapon alinement	.0103
B. Load	
1. inspect top round alinement	.0041
2. apply blow to seat magazine	.0027
3. insure the first round is seated in the chamber	.0027
II. Maintain operation	
A. Reload	
1. remove the magazine	.0025
2. see 'load'	
B. Reduce a stoppage	
1. perform immediate action procedure	.0027
2. inspect an M-16 and diagnose the stoppage	.0025
3. take the appropriate action for reducing a stoppage	.0025
III. Operate	
A. Man-machine interface	
1. trigger control	.0274
2. grip on weapon	.0024
3. breath control	.0077
4. relax	.0038
5. compensate for recoil	.0001
6. change firing mode	.0003
7. stock weld	.0024
8. firing elbow	.0022

Table 4-10 (Cont'd)

III.	Operate (Cont'd)	
	B. Marksmanship	
	1. compensate for range	.0069
	2. compensate for wind	.0052
	3. compensate for target movement	.0021
	4. transfer of fire	.0007
	5. obtain a proper sight picture (aimed fire)	.0048
	6. obtain a proper aiming point (aimed fire)	.0005
	7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	.0002
	8. aimed fire from:	
	a. prone	.0110
	b. sitting	.0080
	c. squatting	.0008
	d. kneeling	.0082
	e. standing	.0016
	f. foxhole supported	.0165
	g. foxhole unsupported	.0137
	9. pointed fire from:	
	a. standing	.0004
	b. crouching	.0013
	c. moving	.0021
IV.	Engage	
	A. Detect and identify targets	.0096
	B. Assault	.2469
	C. Defense	.2743
	D. Patrol operation	.0007
	E. Ammunition rationing	.0026
	F. Threat evaluation	.0055
	G. Concealment	.0023
V.	Team fire	.2880

Information quality is defined as the extent to which a d/dc provides *trustworthy* information relevant to a particular OM. Also considered as part of information quality was the amount of information provided; that is, the number of relevant performance conditions that are addressed by a d/dc. In the demonstration CIEA, information quality ratings were obtained using the procedure outlined as follows:

1. Order the d/dcs from "best" to "worst" according to the degree to which each is capable of providing quality information relevant to the OM under consideration. Raters were instructed to consider the following characteristics in making quality judgments:

   a. Amount of information. The number of relevant performance conditions addressed.

   b. Dependability. The judged trustworthiness of the data. This was obtained from the dependability ratings made previously (i.e., Table 4-8).

   Ties were permitted. If one or more of the alternatives were judged equivalent in terms of the quality of the information they provided, they were assigned the same rank.

2. Numerically position the best and worst d/dcs on a 0-to-100 scale. The following benchmark ratings were used as a guide:

   0 - The d/dc provides no data relevant to the OM under consideration.

   25 - Marginal. The d/dc provides partial data on the OM and the data are likely to be undependable (e.g., the recording/scoring method is poor resulting in low validity or low reliability).

   50 - Adequate. The d/dc provides the required data but some dependability problems are apparent. For example, the most appropriate recording/scoring method is not used or the data are likely to have only moderate reliability.

   75 - Good. The d/dc provides required data in an acceptable manner. Recording methods are acceptable; reliability is likely to be reasonably high.

100 - Excellent. The d/dc is the best possible, given the current technical state of the art. Recording methods are automated and precise; reliability is likely to be very high.

3. Position the remaining alternatives between the best and worst cases on the 0-to-100 scale. Again, the benchmark rating points presented previously were suggested as a guide.

Tables 4-11 and 4-12 present the d/dc Quality ratings for Readiness Evaluation and Training Management, respectively.

After information quality ratings had been assigned to each d/dc on each OM, the next substep in obtaining effectiveness ratings was to determine the utility of the evaluation frequency associated with each DORAC alternative. Frequency utility ratings were obtained by applying the following actions to each OM for each alternative:

1. Consider the frequency of the information provided by each alternative (e.g., quarterly, twice a year, yearly, etc.). Now, specifically considering the highest and lowest frequencies, rate the usefulness of receiving DORAC generated information with the frequencies indicated. Use a 0-to-100 scale in assigning the ratings.

2. Next, consider the remaining (i.e., intermediate) frequencies. Position the remaining frequencies between the extreme values (i.e., ratings for the highest and lowest frequencies) on the 0-to-100 scale.

The results of the frequency utility rating procedure are presented in Tables 4-13 and 4-14. Zero entries indicate that an alternative did not provide a vehicle for evaluating a given performance.

The final substep in the process of obtaining effectiveness ratings for alternatives was to combine the quality and frequency ratings into a single measure of system effectiveness. Quality and frequency were combined using the formula:

$$\varepsilon_{ijk} = [Q_{ijk} \times F_{ijk}]/100, \qquad (4\text{-}1)$$

where ε_{ijk} is the effectiveness of the i^{th} alternative on the k^{th} OM nested within the j^{th} WD,

Q_{ijk} is the Quality for the training devices comprising the i^{th} alternative on the k^{th} OM nested within the j^{th} WD (Tables 4-11 and 4-12),

and F_{ijk} is the utility of obtaining information on the k^{th} OM nested within the j^{th} WD with the frequency specified by the i^{th} alternative (Tables 4-13 and 4-14).

Table 4-11

Information Quality Ratings
for Training Devices and Device Combinations
on Readiness Evaluation

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Condition to operate						
A. Calibrate (zero)	75	0	0	75	75	75
B. Load	75	10	10	75	75	75
Maintain operation						
A. Reload	75	10	10	75	75	75
B. Reduce a stoppage	75	10	10	75	75	75
Operate						
A. Aimed fire from:						
1. prone	75	50	50	75	80	80
2. sitting	75	50	50	75	80	80
3. squatting	75	50	50	75	80	80
4. kneeling	75	50	50	75	80	80
5. standing	75	50	50	75	80	80
6. foxhole supported	75	50	50	75	80	80
7. foxhole unsupported	75	50	50	75	80	80
B. Pointed fire from:						
1. standing	0	0	50	0	50	50
2. crouching	0	0	50	0	50	50
3. moving	0	0	0	0	0	0
Engage						
A. Detect and identify targets	75	0	50	75	80	80
B. Assault	0	0	0	0	0	0
C. Defense	0	0	50	0	50	50

Table 4-11 (Cont'd)

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Engage (Cont'd)						
D. Patrol	0	0	0	0	0	0
E. Ammunition rationing	0	0	0	0	0	0
F. Threat evaluation	0	0	40	0	40	40
G. Concealment	0	0	0	0	0	0
Team fire	0	0	25	0	25	25

Table 4-12

Information Quality Ratings
for Training Devices and Device Combinations
on Training Management

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Condition to operate						
A. Calibrate (zero)						
1. adjust for minute of angle	100	0	0	100	100	100
2. adjust for gravity effect	100	0	0	100	100	100
3. sight weapon alinement	100	0	0	100	100	100
B. Load						
1. inspect top round alinement	100	0	90	100	100	100
2. apply blow to seat magazine	100	100	100	100	100	100
3. insure the first round is seated in the chamber	100	0	75	100	100	100
Maintain operation						
A. Reload						
1. remove the magazine	100	100	100	100	100	100
2. see 'load'	100	0	75	100	100	100
B. Reduce a stoppage						
1. perform immediate action procedure	100	25	90	100	100	100
2. inspect an M-16 and diagnose the stoppage	100	0	0	100	100	100
3. take the appropriate action for reducing a stoppage	100	0	0	100	100	100
Operate						
A. Man-machine interface						
1. trigger control	100	90	100	100	100	100

Table 4-12 (Cont'd)

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Operate (Cont'd)						
A. Man-machine interface (Cont'd)						
2. grip on weapon	100	90	100	100	100	100
3. breath control	100	100	90	100	100	100
4. relax	100	50	75	100	100	100
5. compensate for recoil	100	100	75	100	100	100
6. change firing mode	25	90	100	90	100	100
7. stock weld	100	75	90	100	100	100
8. firing elbow	100	75	90	100	100	100
B. Marksmanship						
1. compensate for range	90	50	0	90	90	90
2. compensate for wind	90	0	0	90	90	90
3. compensate for target movement	0	0	90	0	90	90
4. transfer of fire	90	50	100	90	100	100
5. obtain a proper sight picture (aimed fire)	100	90	100	100	100	100
6. obtain a proper aiming point (aimed fire)	90	80	100	90	100	100
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	60	0	0	60	60	60

Table 4-12 (Cont'd)

	Individual Devices			Device Combinations		
	RF	WP	SWAT	RF + WP	RF + SWAT	RF + WP + SWAT
Operate (Cont'd)						
B. Marksmanship (Cont'd)						
8. aimed fire from:						
a. standing	0	90	95	90	95	95
b. sitting	0	90	95	90	95	95
c. squatting	0	90	95	90	95	95
d. kneeling	0	90	95	90	95	95
e. prone	95	90	95	95	95	95
f. foxhole supported	95	90	0	95	95	95
g. foxhole unsupported	0	90	0	90	90	90
9. pointed fire from:						
a. standing	0	90	95	90	95	95
b. crouching	0	90	95	90	95	95
c. moving	0	0	25	0	25	25
Engage						
A. Detect and identify targets	10	5	90	10	90	90
B. Assault	0	0	0	0	0	0
C. Defense	10	10	50	10	50	50
D. Patrol operation	0	0	0	0	0	0
E. Ammunition rationing	0	0	75	0	0	75
F. Threat evaluation	0	0	80	0	0	80
G. Concealment	0	0	0	0	0	0
Team fire	0	0	90	0	90	90

Table 4-13

Frequency Utility Ratings for DORAC Alternatives on Readiness Evaluation

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Condition to operate										
A. Calibrate (zero)	75	80	85	0	75	75	0	75	75	75
B. Load	75	75	75	10	75	75	10	75	75	75
Maintain operation										
A. Reload	75	75	75	10	75	75	10	75	75	75
B. Reduce a stoppage	75	75	75	10	75	75	10	75	75	75
Operate										
A. Aimed fire from:										
1. prone	75	80	85	50	75	80	50	80	85	88
2. sitting	75	80	85	50	75	80	50	80	85	88
3. squatting	75	80	85	50	75	80	50	80	85	88
4. kneeling	75	80	85	50	75	80	50	80	85	88
5. standing	75	80	85	50	75	80	50	80	85	88
6. foxhole supported	75	80	85	50	75	80	50	80	85	88
7. foxhole unsupported	75	80	85	50	75	80	50	80	85	88
B. Pointed fire from:										
1. standing	0	0	0	0	0	0	50	50	60	50
2. crouching	0	0	0	0	0	0	50	50	60	50
3. moving	0	0	0	0	0	0	0	0	0	0
Engage										
A. Detect and identify targets	75	80	85	0	75	75	50	80	85	82
B. Assault	0	0	0	0	0	0	0	0	0	0

Table 4-13 (Cont'd)

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Engage (Cont'd)										
C. Defense	0	0	0	0	0	0	50	50	60	50
D. Patrol	0	0	0	0	0	0	0	0	0	0
E. Ammuni _on rationing	0	0	0	0	0	0	40	40	50	40
G. Concealment	0	0	0	0	0	0	25	25	40	25
Team fire	0	0	0	0	0	0	25	25	40	24

Table 4-14

Frequency Utility Ratings for DORAC Alternatives
on Training Management

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Condition to operate										
A. Calibrate (zero)										
1. adjust for minute of angle	50	75	90	0	50	50	0	50	50	80
2. adjust for gravity effect	50	75	90	0	50	50	0	50	50	80
3. sight weapon alinement	50	75	90	0	50	50	0	50	50	80
B. Load										
1. inspect top round alinement	75	90	98	0	75	75	75	85	98	90
2. apply blow to seat magazine	75	90	100	100	90	90	100	90	100	100
3. insure the first round is seated in the chamber	75	90	100	0	75	75	75	90	100	95
Maintain operation										
A. Reload										
1. remove the magazine	75	90	100	0	90	90	100	90	100	100
2. see 'load'										
B. Reduce a stoppage										
1. perform immediate action procedure	35	70	90	30	40	50	35	70	75	70
2. inspect an M-16 and diagnose the stoppage	50	75	90	0	50	50	0	50	50	80
3. take the appropriate action for reducing a stoppage	50	75	90	0	50	50	0	50	50	80

Table 4-14 (Cont'd)

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Operate										
A. Man-machine interface										
1. trigger control	50	70	85	58	70	95	35	50	60	80
2. grip on weapon	60	85	95	60	85	95	60	85	95	95
3. breath control	55	75	90	59	75	95	50	70	80	90
4. relax	75	90	100	65	90	100	65	90	90	95
5. compensate for recoil	100	100	100	100	100	100	100	100	100	100
6. change firing mode	50	50	50	60	60	80	60	60	75	75
7. stock weld	80	90	95	80	90	90	70	90	90	95
8. firing elbow	80	90	95	80	90	90	70	90	90	95
B. Marksmanship										
1. compensate for range	60	75	90	50	65	70	0	60	60	75
2. compensate for wind	50	70	80	0	50	50	0	50	50	50
3. compensate for target movement	0	0	0	0	0	0	50	50	75	55
4. transfer of fire	60	80	90	50	60	70	70	75	95	80
5. obtain a proper sight picture (aimed fire)	75	90	98	75	90	95	75	90	95	98
6. obtain a proper aiming point (aimed fire)	70	85	90	70	85	90	75	85	90	95

Table 4-14 (Cont'd)

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Operate (Cont'd)										
B. Marksmanship (Cont'd)										
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	50	70	85	0	50	50	0	50	50	70
8. aimed fire from:										
a. standing	0	0	0	30	30	70	50	50	75	90
b. sitting	0	0	0	30	30	70	50	50	75	90
c. squatting	0	0	0	30	30	70	50	50	75	90
d. kneeling	0	0	0	30	30	70	50	50	75	90
e. prone	50	70	95	58	70	85	35	50	60	80
f. foxhole supported	50	70	95	58	70	85	0	50	60	80
g. foxhole unsupported	0	0	0	58	70	95	0	50	60	80
9. pointed fire from:										
a. standing	0	0	0	30	30	70	50	50	75	80
b. crouching	0	0	0	30	30	70	50	50	75	80
c. moving	0	0	0	0	0	0	20	20	20	20
Engage										
A. Detect and identify	15	30	50	5	20	20	30	30	75	55
B. Assault	0	0	0	0	0	0	0	0	0	0

Table 4-14 (Cont'd)

	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Engage (Cont'd)										
C. Defense	10	10	10	10	10	10	30	30	50	30
D. Patrol operation	0	0	0	0	0	0	0	0	0	0
E. Ammunition rationing	0	0	0	15	15	15	25	25	60	35
F. Threat evaluation	0	0	0	0	0	0	15	15	50	30
G. Concealment	0	0	0	0	0	0	0	0	0	0
Team fire	0	0	0	0	0	0	25	25	60	32

For example, the Effectiveness score of "calibrate (zero)" for alternative one, RF, on Readiness Evaluation was given by:

$$\varepsilon_{111} = (75)(75)/100 = 56.25 \quad (4\text{-}2)$$

Effectiveness ratings for the DORAC alternatives on the two WDs are presented in Tables 4-15 and 4-16.

Determine Partial Utilities for WDs. Following the generation of the systems effectiveness array, the next step in the analysis was to produce partial utility scores for each alternative on each WD. The general form of the equation used to aggregate effectiveness ratings across OMs is given in (4-3):

$$f[u(x_{ij})] = \sum_k u_{jk}\, \varepsilon_{ijk} \quad (4\text{-}3)$$

where $f[\cdot]$ is the partial information utility score of the i^{th} alternative on the j^{th} WD,

u_{jk} is the utility score of the k^{th} OM nested in the j^{th} WD (Tables 4-9 and 4-10),

and ε_{ijk} is the effectiveness rating of the i^{th} DORAC alternative on the k^{th} OM nested within the j^{th} WD (Tables 4-15 and 4-16).

Table 4-17 presents the partial information utility (IU) scores of each of DORAC alternatives on the two WDs, Readiness Evaluation (RE) and Training Management (TM).

Aggregate Partial Utility Scores. The final step in generating the systems-versus-criteria array was to aggregate partial IU scores across WDs to produce a global IU score for each alternative. The expression used to obtain global IU scores is presented as follows:

$$IU_i = \sum_j W_j f[u(x_{ij})], \quad (4\text{-}4)$$

where IU_i represents the global IU score for the i^{th} DORAC alternative,

W_j is the importance weight for the j^{th} WD (page 4-27),

and $f[\cdot]$ is the partial IU score of the i^{th} alternative on the j^{th} WD (Table 4-17).

Table 4-15

Effectiveness Ratings of DORAC Alternatives for Readiness Evaluation

	Alternative									
	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Condition to operate										
A. Calibrate (zero)	56.25	60	63.75	0	56.25	56.25	0	56.25	56.25	56.25
B. Load	56.25	56.25	56.25	1	56.25	56.25	1	56.25	56.25	56.25
Maintain operation										
A. Reload	56.25	56.25	56.25	1	56.25	56.25	1	56.25	56.25	56.25
B. Reduce a stoppage	56.25	56.25	56.25	1	56.25	56.25	1	56.25	56.25	56.25
Operate										
A. Aimed fire from:										
1. prone	56.25	60	63.75	25	56.25	60	25	64	68	70.4
2. sitting	56.25	60	63.75	25	56.25	60	25	64	68	70.4
3. squatting	56.25	60	63.75	25	56.25	60	25	64	68	70.4
4. kneeling	56.25	60	63.75	25	56.25	60	25	64	68	70.4
5. standing	56.25	60	63.75	25	56.25	60	25	64	68	70.4
6. foxhole supported	56.25	60	63.75	25	56.25	60	25	64	68	70.4
7. foxhole unsupported	56.25	60	63.75	25	56.25	60	25	64	68	70.4
B. Pointed fire from:										
1. standing	0	0	0	0	0	0	25	25	30	25
2. crouching	0	0	0	0	0	0	25	25	30	25
3. moving	0	0	0	0	0	0	0	0	0	0

Table 4-15 (Cont'd)

	Alternative									
	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Engage										
A. Detect and identify targets	56.25	60	63.75	0	56.25	56.25	25	64	68	65.6
B. Assault	0	0	0	0	0	0	0	0	0	0
C. Defense	0	0	0	0	0	0	25	25	30	25
D. Patrol	0	0	0	0	0	0	0	0	0	0
E. Ammunition rationing	0	0	0	0	0	0	0	0	0	0
F. Threat evaluation	0	0	0	0	0	0	16	16	20	16
G. Concealment	0	0	0	0	0	0	0	0	0	0
Team fire	0	0	0	0	0	0	6.25	6.25	10	6.25

Table 4-16

Effectiveness Ratings of DORAC Alternatives for Training Management

	Alternative									
Condition to operate	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
A. Calibrate (zero)										
1. adjust for minute of angle	50	75	90	0	50	50	0	50	50	80
2. adjust for gravity effect	50	75	90	0	50	50	0	50	50	80
3. sight weapon alinement	50	75	90	0	50	50	0	50	50	80
B. Load										
1. inspect top round alinement	75	90	98	0	75	75	6.75	85	98	90
2. apply blow to seat magazine	75	90	100	100	90	90	100	90	100	100
3. insure the first round is seated in the chamber	75	90	100	0	75	75	56.25	90	100	95
Maintain operation										
A. Reload										
1. remove the magazine	75	90	100	0	90	90	100	90	100	100
2. see 'load'										
B. Reduce a stoppage										
1. perform immediate action procedure	35	70	90	7.5	40	50	31.5	70	75	70

Table 4-16 (Cont'd)

	Alternative									
	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Maintain operation (Cont'd)										
B. Reduce a stoppage (Cont'd)										
2. inspect an M-16 and diagnose the stoppage	50	75	90	0	50	50	0	50	50	80
3. take the appropriate action for reducing a stoppage	50	75	90	0	50	50	0	50	50	80
Operate										
A. Man-machine interface										
1. trigger control	50	70	85	58	70	95	31.5	50	60	80
2. grip on weapon	60	85	95	60	85	95	54	85	95	95
3. breath control	55	75	90	59	75	95	45	70	80	90
4. relax	75	90	100	32.5	90	100	48.75	90	90	95
5. compensate for recoil	100	100	100	100	100	100	75	100	100	100
6. change firing mode	12.5	12.5	12.5	54	54	72	60	60	75	75
7. stock weld	80	90	95	60	90	90	63	90	90	95
8. firing elbow	80	90	95	60	90	90	63	90	90	95

Table 4-16 (Cont'd)

	Alternative									
	RF(1)	RF(2)	RF(4)	WP(1)	PF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Operate (Cont'd)										
B. Marksmanship										
1. compensate for range	54	67.5	81	25	58.5	63	0	54	54	67.5
2. compensate for wind	45	63	72	0	45	45	0	45	45	45
3. compensate for target movement	0	0	0	0	0	0	45	45	67.5	49.5
4. transfer of fire	54	72	81	25	54	63	70	75	95	80
5. obtain a proper sight picture (aimed fire)	75	90	98	67.5	90	95	75	90	95	98
6. obtain a proper aiming point (aimed fire)	63	76.5	81	56	76.5	81	75	85	90	95
7. estimate an adequate weapon aspect, round impact point relationship (pointed fire)	30	42	51	0	30	30	0	30	30	42
8. aimed fire from:										
a. standing	0	0	0	27	27	63	47.5	47.5	71.25	85.5
b. sitting	0	0	0	27	27	63	47.5	47.5	71.25	85.5
c. squatting	0	0	0	27	27	63	47.5	47.5	71.25	85.5

Table 4-16 (Cont'd)

	Alternative									
	RF(1)	RF(2)	RF(4)	WP(1)	RF(1) + WP(1)	RF(1) + WP(3)	SWAT(1)	RF(1) + SWAT(1)	RF(1) + SWAT(3)	RF + WP + SWAT
Operate (Cont'd)										
B. Marksmanship (Cont'd)										
8. aimed fire from: (Cont'd)										
d. kneeling	0	0	0	27	27	63	47.5	47.5	71.25	85.5
e. prone	47.5	66.5	90.25	52.2	66.5	80.75	33.25	47.5	57	76
f. foxhole supported	47.5	66.5	90.25	52.2	66.5	80.75	0	47.5	57	76
g. foxhole unsupported	0	0	0	52.2	63	75.5	0	45	54	72
9. pointed fire from:										
a. standing	0	0	0	27	27	63	47.5	47.5	71.25	76
b. crouching	0	0	0	27	27	63	47.5	47.5	71.25	76
c. moving	0	0	0	0	0	0	5	5	5	5
Engage										
A. Detect and identify	1.5	3	5	.25	2	2	27	27	67.5	49.5
B. Assault	0	0	0	0	0	0	0	0	0	0
C. Defense	1	1	1	1	1	1	15	15	25	15
D. Patrol operation	0	0	0	0	0	0	0	0	0	0
E. Ammunition rationing	0	0	0	0	0	0	18.75	0	0	26.25
F. Threat evaluation	0	0	0	0	0	0	12	0	0	24
G. Concealment	0	0	0	0	0	0	0	0	0	0
Team fire	0	0	0	0	0	0	22.5	22.5	54	28.8

Table 4-17

Partial Utility Scores for DORAC Alternatives

Alternative	Worth Dimension RE	TM
1. RF(1)	29.25	7.48
2. RF(2)	30.90	10.06
3. RF(4)	32.47	12.07
4. WP(1)	7.71	6.42
5. RF(1) + WP(1)	29.25	10.50
6. RF(1) + WP(3)	30.40	12.93
7. SWAT(1)	15.52	15.72
8. RF(1) + SWAT(1)	37.58	20.34
9. RF(1) + SWAT(3)	40.46	34.08
10. RF + WP + SWAT	39.70	26.05

The global IU scores for each of the ten DORAC alternatives used in the demonstration CIEA are presented in Table 4-18.

Table 4-18

Information Utility Scores for DORAC Alternatives

Alternative	IU Score
1. RF(1)	25.23
2. RF(2)	27.05
3. RF(4)	28.70
4. WP(1)	7.47
5. RF(1) + WP(1)	25.79
6. RF(1) + WP(3)	27.17
7. SWAT(1)	15.56
8. RF(1) + SWAT(1)	34.39
9. RF(1) + SWAT(3)	39.28
10. RF + WP + SWAT	37.18

Estimate Costs of Alternatives. The next-to-the-last step in defining the systems-versus-criteria array involved estimating the cost of each DORAC alternative. Cost estimates for each of the demonstration DORAC alternatives are presented in Table 4-19. The cost estimates were obtained usin the DORAC Costing Guidelines presented in Hawley and Dawdy (1981). Estimates are based on the resources required to accommodate a standard evaluation unit (i.e., Ft. Bliss, TX) using each of the DORAC alternatives.[3] Additional details on the costing process are provided in Appendix D.

Table 4-19

Total Estimated Costs for DORAC Alternatives

Alternative	Total Estimated Cost ($000's)
1. RF(1)	261.8
2. RF(2)	467.4
3. RF(4)	846.0
4. WP(1)	79.2
5. RF(1) + WP(1)	341.7
6. RF(1) + WP(3)	438.2
7. SWAT(1)	106.2
8. RF(1) + SWAT(1)	382.9
9. RF(1) + SWAT(3)	498.9
10. RF + WP + SWAT	651.9

Determine Relative Information Worth. Within the standard context of cost-effectiveness analysis (e.g., Barish & Kaplan, 1978; TRADOC Pam 11-8), Relative Information Worth (RIW) is obtained by determining Relative Information Utility (RIU) and Relative Information Cost (RIC) for each alternative and then combining them. RIU for alternative $\underline{i}$ (RIU_i) is determined by dividing the IU measure for alternative $\underline{i}$ (IU_i) by that of another, usually the baseline alternative:

$$RIU_i = IU_i/IU_b. \qquad (4-5)$$

[3] The cost estimates for alternatives involving training devices are based on a device density required to support only evaluation activities.

Relative Information Cost for alternative $\underline{i}$ (RIC_i) is determined in a similar fashion:

$$RIC_i = C_i/C_b, \tag{4-6}$$

where C_i is the estimated cost of the i^{th} alternative and C_b is the estimated cost of the baseline alternative.

Applying (4-5) and (4-6), RIU and RIC scores for the demonstration DORAC alternatives were obtained. The scores are presented in Table 4-20. Ranks for each of the alternatives are also provided.

Table 4-20

Relative Information Utility and Relative Information Cost for DORAC Alternatives

Alternative	RIU	Rank	RIC	Rank
1. RF(1)	1.00	8	1.00	3
2. RF(2)	1.07	6	1.79	7
3. RF(4)	1.14	4	3.23	10
4. WP(1)	0.30	10	0.30	1
5. RF(1) + WP(1)	1.02	7	1.31	4
6. RF(1) + WP(3)	1.08	5	1.67	6
7. SWAT(1)	0.62	9	0.41	2
8. RF(1) + SWAT(1)	1.36	3	1.46	5
9. RF(1) + SWAT(3)	1.56	1	1.91	8
10. RF + WP + SWAT	1.47	2	2.49	9

RIU and RIC are descriptively useful, but have limited value in the context of an analysis like CIEA where the objective is to identify the most cost-effective DORAC alternative. To determine a preferred capability, RIU and RIC were integrated into a measure of Relative Information Worth (RIW) for each alternative. The RIW of the i^{th} alternative (RIW_i) was defined as follows:

$$RIW_i = RIU_i/RIC_i = \frac{IU_i/IU_b}{C_i/C_b}. \tag{4-7}$$

An RIW score greater than one indicates that alternative i is more cost and information effective than the baseline alternative. What is done, in effect, is to normalize system cost and information utility relationships, with the baseline alternative assigned a unit value. Table 4-21 presents the RIW scores for each of the demonstration DORAC alternatives.

Table 4-21

Relative Information Worth Scores
for DORAC Alternatives

Alternative	RIW	Rank
1. RF(1)	1.00	2.5 (tie)
2. RF(2)	0.60	8
3. RF(4)	0.35	10
4. WP(1)	1.00	2.5 (tie)
5. RF(1) + WP(1)	0.78	6
6. RF(1) + WP(3)	0.65	7
7. SWAT(1)	1.51	1
8. RF(1) + SWAT(1)	0.93	4
9. RF(1) + SWAT(3)	0.82	5
10. RF + WP + SWAT	0.59	9

As a final step in Phase 6, all of the system evaluation criteria were assembled into a formal systems-versus-criteria array. In this array, the rows represent DORAC alternatives and the columns represent the various system evaluation criteria (e.g., IU, RIU, IC, RIC, and RIW). Table 4-22 presents the summary systems-versus-criteria array for the demonstration DORAC alternatives:

Table 4-22

Systems-Versus-Criteria Array for DORAC Alternatives

Alternative	IU	RIU	IC	RIC	RIW
1. RF(1)	25.23	1.00	261.8	1.00	1.00
2. RF(2)	27.05	1.07	467.4	1.79	0.60
3. RF(4)	28.70	1.14	846.0	3.23	0.35
4. WP(1)	7.47	0.30	79.2	0.30	1.00
5. RF(1) + WP(1)	25.79	1.02	341.7	1.31	0.78
6. RF(1) + WP(3)	27.17	1.08	438.2	1.67	0.65
7. SWAT(1)	15.56	0.62	106.2	0.41	1.51
8. RF(1) + SWAT(1)	34.39	1.36	382.9	1.46	0.93
9. RF(1) + SWAT(3)	39.28	1.56	498.9	1.91	0.82
10. RF + WP + SWAT	37.18	1.47	651.9	2.49	0.59

Perform Sensitivity Analyses

It is likely that many of the values used in CIEA to specify IU or system cost will be based upon assumption, expert opinion, or incomplete data and thus be of unknown validity. Sensitivity analysis refers to an investigation of the effects on system evaluation criteria of estimated parameters taking on values different from those used in the analysis (Shannon, 1975). Such analyses usually consist of systematically varying the values of selected decision variables over a range of interest and observing the effects of these changes on system evaluation criteria.

Sensitivity analysis can indicate the robustness of the results of a CIEA. It is desirable to determine how far off certain parameter estimates can be without changing the basic conclusions of the analysis. If the results are insensitive to a fairly wide range of changes in selected parameters, then excessive concern need not be given to the accuracy of these parameters. On the other hand, if the results prove to be highly dependent on the values of certain parameters, it might be prudent to expend additional resources and obtain more precise estimates for the parameters in question.

In CIEA, one candidate for sensitivity investigation is the effect of estimated system cost on the selection of a preferred alternative. The first step in the conduct of a cost sensitivity analysis is to establish the cost range over which the top-rated alternative is preferred; that is, to determine the cost estimate that would make the top-rated alternative no longer preferred. Then determine a pessimistic (i.e., highest) cost estimate for the preferred alternative. The pessimistic cost estimate can be obtained by reverting to the cost determination portion of the CIEA and using pessimistic instead of expected values in the cost analysis. Next, compare the pessimistic cost estimate with the upper bound of the cost range where the top-rated alternative is preferred. If the pessimistic cost estimate is below the upper cost bound, the top-rated alternative is still preferred. However, if the pessimistic cost estimate is above the upper cost bound, then the highest rated DORAC alternatives should be examined in greater detail before selecting a preferred capability.

To illustrate the cost sensitivity analysis procedure, consider the top-rated demonstration DORAC alternative from Table 4-22. Alternative 7, SWAT one time per year, has an RIU score of 0.62, an RIC score of 0.41, and a resulting RIW score of 1.51. The second rated alternatives, 1 and 4, both have RIW scores of 1.00. Following the procedure outlined in the previous paragraph, the RIC value for alternative 7 would have to exceed 0.62 for 7's RIW score to be less than the scores of alternatives 1 and 4. That is, alternative 7's pessimistic cost estimate would have to exceed \$261,800 x 0.62 = \$162,316 before the results of the analysis would be reconsidered on the basis of cost sensitivity results alone.

Situations may also arise in which importance ratings for WDs, utility scores for OMs, or effectiveness ratings for DORAC alternatives are at issue; that is, varied opinions concerning the values of certain of these parameters are apparent or the potential impact of errors or misjudgments is of concern. One approach to resolving issues such as these is to conduct a sensitivity investigation generally referred to as parametric analysis. In a parametric analysis, the values of the parameters in question are systematically varied over a range of interest (e.g., the range dictated by different value structures). The effects of these variations on system selection criteria are observed. If the parametric analysis indicates that different parameter values reflecting different points of view result in changes in system rankings, then a decision must be made concerning which value structure is to dominate.

In the present demonstration CIEA, a parametric sensitivity investigation was not performed because no radically different value structures surfaced during the parameter elicitation sessions.

Select Preferred Alternative

The last phase in CIEA is to select a preferred DORAC alternative from among those under consideration. In many situations, the decision rule is simple: maximize RIW. This choice should be made after reviewing the results of appropriate sensitivity analyses.

If the RIW scores for a number of alternatives are virtually identical, an appropriate course of action might be to conclude that there are no differences among the top-rated alternatives. In such situations, the selection of a preferred DORAC alternative would then have to be made on the basis of additional analyses or on the basis of considered military judgment.

As a final note, a special selection case arises when one or more of the evaluation criteria (e.g., system cost or information utility) is subject to a constraint. For example, it will often be the case that there will be a maximum acceptable cost and a minimum allowable IU value. The rule to maximize RIW is easily adapted to situations involving maximum or minimum acceptable values for a given evaluation criterion. When such situations arise, simply eliminate alternatives that violate constraints, regardless of their overall RIW scores.

Using RIW alone as a basis for a decision concerning a preferred alternative should be done cautiously. The results of the demonstration CIEA illustrate exactly why: The top-rated alternative, SWAT one time per year, has an IU score of 15.56 and a cost of $106,200. It might be, for example, that this IU score would be judged too low. If that were the case, alternative 7 (and all rating below it on IU) should be dropped from consideration. The result of such a decision would be to designate alternative 1, RF, as the preferred alternative. In any event, the decision-making group should review both the RIU and IC results carefully and reject alternatives that exceed cost constraints or do not provide a sufficiently high value for IU.

Discussion

This section of the report has presented the results of a demonstration application of a preliminary methodology for the conduct of CIEA. The results of the application indicate that the preliminary methodology (MAUM-CIEA) is usable. Also, the DORAC implementation considered in the demonstration exercise (i.e., for the M16A1) was judged to have potential utility (as indexed by the IU scores of the alternatives).

A detailed discussion of the methodological issues underlying the application of MAUM-CIEA is presented in Hawley and Dawdy (1981). To summarize these results, the following points are noted:

1. MAUM-CIEA is valid if the assumption that IU can be used as a proxy measure for strict IW is found to be tenable.

2. Given point 1, DORAC evaluation using RIU and RIW is valid if the level of measurement for RIU is at least equal-interval.

The objective of this section is, however, to assess the feasibility of the *operational procedures* involved in applying MAUM-CIEA. During post-session discussions with the participants, most stated that they did not have a great deal of difficulty in making the required judgments. Several points relevant to improving the MAUM-CIEA elicitation process were noted. These points are listed as follows:

1. Training Management per se represented too broad a range of uses to be included as a single WD. TM should have been separated into smaller worth units, such as Basic Combat Training, Advanced Individual Training, Resident School, or Unit Training Management.

2. With respect to both Training Management and Readiness Evaluation, explicit provisions should be made for the consideration of factors such as personnel turnover, personnel aptitude levels, skill decay rates, and so forth. Issues such as these impact upon the utility of different types of information for different uses and the frequency with which information should be received.

3. The current manual MAUM elicitation procedure places an excessive load on users. The elicitation session leader must be trained in the use of the methodology; also, elicitation sessions are time-consuming and tedious. These points suggest that the acceptability of MAUM-CIEA would be greatly enhanced if the elicitation procedure were computer-aided.

SECTION 5

SUMMARY AND RECOMMENDATIONS

Summary

The objective of this report was to present the results of an analytical and empirical investigation of DORAC feasibility and utility. In developing the material, three separate issues impacting upon DORAC feasibility and utility were examined:

1. Acceptability
2. Technical Feasibility
3. Financial Feasibility

Important summary points relevant to each of these issues are presented as follows:

Acceptability

1. The Army's external training evaluation system (i.e., SQTs and ARTEPs) functions much as formally prescribed. Internal evaluation activities are, however, characterized as deficient. The primary areas of deficiency are a lack of: (1) standardization of evaluation procedures, and (2) objective performance standards.

2. Field personnel suggested a number of revisions to improve the TE system. Among the more frequently heard suggestions were the following:

   - More realism in evaluation.
   - Integrated evaluation procedures.
   - Standardized evaluation procedures.
   - Adherence to objective performance standards.

3. The expressed need for standardized evaluation procedures is exactly what DORAC provides. DORAC is intended to support the need for integrated evaluation procedures. Also, DORAC is not antithetical to the need for more realism in evaluation.

4. The idea of using training devices as a vehicle for the conduct of evaluation activities was not well received. Field personnel generally have a low opinion of the utility of training devices; this position resulted in the attitudes expressed. The results from ADA survey respondents and the reaction of the M16A1 CIEA participants indicated, however, that the use of training devices in evaluation can be made acceptable to field personnel if the concept is developed carefully.

5. In terms of DORAC concept acceptability, the issue was answered with a qualified "yes". Given appropriate planning and proper support, the DORAC concept can be sold to field personnel. The keyword is sold, however; DORAC will not be accepted without some amount of resistance.

Technical Feasibility

The DORAC concept is technically feasible. A large number of training devices having proficiency assessment potential (although not explicit) currently exist. The assessment potential of projected training devices appears even more promising. The implementation of any DORAC will, however, require development of standardized evaluation procedures and performance standards prior to fielding. The development effort will require both analysis and empirical study. Also, for the development of a useful capability, a procedure for identifying the most critical job activities for assessment must be employed (i.e., CIEA). The apparent usability of the preliminary CIEA methodology is encouraging in this respect.

Financial Feasibility

If a DORAC is developed, it must be supported to a greater extent than is reportedly true for current training devices. It should be recognized that the resource committment required to effect the required level of support is potentially quite high. This point again underscores the necessity for a usable methodology for identifying the most cost-effective capability.

Recommendations for Maximum Payoff

An obvious question that arises from all of the previous discussion is: "Under what conditions is the maximum payoff from the implementation of the DORAC concept likely to occur?" Several comments relevant to this issue are presented as follows:

1. The DORAC concept should be implemented incrementally. To overcome potential field resistance to the use of training devices in evaluation, the initial application should be carefully selected so as to maximize the likelihood of a visible success. Additional applications should also be selected deliberately, always remembering that field personnel must accept the concept for it to be successfully implemented.

2. DORACs should be used to provide detailed data (down to the task element level) on performances inherent in materiel system use. End-result information (i.e., summary scores) should also be provided. In its initial form, the DORAC concept might not prove useful in assessing tactics, doctrinal adherence, or other more global performances.

3. When possible, DORAC systems should be designed to assess crew proficiency, as well as individual capabilities. Field personnel expressed a desire for *integrated* performance evaluation. Also, the successful application of the Air Defense system of quasi-DORACs (e.g., the AN/MPQ-T1 Nike Hercules simulator and the AN/TPQ-29 IHAWK simulator) speaks well for this point.

4. When fielded, DORAC systems should be designed to assess a unit's proficiency on its *primary* weapons system(s). For example, a small arms DORAC (e.g., one based on SWAT or Weaponeer) would likely be ill-received in an Armored unit, since a tank unit is authorized few small arms and does not *perceive* small arms proficiency as mission essential.

5. When possible, DORACs should be designed to be integrated into actual materiel system equipment, as in the Air Defense system of quasi-DORACs. This situation would tend to lessen the overall cost of acquiring a capability and also assist in overcoming user objections to the DORAC concept. DORAC then would not be so heavily identified with training devices.

6. DORAC obtained proficiency information should be included in the USR much as the personnel and equipment data are now. That is, guidelines for assigning the training rating should be provided. Current Air Force and Army aviation readiness resporting procedures follow a similar system. When tentative USR modifications have been established, they should not be implemented all at once. Rather, changes should be phased in thus allowing commanders time to establish what their actual proficiency levels are, and to use the information to re-orient their training programs in order to reach desired proficiency levels. In this manner, the DORAC might be perceived initially as a constructive aide rather than as a purely evaluation tool imposed on units from the outside.

Developmental Recommendations

The previous results are suggestive of a series of recommendations concerning the next developmental steps for the DORAC concept. These recommended steps are listed as follows:

1. Develop an initial DORAC test bed for training evaluation and proficiency assessment. Select the test bed where an adequate, accepted training device is available and in use. Expend the effort necessary to determine the most cost-effective DORAC; standardize evaluation procedures; and, where required, provide realistic performance standards.

2. Monitor and evaluate field reaction to the prototype DORAC. Assess what changes result from the receipt of DORAC data.

3. Introduce a modified USR reporting procedure. Assess user reactions to its use. Evaluate and document the effects (if any) on unit functioning of improved proficiency reporting.

4. Integrate all initial results and structure a trial DORAC field implementation concept.

5. Select an independent test bed unit and re-implement DORAC with a minimum of external interference. Monitor the situation and evaluate the results.

6. Make a decision regarding additional implementation of the DORAC concept. At this point, sufficient empirical data concerning the acceptability of the concept and its actual utility should be available to enable a rational decision to be made.

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APPENDIX A

DORAC INTERVIEW GUIDE

I. What kinds of formal training evaluation do you now do?

1. SQT:

   --external (define)
   --internal (define)

2. ARTEP:

   --external
   --internal

3. Other

4. How are training evaluation activities (internal and external) scheduled?

5. Job books?

II. How frequently do you conduct training evaluation?

1. SQT:

   --external
   --internal

2. ARTEP:

   --external
   --internal

3. Other:

III. Please describe your procedures for the conduct of each of the training evaluations that you do. (Complete the following for SQT, ARTEP, etc.)

1. What is prescribed?

2. Where do you obtain the required materials?

3. Administrative activities:

   --Who is responsible?
   --How many personnel are involved?
   --Where is it conducted?

4. Scoring procedures:

   --How established?
   --Who evaluates?

5. Accountability:

   --To higher HQ?
   --Within your unit?

6. What is done with the information:

   --Within your unit?
   --Outside your unit?

IV. We would now like to find out what resources (men, materiel, money) your unit uses in the conduct of training evaluation:

1. Preparation time?

2. Training/preparation for administration, scoring, and record keeping?

3. POL/ammunition/other expendable supplies?

4. Facilities and equipment?

5. Personnel:

   --Evaluators?
   --Testees?

6. Transportation?

7. Record keeping?

8. Coordination with other organizations (equipment, evaluators, etc.)?

9. Job books?

V. In your opinion, what are the major inadequacies in the present training evaluation system?

1. Does evaluation result in skills improvement?

2. Is training evaluation supported by higher HQ in terms of time, money, and materials?

3. Do you evaluate the skills that really need to be evaluated?

4. Are the results a valid characterization of individual/unit combat readiness?

5. Scheduling problems?

VI. In what ways do you think the Army's training evaluation system could be improved to better meet its intended objectives--provide feedback to the training system, characterize individual/unit proficiency?

VII. AR 220-1 states that unit commanders should consider SQT, ARTEP, and other formal training evaluation activities when formulating the training portion of the Unit Status Report (USR). How do you determine your unit's training readiness level for input into the USR?

VIII. It has been suggested that one method of improving the Army's training evaluation system is to increase the use of trainers (e.g., simulators, mock-ups, etc.) in skills evaluation.

1. Does your unit currently use such training equipment in formal training evaluation?

2. What is your opinion of using trainers in training evaluation?

3. In your unit, (where additionally) could trainers be used in evaluation? (elaborate on potential)

4. What about the inclusion of trainer-generated skills evaluation data in the training portion of your USR? (elaborate on potential and attitude)

APPENDIX B

DORAC QUESTIONNAIRE

STAFF LEVEL

Please answer the following questions. Put additional comments on the back of the page.

1. What kinds of formal training evaluation do you do now?

Type of evaluation	Yes or No	Frequency
SQT		
ARTEP		
ORE		
FTX		
CPX		
EDRE		
FIRING ARTEP		
ASP		
Other (list):		

2. How are formal training evaluation activities scheduled?

SQT:

ARTEP:

ORE:

FTX:

CPX:

EDRE:

FIRING ARTEP:

ASP:

OTHER:

3. Complete the following table for <u>formal</u> training evaluations (leave non-applicable squares blank).

Type of Evaluation	What is Prescribed?	Req'd materials obtained from:	Responsible Agency (S3, etc.):
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (list)			

3. (Continued)

Type of Evaluation	No. of Personnel Involved:	Location:	Evaluator:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (list)			

3. (Continued)

Type of Evaluation	Standards Set By:	Accountable to:	Evaluation Information Used to:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (list)			

4. What resources does your unit use in the conduct of formal training evaluation?

Type of Evaluation	Preparation Time	Training/Preparation for administration, scoring, record keeping	POL, ammunition, other expendables
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (List)			

4. (Continued)

Type of Evaluation	Facilities	Equipment	Evaluators
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (List)			

4. (Continued)

Type of Evaluation	Testers	Transportation	Record keeping
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (List)			

4. (Continued)

Type of Evaluation	Coordination with other units (eqpt., evaluators, etc.).	Job books	Other
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
FIRING ARTEP			
ASP			
Other (List)			

5. Indicate how formal training evaluation is supported by higher HQ.

	Time	Money	Materials	Personnel	Other
SQT					
ARTEP					
ORE					
FTX					
CPX					
EDRE					
FIRING ARTEP					
ASP					

Other

6. What kinds of internal (i.e., intraunit) training evaluation do you do now?

Type of Evaluation	Yes or No	Frequency
SQT		
ARTEP		
ORE		
FTX		
CPX		
EDRE		
Other (list):		

7. How are internal (i.e., intraunit) training evaluation activities scheduled?

SQT:

ARTEP:

ORE:

FTX:

CPX:

EDRE:

Other:

8. Complete the following table for internal (i.e., intraunit) training evaluations (leave non-applicable squares blank)

Type of Evaluation	What is Prescribed?	Req'd materials obtained from:	Responsible Agency (S3, etc.):
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

8. (Continued)

Type of Evaluation	No. of Personnel Involved:	Location:	Evaluator:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

8. (Continued)

Type of Evaluation	Standards Set By:	Accountable to:	Evaluation Information Used to:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

9. What resources does your unit use in the conduct of internal (i.e., intraunit) training evaluation?

Type of Evaluation	Preparation Time	Training/Preparation for administration, scoring, record keeping	POL, ammunition, other expendables
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

9. (Continued)

Type of Evaluation	Facilities	Equipment	Evaluators
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

9. (Continued)

Type of Evaluation	Testers	Transportation	Record keeping
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

9. (Continued)

Type of Evaluation	Coordination with other units (eqpt., evaluators, etc.).	Job books	Other
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			
Other (List)			

10. Indicate how informal training evaluation is supported by higher HQ.

	Time	Money	Materials	Personnel	Other
SQT					
ARTEP					
ORE					
FTX					
CPX					
EDRE					

Other

11. For what MOSs are sufficient job books not available?

12. List those training evaluations which you feel result in skills improvement. Indicate whether the evaluation is formal or internal.

13. Do you presently evaluate the skills that really need to be evaluated?

14. Which evaluation results yield a valid characterization of individual/unit combat readiness? Why?

15. What kinds of scheduling pro ms do you encounter?

16. Primary objectives of the Army's training evaluation system are to provide feedback to the training system and to characterize individual/unit proficiency. Briefly, how could the Army's training evaluation system be improved to better meet these objectives?

17. How do you determine your unit's readiness level for input into the USR?

18. It has been suggested that one method of improving the Army's training evaluation system is to increase the use of trainer (e.g., simulators, mockups, etc.) in skills evaluation. If your unit uses such devices in evaluation, fill out the following matrix.

Type of Trainer/ Simulator	Type of Evaluation	Formal or Informal Evaluation	Availability

19. Briefly, what is your opinion of using trainers or simulators in training evaluation?

20. In your unit, where could trainers or simulators be used in evaluation? Elaborate on the potential of using such devices.

21. For the training portion of your USR, could you use skills evaluation data which has been generated by trainers/simulators? How could you use such information, and what is your attitude concerning its use?

22. How do you conduct rifle training?

23. Could you use a simulator for this, if one was available?

APPENDIX C

DORAC QUESTIONNAIRE

COMPANY/BATTERY/TROOP

Please answer the following questions. Put additional comments on the back of the page.

1. What kinds of internal (i.e., intraunit) training evaluation do you do now?

Type of Evaluation	Yes or No	Frequency
SQT		
ARTEP		
ORE		
FTX		
CPX		
EDRE		
Other (list)		

2. How are internal (i.e., intraunit) training evaluation activities scheduled?

SQT:

ARTEP:

ORE:

FTX:

CPX:

EDRE:

Other:

3. Complete the following table for internal (i.e., intraunit) training evaluations (leave non-applicable squares blank):

Type of Evaluation	What is Prescribed?	Req'd materials obtained from:	Responsible Agency (S3, etc.):
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

3. (Continued)

Type of Evaluation	No. of Personnel Involved:	Location:	Evaluator:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

3. (Continued)

Type of Evaluation	Standards Set By:	Accountable to:	Evaluation Information Used to:
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

4. What resources does your unit use in the conduct of <u>internal</u> (i.e., intraunit) training evaluation?

Type of Evaluation	Preparation Time	Training/Preparation for administration, scoring, record keeping	POL, ammunition, other expendables
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

4. (Continued)

Type of Evaluation	Facilities	Equipment	Evaluators
SQT			
ARTEP			
ORE			
FTX			
CPX			
ORE			

Other
(List)

4. (Continued)

Type of Evaluation	Testers	Transportation	Record keeping
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

4. (Continued)

Type of Evaluation	Coordination with other units (eqpt., evaluators, etc.).	Job books	Other
SQT			
ARTEP			
ORE			
FTX			
CPX			
EDRE			

Other
(List)

5. Indicate how informal training evaluation is supported by higher HQ.

	Time	Money	Materials	Personnel	Other
SQT					
ARTEP					
ORE					
FTX					
CPX					
EDRE					

Other
(List)

6. For what MOSs are sufficient job books not available?

7. List those training evaluations which you feel result in skills improvement. Indicate whether the evaluation is formal or internal.

8. Do you presently evaluate the skills that really need to be evaluated?

9. Which evaluation results yield a valid characterization of individual/unit combat readiness? Why?

10. What kinds of scheduling problems do you encounter?

11. Primary objectives of the Army's training evaluation system are to provide feedback to the training system and to characterize individual/unit proficiency. Briefly, how could the Army's training evaluation system be improved to better meet these objectives?

12. It has been suggested that one method of improving the Army's training evaluation system is to increase the use of trainer (e.g., simulators, mockups, etc.) in skills evaluation. If your unit uses such devices in evaluation, fill out the following matrix.

Type of Trainer/ Simulator	Type of Evaluation	Formal or Informal Evaluation	Availability

13. Briefly, what is your opinion of using trainers or simulators in training evaluation?

14. In your unit, where could trainers or simulators be used in evaluation? Elaborate on the potential of using such devices.

15. For the training portion of your USR, could you use skills evaluation data which has been generated by trainers/simulators? How could you use such information, and what is your attitude concerning its use?

16. Indicate how formal training evaluation is supported by higher HQ.

	Time	Money	Materials	Personnel	Other
SQT					
ARTEP					
ORE					
FTX					
CPX					
EDRE					
FIRING ARTEP					
ASP					

Other

17. How do you conduct rifle training?

18. Could you use a simulator for this, if one was available?

APPENDIX D

Alternative Cost/Device (AC/D) = # of type device (NDR_i) X the Device Type Hardware Cost (HC_i)

$$NDR_i = \frac{\text{Adjusted Facility Load (AFL)}}{\text{Device Capability (DC)}}$$

AFL = Re-evaluations (RE) + Estimated Facility Load (EFL)

RE = Estimated % of lost evaluations X EFL

EFL = Base Facility Load (BFL) X Annual Evaluation Frequency (AEF)

BFL = Σ Organization; Evaluations (OE) or $\overline{OE}$ X # organizations

$$OE = \frac{\text{Evaluatees/Organization (E/O)}}{\text{Organization Evaluation Unit Size (OEUS)}}$$ (Rounded to next higher number)

E/O = Total # of Personnel w/i the Organization that the Evaluation is applicable to

OEUS = The evaluate group size organic to the organization that most closely matches, without exceeding, the Evaluation Cycle Size (ECS)

ECS = The number of evaluation positions that can be used simultaneously

AEF = The number of times each evaluatee must be evaluated annually with the device

DC = Estimated # of training days/year the device is operational ready for training (TDA) X Number of Evaluation Cycles/Day (EC/D)

$$TDA = \frac{\text{\# of Days Per Year Device Available}}{365} \text{ X \# of training days/year}$$

$$EC/D = \frac{\text{Work Segment Length (WSL) X \# Work Segments/Day (SN)}}{\text{Evaluation Cycle Length (ECL) + Time Between Cycles (TBC)}}$$

WSL = The length of time between work starts and stops during the work day

SN = the # of WSL/day

ECL = the average running time for an evaluation scenario

TBC = the time between evaluation cycles (orientation briefing, critique, and data collection)

Note: When a non-integer results from a calculation, round up.

$$HC_i = \frac{\text{Acquisition cost of device}_i\ \text{(ACD)}}{\varepsilon\ \text{yr}} + \text{Initial Cost of Maintenance Supplies (ICMS)} +$$

$$\text{Annual Maintenance Cost (AMC)} + \text{Expected end-item replacement/yr}$$

ADC = Direct Personnel Costs (DPC) + Personnel Training Cost (PTC) + Administrative Operating Costs (AOC) + Facilities Cost (FC)

DPC = Sum of (the estimated #, by proposed grade structure of Operators, Evaluators, Operations, and Maintenance Personnel X Cost/paygrade)/Facility Option

$$\text{PTC} = \frac{\text{Cost of initial training}}{\text{Expected \# years use } (\varepsilon\ \text{yr})} + \text{Expected Follow-on Training/Year / Facility Option}$$

AOC = Expendable Supplies (ExS) + Transportation Costs (TC)/Facility Option

ExS = data recording supplies + office supplies _ facilities supplies + equipment supplies + utilities + ammunition + targets

TC + Evaluatees + cadre

$$\text{FC} = \frac{\text{Total cost of Acquisition, Construction, Modification}}{\varepsilon\ \text{yr}} + \text{annual expected maintenance costs}$$

$$+ \text{utilities}$$

	$ AC/Yr	$ AC/D	NDR	AFL	RE	EFL	BFL	OE	E/O	OEUS	ECS	AEF	DC	TDA	EC/D	WSL
1	261.8	32.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 1/Yr	---	32.8	1	478	182	296	296	4	120	32	32	1	960	240	4	4
2	467.4	65.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 2/Yr	---	65.6	1	956	364	592	296	4	120	32	32	2	960	240	4	4
3	845.5	131.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 4/Yr	---	131.2	2	1912	728	1184	296	4	120	32	32	4	960	240	4	4
4	79.2	16.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WP 1/Yr	---	16.5	3	9324	444	8880	8880	120	120	1	1	1	3840	240	16	4
5	341.7	49.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 1/Yr	---	32.8	1	478	132	296	296	4	120	32	32	1	960	240	4	4
WP 1/Yr	---	16.5	3	9324	444	8880	8880	120	120	1	1	1	3840	240	16	4
6	438.2	76.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 1/Yr	---	32.8	1	478	182	296	296	4	120	32	32	1	960	240	4	4
WP 3/Yr	---	44.0	8	27972	1332	26640	8880	120	120	1	1	3	3840	240	16	4
7	106.2	43.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SWAT 1/Yr	---	43.5	3	2098	100	1998	1998	27	120	4.5	5	1	960	240	4	2
8	382.9	76.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 1/Yr	---	32.8	1	478	182	296	296	4	120	32	32	1	960	240	4	4
SWAT 1/Yr	---	43.5	3	2098	100	1998	1998	27	120	4.5	5	1	960	249	4	2
9	498.9	134.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 1/Yr	---	32.8	1	478	182	296	296	4	120	32	32	1	960	240	4	4
SWAT 3/Yr	---	161.5	7	6294	300	5994	1998	27	120	4.5	5	3	960	240	4	2
10	651.9	125.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RF 2/Yr	---	65.6	1	956	364	592	296	4	120	32	32	2	960	240	4	4
WP 1/Yr	---	16.5	3	9324	444	8880	8880	120	120	1	1	1	3840	240	16	4
SWAT 1/Yr	---	43.5	3	2098	100	1998	1998	27	120	4.5	5	1	960	240	4	2

Ex = Existing
N/A = Not available
OJT = On-the-job training

$ = given in 1,000's
Note: See D-2 & D-3 for explanation for top margin labels

	SN	ECL	TBC	HC $	ADC $	DPC $	PTC $	AOC $	ExS	TC $	FC	ACD	ICMS	AMC	EEIR
1	---	---	---	---	229	92.3	0	136.7	99.2	37.5	0	0	0	23.4	9.4
RF 1/Yr	2	1½	½	32.8	---	---	OJT	---	---	37.5	Ex	Ex	Ex	23.4	9.4
2	---	---	---	---	401.8	128.7	0	273.1	198.1	75	0	0	0	46.8	18.8
RF 2/Yr	2	1½	½	32.8	---	---	OJT	---	---	75	Ex	Ex	Ex	46.8	18.8
3	---	---	---	---	714.3	169.2	0	545.6	395.6	150	0	0	0	93.6	37.6
RF 4/Yr	2	1½	½	32.8	---	---	OJT	---	---	150	Ex	Ex	Ex	93.6	37.6
4	---	---	---	---	62.7	61.8	0	.9	.9	0	0	40	15	0	0
WP 1/Yr	2	1/3	1/6	5.5	---	---	N/A	---	---	0	Ex	40	15	N/A	N/A
5	---	---	---	---	292.4	155.1	0	137.3	99.8	37.5	0	40	15	23.4	9.4
RF 1/Yr	2	1½	½	32.8	---	---	OJT	---	---	37.5	Ex	Ex	Ex	23.4	9.4
WP 1/Yr	2	1/3	1/6	5.5	---	---	N/A	---	---	0	Ex	40	15	N/A	N/A
6	---	---	---	---	361.4	223.4	0	138.2	100.7	37.5	0	40	15	23.4	9.4
RF 1/Yr	2	1½	½	32.8	---	---	OJT	---	---	37.5	Ex	Ex	Ex	23.4	9.4
WP 3/Yr	2	1/3	1/6	5.5	---	---	N/A	---	---	0	Ex	40	15	N/A	N/A
7	---	---	---	---	62.7	61.8	0	.9	.9	0	0	125	20	23.4	9.4
SWAT 1/Yr	4	1½	½	14.5	---	---	N/A	---	---	0	Ex	Ex	Ex	23.4	9.4
8	---	---	---	---	306.6	169.6	0	137	99.5	37.5	0	125	20	N/A	N/A
RF 1/Yr	2	1½	½	32.8	---	---	OJT	---	---	37.5	Ex	Ex	Ex	23.4	9.4
SWAT 1/Yr	4	1½	½	14.5	---	---	N/A	---	---	0	Ex	125	20	N/A	N/A
9	---	---	---	---	364.6	226.4	0	138.2	100.7	37.5	0	125	20	23.4	9.4
RF 1/Yr	2	1½	½	32.8	---	---	OJT	---	---	37.5	Ex	Ex	Ex	23.4	9.4
SWAT 3/Yr	4	1½	½	14.5	---	---	N/A	---	---	0	Ex	125	20	N/A	N/A
10	---	---	---	---	526.3	252.3	0	27.4	199	75	0	165	35	23.4	9.4
RF 2/Yr	2	1½	½	32.8	---	---	OJT	---	---	75	Ex	Ex	Ex	23.4	9.4
WP 1/Yr	2	1/3	1/6	5.5	---	---	N/A	---	---	0	Ex	40	15	N/A	N/A
SWAT 1/Yr	4	1½	½	14.5	---	---	N/A	---	---	0	Ex	125	20	N/A	N/A

Number of Devices Required

Record Fire: Annual Evaluation Frequency of 1

AEF = 1
ECS = 32
OEUS = 32
E/O = 120 = $\bar{X}$
OE = $\frac{120}{32}$ = 3.75 → 4

# Organizations = 74
BFL = 74 X 4 = 296
EFL = 296 X 1 = 296
RE = 9% X 296 = 26.64 → 27
AFL = 27 + 296 = 323
ECL = 1½ hr.
TBC = ½ hr.
SN = 2
WSL = 2
EC/D = $\frac{4 \times 2}{1\frac{1}{2} = \frac{1}{2}}$ = $\frac{8}{2}$ = 4

TDA = $\frac{343}{360}$ X 240 = 228

DC = 228 X 4 = 912

NDR = $\frac{323}{912}$ = .354 → 1

Number of Devices Required

Record Fire: Annual Evaluation Frequency of 2

AEF = 2
ECS = 32
OEUS = 32
E/O = 120 = $\overline{X}$
OE = $\frac{120}{32}$ = 3.75 ⟶ 4

# Organizations = 74
BFL = 74 X 4 = 296
EFL = 296 X 2 = 592
RE = 9% X 592 = 53.28 ⟶ 54
AFL = 54 + 592 = 646
ECL = 1½ Hr.
TBC = ½ Hr.
SN = 2
WSL = 4
EC/D = $\frac{4 \times 2}{1\frac{1}{2} + \frac{1}{2}}$ = $\frac{8}{2}$ = 4

TDA = $\frac{343}{360}$ X 240 = 228

DC = 228 X 4 = 912

NDR = $\frac{646}{912}$ = .708 ⟶ 1

Number of Devices Required

Record Fire: Annual Evaluation Frequency of 4

AEF = 4
ECS = 32
OEUS = 32
E/O = 120 = $\overline{X}$
OE = $\frac{120}{32}$ = 3.75 ⟶ 4

# Organizations = 74
BFL = 74 X 4 = 296
EFL = 296 X 4 = 1184
RE = 9% X 1184 = 106.56 ⟶ 107
AFL = 107 + 1184 = 1291
ECL = $1\frac{1}{2}$ hr.
TBC = $\frac{1}{2}$ hr.
SN = 2
WSL = 4
EC/D = $\frac{4 \times 2}{1\frac{1}{2} + \frac{1}{2}} = \frac{8}{2} = 4$

TDA = $\frac{343}{360} \times 240 = 228$

DC = 228 X 4 = 912

NDR = $\frac{1291}{912}$ = 1.42 ⟶ 2

Number of Devices Required

Weaponeer: Annual Evaluation Frequency of 1

AEF = 1

ECS = 1

OEUS = 1

E/O = 120 = $\overline{X}$

OE = $\frac{120}{1}$ = 120

Organizations = 74

BFL = 74 X 120 = 8880

EFL = 8880 X 1

RE = 5% X 8880 = 444

AFL = 444 + 8880 = 9324

ECL = 1/3 hr.

TBC - 1/6 hr.

SN = 2

WSL = 4

EC/D = $\frac{4 \times 2}{1/3 + 1/6} = \frac{8}{\frac{1}{2}} = 16$

TDA = $\frac{365}{365} \times 240 = 240$

DC = 240 X 16 - 3840

NDR = $\frac{9324}{3840} = 2.428 \longrightarrow 3$

Number of Devices Required

Weaponeer: Annual Evaluation Frequency of 3

AEF = 3
ECS = 1
OEUS = 1
E/O = 120 = $\overline{X}$

$$OE = \frac{120}{1} = 120$$

\# Organizations = 74
BFL = 74 X 8880
EFL = 8880 X 3 = 26640
RE = 5% X 26640 = 1332
AFL = 1332 + 26640 + 27972
ECL = 1/3 hr.
TBC - 1/6 hr.
SN = 2
WSL = 4

$$EC/D = \frac{4 \times 2}{1/3 + 1/6} = \frac{8}{\frac{1}{2}} = 16$$

$$TDA = \frac{365}{365} \times 240 = 240$$

DC = 240 x 16 = 3840

$$NDR = \frac{27972}{3840} = 7.284 \longrightarrow 8$$

Number of Devices Required

SWAT: Annual Evaluation Frequency of 1

AEF = 1
ECS = 5
OEUS = 4.5
E/O = 120 = $\overline{X}$
OE = $\frac{120}{4.5}$ = 27

\# Organizations = 74
BFL = 74 X 27 = 1998
EFL = 1998 X 1 = 1998
RE = 5% X 1998 = 100
AFL = 100 + 1998 = 2098
ECL = 1½ hr.
TBC = ½ hr.
SN = 4
WSL = 2

EC/D = $\frac{2 \times 4}{1\frac{1}{2} + \frac{1}{2}} = \frac{8}{2} = 4$

TDA = $\frac{365}{365} \times 240 = 240$

DC = 240 X 4 = 960

NDR = $\frac{2098}{960} = 2.19 \longrightarrow 3$

Number of Devices Required

SWAT: Annual Evaluation Frequency of 3

AEF = 3
ECS = 5
OEUS = 4.5
E/O = 120 = $\overline{X}$
OE = $\frac{120}{45}$ = 27

\# Organizations = 74
BFL = 74 X 27 = 1998
EFL = 1998 X 3 = 5994
RE = 5% X 5994 = 299.7 ⟶ 300
AFL = 300 + 5994 = 6294
ECL = 1½ hr.
TBC = ½ hr.
SN = 4
WSL = 2
EC/D = $\frac{2 \times 4}{1\frac{1}{2} + \frac{1}{2}}$ = $\frac{8}{2}$ = 4

TDA = $\frac{365}{365}$ X 240 = 240

DC = 240 X 4 = 960

NDR = $\frac{6294}{960}$ = 6.556 ⟶ 7

Direct Personnel Cost/Alternative

Alternative 1

Grade	Number	Cost	Sub-Total
WG8	1	15,500*	15,500
E4	3	10,443	31,329
E6	2	14,562	29,124
E7	1	17,304	17,304
			93,257

Alternative 2

Grade	Number	Cost	Sub-Total
WG8	1	15,500*	15,500
E4	5	10,443	52,215
E6	3	14,562	43,686
E7	1	17,304	17,304
			128,705

Alternative 3

Grade	Number	Cost	Sub-Total
WG8	2	15,500*	31,000
E4	6	10,443	62,658
E6	4	14,562	58,248
E7	1	17,304	17,304
			169,210

Alternative 4

Grade	Number	Cost	Sub-Total
GS7	.5	15,317	7,659
E5	3	12,279	36,837
E7	1	17,304	17,304
			61,800

* approximate

Note: Costs from TRADOC cost factors handbook effective 1 Oct 79.

Alternative 5

Grade	Number	Cost	Sub-Total
WG8	1	15,500*	15,500
GS7	.5	15,317	7,659
E4	3	10,443	31,329
E5	3	12,279	36,837
E6	2	14,562	29,124
E7	2	17,304	17,304
			155,057

Alternative 6

Grade	Number	Cost	Sub-Total
GS7	1	15,317	15,317
E4	3	10,443	31,329
E5	8	12,279	98,232
E6	3	14,562	43,686
E7	2	17,304	34,608
			223,172

Alternative 7

Grade	Number	Cost	Sub-Total
GS7	.5	15,317	7,659
E5	3	12,279	36,837
E7	1	17,304	17,304
			61,800

Alternative 8

Grade	Number	Cost	Sub-Total
WG8	1	15,500*	15,500
GS7	.5	15,317	7 659
E4	3	10,443	31,329
E5	3	12,279	36,837
E6	3	14,562	43,686
E7	2	17,304	34,608
			169,619

Alternative 9

Grade	Number	Cost	Sub-Total
WG8	1	15,500*	15,500
GS7	1	15,317	15,317
E4	3	10,443	31,329
E5	7	12,279	85,953
E6	3	14,562	43,686
E7	2	17,304	34,608
			226,393

Alternative 10

Grade	Number	Cost	Sub-Total
WG8	1	15,500	15,500
GS7	1	15,317	15,317
E4	5	10,443	52,215
E5	6	12,279	73,674
E6	3	14,562	43,686
E7	3	17,304	51,912
			252,304