

HUMAN FACTORS AND SAFETY EVALUATION OF THE AUTOMATIC
TEST AND REPAIR SYSTEM [AN/MSM-105(V)1]

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U. S. Army

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July 1984

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Note 84-107	2. GOVT ACCESSION NO. AD -A143422	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HUMAN FACTORS AND SAFETY EVALUATION OF THE AUTOMATIC TEST AND REPAIR SYSTEM [AN/MSM-105(V)1]		5. TYPE OF REPORT & PERIOD COVERED Final Report 9 Aug - 19 Nov 82
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Edwin R. Smootz and Richard A. Kass		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute 5001 Eisenhower Avenue Alexandria, VA 22333		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263739A793
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute 5001 Eisenhower Avenue Alexandria, VA 22333		12. REPORT DATE July 1984
		13. NUMBER OF PAGES 123
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) President USACEBD ATTN: ATZH-BDE Fort Gordon, GA 30905		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES This report appears as part of Chapter 2 of Final Test Report for Operational Test III of Automatic Test and Repair System [AN/MSM(V)1], TRADOC TRMS NO 2-OTN-760, February, 1983.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Human Factors Human Engineering Safety		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report presents the results of a human factors and safety evaluation of the Automatic Test and Repair System [AN/MSM-105(V)1]. The evaluation was part of Operational Test III conducted by the U.S. Army Communications-Electronics Board at Fort Hood, Texas in the Fall of 1982. Numerous human factors and safety problems were identified. The results were used in assessing the operational effectiveness and suitability of the system prior to type classification standard action.		

FOREWORD

As the U.S. Army continues to procure more and more complex electronic equipment incorporating an ever increasing degree of technological sophistication, the problem of maintaining that equipment grows ever more severe. Manual test methods are too long and cumbersome to be effectively used in troubleshooting such complex equipment within reasonable time constraints and without a great deal of human error. A shortage of trained maintainers that know how to employ such methods compounds the problem. Additionally, such problems would undoubtedly be exacerbated in a combat environment where arduous working conditions, fatigue and time pressures are common.

In an attempt to solve this problem the Army has introduced the use of automatic test systems which make use of the speed and accuracy of modern digital computers to run the large number of tests that are needed to accurately diagnose and isolate faults in many of the complex electronic systems currently in the Army inventory. This concept for computer-controlled automatic test equipment (CATE) fully emerged in the late 1960's and to date has found its fullest expression within the Army in the Automatic Test and Repair System [AN/MSM-105(V)1] that is the subject of the following report.

The U.S. Army Research Institute (ARI) is frequently tasked by various Army organizations like the U.S. Army Communications-Electronics Board to conduct human factors and safety evaluations of systems in operational field test environments. The purpose is to insure that the system under review is designed in such a way that it can be effectively operated by the type of soldiers designated to use it. If found otherwise, recommendations as to how the system can be improved can be made. The present human factors and safety evaluation of the automatic test and repair system is an example of one such effort.

This report was formally published in its entirety as Chapter 2 in Final Test Report for Operational Test III of Automatic Test and Repair System [AN/MSM-105(V)1]. TRADOC TRMS NO. 2-OTN-760, U.S. Army Communications-Electronics Board, February 1983.



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HUMAN FACTORS AND SAFETY EVALUATION OF THE AUTOMATIC
TEST AND REPAIR SYSTEM [AN/MSM-105(V)1]

EXECUTIVE SUMMARY

Requirement:

The Automatic Test and Repair System [AN/MSM-105(V)1] is a transportable test and repair system for electronic equipment that consists of an electronic test facility (ETF) and an electronic repair facility (ERF) configured in two 35 foot long semi-trailers and designed for use in corps level general support maintenance units. The system is used to automatically test electronic units (assemblies and components) to determine if they perform within specified tolerance limits, and to diagnose and isolate faults. Repair of tested units, such as printed circuit boards, is also accomplished within the system. The system is manned by two operators who operate the test equipment, four repairmen who repair fault isolated units, and a team chief. The U.S. Army Communications-Electronics Board conducted an operational test (OT III) of this system at Fort Hood, Texas in the Fall of 1982, and tasked the ARI Field Unit-Fort Hood, to satisfy the human factors and safety issues of that test. The following report is in response to that tasking.

Procedure:

Questionnaires and interviews were administered to operators, repairers and the team chief in order to obtain information about the system from a human factors and safety perspective. Areas covered included immediate environment in which the system was operated, individual equipment characteristics, overall equipment configuration, job procedures and computer software. In addition, a human factors and safety evaluator recorded relevant observations during the test, and recorded measurements of light levels, sound levels and physical dimensions of pieces of equipment and workspaces on which adverse comments had been made by operators and maintainers. The questionnaire results were tabulated, the interviews and evaluator observations were summarized, and the light, sound and physical measurements were compared to appropriate military standards. This information was used to identify user-machine interface problems and to identify ways of solving the problems by equipment redesign, training, or changes in operating procedures.

Findings:

Safety. Several safety problems were noted. The major ones included the emission of noxious fumes during the application or removal of conformal coating to or from PCB's and the high incidence of tearing of NBC protective gloves during displacement operations.

Environment. The light level at the microscope inspection station in the ERF was below military standards for fine inspection tasks.

Overall Configuration. There was a severe lack of storage space for personal gear in both the ETF and the ERF, and in the ETF there was not nearly enough room for the storage of the interconnect devices, tapes and manuals for

test program sets. Additionally, the organization of equipment in the ETF was such that two operators were required to conduct testing whereas a reorganization of several pieces of equipment would allow one operator to conduct testing by himself. Within the ERF, the eyewash station was not optimally positioned.

Job Procedures. A problem existed in administrative procedures. Procedures did not exist for organizing the system with respect to such administrative activities as workload and maintenance of parts inventory, causing disarray and confusion in the work environment.

Emplacement/Displacement. One problem involved in emplacing and displacing the system centered on the use of NBC gloves. It proved to be impossible to install the head restraint on the disk drive while wearing NBC gloves because they were too large and bulky and prevented the fine finger movements necessary for accomplishing this task. Another problem centered on the difficulties involved in raising and securing into position the front platform on the same trailers. A hand operated wench is recommended as a solution to this problem.

Utilization: Information from this evaluation was used in assessing the operational effectiveness and suitability of the Automatic Test and Repair System prior to type classification standard action.

HUMAN FACTORS AND SAFETY EVALUATION OF THE AUTOMATIC TEST AND REPAIR SYSTEM [AN/MSM-105(V)1]

CONTENTS	Page
INTRODUCTION.....	1
SAFETY.....	3
Objective.....	3
Test Issues and Associated Criteria.....	3
Method.....	3
Results.....	3
Analysis.....	5
Conclusions.....	6
HUMAN FACTORS.....	7
Objective.....	7
Test Issues and Associated Criteria.....	7
Method.....	7
Results.....	8
Analysis.....	18
Conclusions.....	26
REFERENCES.....	27
APPENDIX	
Table A-1 - Test Player Safety Questionnaires.....	A-1-1
Table A-2 - Illumination and Sound Levels in the ETF and ERF.....	A-2-1
Table A-3 - ETF Operators' Human Factors Questionnaire.....	A-3-1
Table A-4 - ERF Repairers' Human Factors Questionnaire.....	A-4-1
Table A-5 - AN/MSM-105(V)1 Emplacement/Displacement Questionnaire....	A-5-1
Table A-6 - AN/MSM-105(V)1 Team Chief Human Factors Questionnaire....	A-6-1
Table A-7 - AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire.....	A-7-1

INTRODUCTION

The Automatic Test and Repair System [AN/MSM-105(V)1] is a transportable test and repair system for electronic equipment that is configured in two 35 foot long semi-trailers. Each trailer contains one of two subsystems: the electronic test facility (ETF) (OQ-290(V)1/MSM), and the electronic repair facility (ERF) (OA-8991/MSM).

The major component in the ERF is the test station [AN/USM-410(V)2], which consists of equipment designed for automatic testing and fault isolation of electronic equipment, assemblages, sub-assemblages, modules, printed circuit boards (PCB's) and PCB components. The testing and fault isolation is accomplished through the use of interconnect devices and software specific to a given unit undergoing test. A performance test program first determines if the unit performs within specified tolerance limits. If the unit fails the program branches to a diagnostic or alignment subroutine. The diagnostic subroutine identifies faults, guides the operator in probing certain components, and isolates faults to the next lower assembly or component until the replaceable part level is reached. The substations and equipment which comprise the test station and which the operator of the system must know how to use include the control station (contains minicomputer, disk drive, and operator's panel), the tape station (magnetic tape drive) the DC power station (contains power supplies and controls), the unit under test station (contains low frequency stimulus assembly, measurement and voltage sampler assemblies, radio frequency synthesizer, and system clock), the programmable interface unit station (contains programmable power supplies and universal test point electronics), a video displaying terminal (for transmitting and displaying messages to and from the computer) and a printer (for providing hard copy output). In addition, a portable digital card tester (AN/USM-465A) provided an off-line capability for testing and screening PCB's.

The primary components of the ERF are four repair work positions outfitted with soldering equipment sets and hand tool sets for repairing PCB's, an inspection station, and a connection oven.

The system is to be employed in corps level general support maintenance units and is manned by a crew of seven, consisting of a team chief, two test facility operators and four repairers. One complete crew served as test players for this test.

The Automatic Test and Repair System was subjected to operational testing (OT III) by the U.S. Army Communications-Electronics Board (USACEBD) from 9 August to 19 November, 1982 at Fort Hood, Texas. The ARI Field Unit-Fort Hood was tasked by USACEBD to perform a human factors and safety evaluation of the system during the operational test in order to satisfy the human factors and safety issues of the test. The following report was the result of that evaluation and appears as part of Chapter 2 in Final Test Report for Operational Test III of Automatic Test and Repair System [AN/MSM-105(V)1], TRADOC TRMS NO 2-OTN-760, U.S. Army Communications-Electronics Board, February 1983. It is reproduced here in the same format as prepared for inclusion in that report. Consequently, it should be noted that the paragraph numbers do not follow in strict linear sequence because of the omission of information related to other issues in the larger report. Further details about the operational test and the Automatic Test and Repair System itself can be found in the above referenced test report.

HUMAN FACTORS AND SAFETY EVALUATION OF THE AUTOMATIC
TEST AND REPAIR SYSTEM [AN/MSM-105(V)1]

2.1 SAFETY

2.1.1 Objective.

To determine whether the test system was safe to operate.

2.1.2 Test Issues and Associated Criterion.

*2.1.2.1 Safety Issue: Is the AN/MSM-105(V)1 safe for military personnel to operate and maintain (item 18, Appendix C)?

Criterion: Test item will not present any safety or health hazards to operator/maintainer personnel (item 18.1, Appendix C).

*Critical Issue.

2.1.3 Method.

Comments of test player and test directorate personnel were recorded regarding potential safety and health hazards. Questionnaires concerning safety and health hazards (Appendix A-1) were administered to test players shortly after the test began (4th week), at the middle of the test (8th week) and at the end of the test (15th week). Questionnaires concerning safety aspects of emplacing and displacing the system were administered at the 8th and 15th weeks of the test. All questionnaires were followed up by interviews for the purpose of clarifying adverse ratings on the questionnaires.

2.1.4 Results.

2.1.4.1 Safety: Player Personnel Comments

The results of the safety questionnaires are shown in Appendix A, Table A-1. It can be seen that the ETF operators reported receiving cuts or abrasions in several instances. The comments indicated that the cuts were experienced by one operator when his knuckle got caught between the door handle on the back of the ETF van and a padlock that was attached to it. This did not require medical attention.

Other comments along this line were that the UUT test station protrudes into the aisle more than do other pieces of equipment and one can possibly cut or bruise himself on it by accidentally bumping into it, although no operator reported experiencing such an event.

The other area in which ETF operators reported a safety problem was extreme loudness. However, comments were to the effect that the air conditioners were just too noisy.

Several operators indicated that electrical shock was a potential hazard. None of them reported being shocked by any of the equipment, however, and they commented that generally speaking one needs to be careful around electricity and since there are a lot of electrical components in the ETF, one needs to be careful around it.

The primary safety problems reported by repairers while working in the ERF involved burns and noxious fumes. Several repairers reported accidentally touching the soldering iron and receiving small burns on the hand. None of these required medical attention.

With respect to noxious fumes, several repairers reported ill effects, such as headache, dizziness, and queeziness from breathing the fumes from conformal coating when either applying new coating to a printed circuit board or burning off old coating.

That portion of the safety questionnaire dealing with hazards encountered while emplacing or displacing the system revealed that cuts and abrasions were received by several individuals while engaging in these activities. Comments indicate that cuts on the fingers were received while opening the tool box underneath the ERF, threading a tie down strap through a buckle, and setting up the back ramp while wearing NBC gloves.

The final question of the safety questionnaire asked whether the operators and repairers considered any of the procedures involved in emplacing and displacing the system unsafe. None of the operators or repairers indicated that they did.

Several of the results from the Emplacement/Displacement Questionnaire (Table A-5) apply to the area of safety. Personnel indicated that they tore their NBC gloves while emplacing or displacing the system, and frequently resorted to taking the gloves off when attempting to do tasks like threading straps through buckles, removing nuts from bolts, and pushing the snaps together on the passageway. Securing the disk drive head was reported to be impossible to do while wearing NBC gloves.

Finally, several individuals reported having difficulty raising the front platform of the vans in preparation for movement, while other individuals commented that this was no problem.

2.1.4..2 Safety: Test Directorate Personnel Comments

The human factors evaluators observed that sharp corners and edges exist on a number of pieces of equipment. In the ETF van this included the work tables at the front of the van, the VDT table, the front and right side of the printer table, the inner edges of the metal frame of the UUT station, and the edge of the raised floor at the front of the van. In the ERF van this included the shelf in front of the storage cabinets at the right rear of the van and the edge of the raised floor at the front of the van.

Measurements of steady state noise levels (Table A-2) were in the range of 72 to 74 dB(A) in the ETF and 60 to 68 dB(A) in the ERF.

The caution signs on the phase indicator box and the main breaker box in both the ETF and ERF did not conform to military standards in that they consisted of black letters on a gold background.

In the ERF, the sole shorting probe, which was located adjacent to the side door of the ERF van, did not easily extend to the rear of the van.

During the installation of the passageway between the vans it was observed that not all of the posts which support the hand rails were installed. Specifically, those posts which were to be placed adjacent to the vans were usually omitted, with the result that the hand rails did not extend from van to van but were only present midway across the passageway.

A related problem concerns the lack of handrails around the platforms at the rear of the ETF and ERF vans.

Finally, it was observed that most of the test players tore their NBC gloves at some time during emplacement or displacement of the system.

2.1.5 Analysis.

Although several individuals received cuts on their hands while operating or emplacing/displacing the system, there was no single aspect of the system that was responsible for the injuries and none of the injuries were serious enough to require medical attention. Given the nature of the work involved, the injuries received were not unusual. The occurrence of that type of injury could be minimized however, by rounding the edges and corners mentioned previously to the standards prescribed in Military Standard 1472B, Section 5.13.5.4. Based upon system safety requirements in Military Standard 882A, Sections 5.4.3.1 and 5.4.3.2, the hazard severity of this problem is classified as Category III Marginal, and the hazard probability is classified as Level C - Occasional.

The problem of noxious fumes being emitted during the application or removal of conformal coating is a problem which should be dealt with not only from a safety point of view, but also from a work productivity point of view since individuals who are ill will not be productive. This situation could be resolved by establishing a separate work station that is vented to the outside and is used for the purpose of applying or removing conformal coating. The hazard severity of this problem is classified as Category III - Marginal, and the hazard probability is categorized as Level B - Reasonably Probable.

The major safety problem with respect to electrical shock concerns the caution signs on the phase indicator and main circuit breaker boxes. These signs, which consist of black letters on a gold background, do not meet the color requirements of Military Standard 1473A, Section 5.9.1, which require the letters of the word CAUTION to be printed in yellow on a black background, and require any wording underneath the CAUTION to be printed in black letters on a yellow background (in this case the wording is "120/208 Volts AC Inside; Disconnect External Power Cable Prior to Servicing Interior Components"). The problem of personnel receiving an electrical shock because of the nonconformance of the caution signs to military standards is classified as Category I - Catastrophic with respect to hazard severity and as Level D - Remote with respect to hazard probability.

Perhaps the most severe safety problem concerns tearing or removing the NBC gloves while emplacing or displacing the system. In an actual combat situation where an NBC agent was actually present, tearing or removing the NBC

gloves while preparing to displace the system could prove fatal. Individuals who work with the system must be trained to proceed with extreme caution when wearing NBC protective clothing so as not to damage their clothing. It is unlikely that current time standards for emplacement/displacement are correct while wearing NBC protective clothing, and should be extended. Furthermore, a set of gloves which conform well to the shape of the hand must be provided to at least one of the ETF operators so that the disk drive head can be secured during displacement in an NBC environment. The hazard severity of tearing and removing the NBC protective gloves while displacing the system in a potential environment is classified as Category I - Catastrophic, and the hazard probability is classified as Level B - Reasonably Probable.

The problem of the shorting probe in the ERF van could be easily solved by extending the length of the wire assembly by approximately four feet. The hazard severity of this situation is classified as Category III - Marginal, and the hazard probability is classified as Level D - Remote.

The problem with the passageway handrails is related to the distance between the vans. If the vans are parked relatively close together so that the floor assembly of the passageway just fits between them, then the hand rails extend across the three vertical rails which fit into each side of the floor assembly and there is no problem (See pg 2-6 and 2-7 of DEP 11-6625-3019-12). But if the vans are a bit farther apart, then up to three separate floor panels can be used at each end of the floor assembly in order to extend it. Two of these floor panels have holes in them for the insertion of vertical rails which themselves can support an extension of the hand rails. But the ramp panel covers these holes when the floor panel is placed adjacent to the van. Cutting about one inch off of each end of the ramp panels would expose the holes and allow for installation of the vertical rails and extension of the handrails across the full length of the passageway.

A related problem concerns the lack of handrails around the rear platforms of the ETF and ERF vans. Military Standard 1472B, Section 5.13.6.2, specifies that there shall be handrails, safety bars or chains around all platforms, ledges and catwalks. Given the need to rapidly displace and emplace the system in a combat environment, providing posts and chains around the platforms of the ETF and ERF vans would solve this problem. The hazard severity of the lack of handrails around platforms and the passageway in this system is classified as Category III - Marginal, and the hazard probability is classified as Level D - Remote.

Finally, the noise levels in the vans present no safety hazard. Although personnel commented that they did not like the amount of noise produced by the air conditioners, measurements of steady state noise levels in both vans did not exceed that which requires hearing protection because of potential hearing loss (Military Standard 1474A, Section 5.1.1.2).

2.1.6 Conclusions.

Criterion 2.1.2.1 is not met.

2.3 HUMAN FACTORS.

2.3.1 Objective.

To determine whether the human factors engineering of the AN/MSM-105(V)1 contributes to its military utility?

2.3.2 Test Issues and Associated Criteria.

*2.3.2.1 HF Issue: Does the human factors engineering (HFE) of the AN/MSM-105 contribute to its military utility?

Criteria:

a. The internal environment (equipment layout, lighting, noise, etc.) of the AN/MSM-105(V)1 shall conform to good HFE principles.

b. Workspace for operators/maintenance/repairers shall conform to good HFE principles in the performance of all assigned tasks.

c. Controls and indicators shall be clearly marked and visible to the user.

d. Storage space provided for manuals, tools, interconnect devices, software, and TMs for supported systems, and all other items necessary for task accomplishment, shall exist within the OQ0209(V)1 MSM.

e. Storage space provided for manuals, tools, and all other items necessary for PCB repair must exist within the OA-209(V)1 MSM.

f. Storage facilities should include space for personal gear and TA-50.

g. Operator crew shall be capable of performing all critical, tactical tasks while wearing individual CBR protective equipment.

h. Computer prompts shall be complete, understandable, and usable by operators and maintainers.

*Critical Issue

2.3.3 Method

2.3.3.1 Measurements of environmental conditions to include illumination, noise, and temperature levels, were recorded during the test while the system was in an operational mode. Additionally, measurements were taken of the physical dimensions of various pieces of equipment and workspaces which were commented on adversely by test players.

2.3.2.2 Questionnaires and structured interviews (Appendix A) were administered to test players shortly after the beginning of the test (4th week), at the middle of the test (8th week), and at the end of the test (15th week). Ratings and comments were obtained regarding the adequacy of controls, indicators, work and storage spaces, tools, manuals, computer software and job procedures. Observations relevant to these areas were recorded by human factors evaluators throughout the test.

2.3.4 Results

2.3.4.1 Electronic Test Facility (ETF).

The results from the human factors questionnaires and interviews administered to ETF operators are shown in Table A-3.

2.3.4.1.1 Environment.

The temperature inside the ETF received one borderline rating on the questionnaire. The operator who gave this rating commented that the problem was just that the system had to be shut down when the temperature exceeded 80°F. No personal dissatisfaction was reported.

Most of the adverse ratings in this area were given to noise and vibration. The comments made by the operators indicated that the air conditioners were too noisy and that the vibration which the air conditioners caused in the van possibly caused some variable resistors in the UUT test station to frequently need readjusting.

Results of illumination and sound level measurements in the ETF are shown in Table A-2. It can be seen that illumination levels varied from 30 foot candles to 60 foot candles, while sound levels ranged from 72 dB(A) to 74 dB(A). The illumination levels at work surfaces where work activities would occur for a prolonged period of time, such as at the VDT keyboard and the work desks, were consistently measured at 60 foot candles.

2.3.4.1.2 Equipment in the ETF.

Operators were generally satisfied with the video display unit (VDT). A borderline rating given to the location of the unit referred to the difficulty encountered in trying to pass between the VDT and the PIU when an ICD and test board was attached (a problem discussed later under Overall Configuration of ETF). The only other comment in this section indicated that a wavy image sometimes appears on the VDT screen when operating off of generator power. This did not seriously interfere with the operators' ability to read messages on the screen, though.

Two relatively minor problems were mentioned with respect to the line printer. One comment was to the effect that there was no separate indicator light to help the operator distinguish whether the paper in the line printer had run out or had become jammed, although the operator indicated that this could be determined visually. The second comment referred to the difficulty in reading print on the heat sensitive paper, but this operator later indicated that he had learned to live with the problem.

One operator gave several adverse ratings with respect to the control station, DC power station, and tape station. He commented that his job would go faster if he could see every piece of equipment from the position of the VDT when he was booting up as well as testing printed circuit boards. One cannot see the front panels of these stations from the VDT position in the current configuration.

One borderline rating was given to the UUT test station. The associated comment was that it is sometimes difficult to open the panels of the UUT test station all the way when there are cables hooked up to it and a self test requires the interchange of some printed circuit boards.

One operator initially rated the location of labels in the PIU as "mostly inadequate," and later rated it as just "borderline." He commented that the card slot numbers inside the A9A2 universal test point drawer are covered up by a metal plate, thus requiring one to count down the row of cards in order to locate a card of a given number. Another "borderline" comment was that some of the resistors in the PIU that needed to be tweaked periodically are somewhat difficult to get to.

2.3.4.1.3 Overall Configuration of the ETF.

Several "borderline" and "mostly inadequate" ratings were given to the location of various pieces of equipment in the ETF. The most common comment was that there is not enough room for an individual to pass between the VDT and the PIU when a large ICD with a large test board is attached to the PIU, or when a PIU drawer is open. One suggestion made to solve this problem was to interchange the positions of the PIU and UUT test stations, thus allowing the VDT operator to easily get to the control station, printer and other stations when he is testing a board or performing the system self-test.

Comments made with respect to storage cabinets suggested that sliding doors rather than the present swinging doors would be more functional, especially for overhead cabinets where one can easily bump his head on a door that one has forgotten to close.

Another comment indicated that the work table near the front of the van is not a good location for the DCT in that it is the wrong height and is uncomfortable to work at for long hours. The chair cannot be pulled close enough to it and the overhead cabinets are in the way.

Finally, several comments were made about the lack of storage space. This problem was mentioned in response to both the "Equipment Location" and "Workspace" questions of the questionnaire. The most frequently made comment was that there is not enough room to store all of the ICD's issued to the system, especially when moving to another location. Numerous comments also indicated a problem with enough space for storing the manuals which are part of each test program set. Another common complaint was that there is no good place for storing personal gear when moving the system, especially when it is competing with ICD's for storage space (such as in the air conditioner room).

Other areas which received adverse comments included the lack of space between the VDT and PIU (mentioned earlier), the lack of places for tying down tool boxes when moving the system, the lack of designated locations for tools rather than just dumping them all in a tool box and having to search through the box each time one needs a given tool, and the lack of a dry place to store tie-down slings other than in the already over-crowded van. Finally, one operator suggested rotating the position of the file cabinet 90° so that there would be room for a second file cabinet for storing manuals.

2.3.4.1.4 Job Procedures.

The operators did not indicate that they had any problems with job procedures such as powering up the equipment, handling the magnetic tape and disk, starting up the computer, handling data transfers, running system self-tests and alignment, and powering down. Several adverse comments, however, were directed toward testing a unit. One comment indicated a problem using the DCT to test a unit because of inadequate memory for a long test program. Another comment indicated that the software for the DCT was not always clear enough or detailed enough. A third comment in this section indicated that one has to be very careful when using a probe to test a board in that the connector pins are often close together and one can easily slip and touch a nearby pin, creating a short and possibly damaging the board being tested.

Adverse responses to the question of operating test equipment centered on the lack of storage space for test program sets (discussed earlier). Also, one operator indicated that the disk storage cabinet is too small and it is difficult to remove disks from it.

A number of "borderline" ratings were given in the area of administrative procedures. Near the first of the test the team chief indicated that he was still learning how to prepare forms and records. Other comments were to the effect that the job of team chief is a difficult one since he frequently needs to be in several places at once, and it is difficult for the assistant team chief to perform the team chief's duties in his absence since he received no training in this area.

Two "borderline" ratings were given in the area of operator maintenance procedures. One of the ratings, associated with the UUT test station, was accompanied with the comment that it takes too much time to make sensitive adjustments to the variable resistors; they are too sensitive in that a very small adjustment can be too much. The other "borderline" rating was associated with the DCT and was accompanied by the comment that the manual for performing maintenance on the DCT is not very clear.

2.3.4.1.5 Computer Software.

Only one adverse rating appeared in the area of computer software. One operator indicated that sometimes a message in the program would tell the operator to disconnect a terminal that he had never been told to connect in the first place.

2.3.4.1.6 Test Team Observations of the ETF.

Three observations were made about human factors aspects of the ETF. First, the temperature ranged from a low of 65°F to a high of 80°F. A typical range during a work day was 65 - 75°F. A typical humidity range was 30 - 60%.

Second, it was observed that there is no good place in the ETF for operating the DCT for prolonged periods of time. Currently, the DCT sits on the work table near the front of the van and a tall swivel chair is provided at that location. Unfortunately, the work table is the top part of a cabinet, which keeps one from placing his knees under the work table so that he can sit close to the work surface.

Finally, it was observed that individuals carrying large items, like ICD's, sometimes appeared to be somewhat off balance when climbing the stair ladder on the rear platform of the ETF. Measurements of the stair ladder revealed that the riser height (distance from the top of one step to the top of the next step) for the first two risers is 13.5 inches, and the width of the stair ladder with one side rail is 18 inches. The diameter of the handrail is 1.04 inches. These dimensions fail to meet the standards specified in Military Standard 1472B, Section 5.7.7.3. In addition, it was observed that no handrail exists around the rear platform. This violates standards in Military Standard 1472B, Section 5.13.6.2.

2.3.4.2 Electronic Repair Facility(ERF)

The results from the human factors questionnaires and interviews administered to ERF repairers are shown in Table A-4.

2.3.4.2.1 Environment

The internal environment of the ERF received several "borderline" and "mostly inadequate" ratings in the areas of temperature, ventilation and vibration. A review of the comments indicated that dissatisfaction with the temperature was from one individual who felt that the temperature inside the ERF was not stable enough during the course of a day and he would periodically adjust the settings on the air conditioners to try to solve the problem. This operator indicated that keeping the temperature at 65°F, which is what he had been advised to do, was too cold for personal comfort.

Comments with respect to ventilation indicated that the van gets rather smoky after individuals smoke in it for some time.

Finally, several comments were made about the problem of vibration. When an individual walks up or down the stair ladder at the rear of the ERF van the whole van vibrates and this can interfere with ongoing repair work.

Measurements of illumination and sound levels are shown in Table A-2. It can be seen that illumination levels at work stations with the desk lamps turned on were consistently at 120 foot candles. Illumination levels at other stations varied from 48 to 70 foot candles. Sound levels ranged from 60 to 68 dB(A).

2.3.4.2.2 Work Dress, Equipment, Tools and Parts

Numerous "borderline" and "mostly inadequate" ratings were given to the configuration of the repairer individual work stations. The problems centered around the amount of work space available, the amount of leg room, and the seating. Numerous comments indicated that there was not enough room at the work station when a repairer had all of the tools out which he needed for repair work. Cords from the PACE unit and soldering iron got in the way and could be burned on the soldering iron if one was not careful. It was also mentioned that it was rather crowded in the van when people other than the repairers were in it.

The problem of leg room was mentioned several times. Comments were to the effect that one's legs bumped against the trash can located in the knee space under the work station, although one repairer mentioned that he eventually got used to this.

Other comments were that the work station was too low, the chair was too low, and the chair backrest was too low.

Comments about the desk and chair being too low, and there not being enough leg room, were also made with respect to the microscope inspection station and the eyeletting work desk. In addition, one operator mentioned that he preferred working at a work bench with a stool rather than at a work desk with a chair.

The black light inspection station received several "borderline" ratings. The most common comment made here was that it would be useful to have a stool at this station.

The eyewash station received several "borderline" ratings with respect to amount of room, although no comment accompanied the ratings. One "mostly inadequate" rating was given to the location of the eyewash station. This problem will be discussed below in the "Overall Configuration of the ERF" section of this report.

One of the most serious problems in this area concerned storage space. Numerous ratings and comments indicated that the lack of storage space for personal gear was a serious problem. Additionally, some dissatisfaction was expressed with the amount of storage space for tools, repair parts and manuals.

A few comments were made about operating the oven. Minor dissatisfaction was expressed by one repairer over the presence of a rocker switch rather than a toggle switch as the on/off switch, and with the location of the oven controls at the lower front of the oven where they were difficult for him to see (this operator measured 6 feet 4 inches tall in his combat boots). A more serious problem concerned the lack of information about how long and at what setting to bake the conformal coating on printed circuit boards. Repairers experienced difficulty with this during the test.

The major problem mentioned with respect to tools and parts concerned the amount of time required to obtain them. Some tools and parts had been on order for several months during the test. One comment at the first of the test was also directed to the lack of a manual to match a part labeled as bad by the computer with the actual location of the part on the board. This latter problem was solved during the test.

2.3.4.2.3 Overall Configuration of the ERF.

The major comment made in this section concerned the location of the eyewash station. It was noted that its current location behind the fourth work station was not optimal and the suggestion was made that it be moved to a location midway between the eyeletting and microscope inspection stations.

A second comment concerning the lack of adequate sized trays for the over was solved during the test by obtaining the right sized trays.

2.3.4.2.4 Job Procedures.

More adverse ratings and comments were made by the repairers about job procedures than about any other topic in the system. In the area of general duties, the most important comments concerned the need for a schematic of each board in order to determine what the faulty component number from the ETF printout is with respect to a given location on a given board, the difficulty of trying to operate and pull PMCS on the DCT (for which there was no formal training), and the need for training and systemization in maintaining records on parts and repair activities. With respect to specific repair procedures, removing and replacing conformal coating received the most adverse ratings and comments. Other repair procedures receiving several adverse ratings and comments were replacing a flat pack and repairing an internal run.

Finally in the area of maintenance most of the comments centered on the lack of training in performing maintenance on DCT, and on the inadequacy of the PMCS manual for the DCT.

2.3.4.2.5 Test Team Observations of the ERF.

It was observed that the rear platform and stair ladder of the ERF were identical to those of the ETF. Thus, the problems of no handrails, excessive riser height, etc., that were mentioned in the previous section on the ETF also exist here. Additionally, measurements of individual repairers work stations revealed that the knee room measured 23.25 inches deep. A trash can measuring 8.25 inches deep and 10 inches wide was mounted on the wall at the back of the knee room area, thus reducing the effective knee room to 15 inches. This does not meet minimum standards of 18 inches specified in Military Standard 1472B, Section 5.7.3.5.

Finally, measurements of the temperature in the ERF ranged from 66°F to 79°F.

2.3.4.3 Emplacement/Displacement

2.3.4.3.1 Test Player Evaluation of Emplacing and Displacing

The results of the Emplacement/Displacement questionnaire are shown in Table A-5. The major area in which there were adverse ratings and comments was in emplacing and displacing the system while wearing NBC protective clothing. Most of the problems derived from the NBC gloves. Personnel reported that it was difficult to do many tasks such as threading straps through buckles, handling nuts and bolts, and pushing the snaps together on the passageway covering. One task, securing the disk drive head, was reported as impossible to do. Personnel also reported frequent tearing of the gloves when doing some of these tasks, and also reported sometimes taking the NBC gloves off to accomplish a task. Wearing the NBC mask also posed some problem in that it restricted the field of view and made it difficult to do things such as installing ground rods in the ground and getting on top of the vans to work on the passageway, especially at night.

A number of problems which did not involve NBC clothing were also reported. For instance, when emplacing the system, a carpenter's level had to be used to level each van, because the leveling bubbles at each corner were out of calibration. Also, some individuals reported having difficulty raising the front platform of each van in preparation for movement. Other individuals reported that they had no problem with this task. The individuals who reported having difficulty were 5 feet 6.5 inches and 5 feet 8.25 inches tall, and were the shortest individuals on the test team. Several individuals reported having difficulty aligning the holes in the front platform with the holes in the van frame so that the platform could be secured for movement.

2.3.4.3.2 Test Team Observations

The observations of the test team with respect to NBC protective clothing supported those of the players. The NBC gloves were bulky and ill fitting, making it difficult to accomplish many tasks and resulting in frequent torn

gloves and sometimes removal of the gloves. Furthermore, in the human factors evaluators' judgement, it is impossible to secure the disk drive head while wearing NBC gloves. Finally, it was observed that the players became very hot in the NBC clothing, especially during daylight hours. This problem, of course, is well known in the military community.

Another problem which was observed was raising and securing in position the front platforms of the vans in preparation for movement, especially if individuals of relatively short stature were involved. Removing the six foot system ground rod when displacing was also a problem. This required a substantial amount of time and effort when it had been driven into rocky terrain, and no special equipment was available to help with the task.

Another problem involved raising the rear landing jacks when preparing the system for displacement. Attempting to raise them before lowering the front of the van proved to be a difficult task.

Finally, it was observed that one of the doors to an outside storage box was bent on one occasion when it had been allowed to fall completely open prior to leveling the van. In the process of leveling, the van was lowered somewhat and the door was caught between the van and the ground, and was slightly bent as a result.

2.3.4.4 Team Chief Duties

The results of the team chief questionnaire are shown in Table A-6. There were essentially no adverse ratings or comments about the specific repair or maintenance activities which are part of his job, although he indicated that he had not had a chance to perform a fair number of them. The adverse ratings and comments which he did make were in the area of administrative duties. Basically, he indicated that he was not prepared at the beginning of the test to supervise the work activities of the system personnel and perform the various administrative duties of the team chief. By the end of the test, however, he indicated that he was better able to accomplish these tasks because of the experience and on the job training he had received. In addition, he commented that it would be useful for personnel to practice setting up and tearing down the system during the initial training process, and that it would be helpful to have assigned to the system a parts clerk who was familiar with the supply system and could handle the ordering of supply parts.

2.3.4.5 System Repair/Calibration Procedures

The results of the AN/MSM-105(V)1 Electronics Repairer/Calibrator Human Factors Questionnaire are shown in Table A-7. The only problem mentioned with respect to the AN/MSM-105(V)1 itself was with the technical bulletin of the modulation analyzer. Several sentences were missing from this bulletin. This problem was corrected by submitting DA Form 2028.

The only other problem which was mentioned in this area concerned a potential problem in maintaining the DCT. It was noted that the calibration personnel would have a difficult time isolating a fault in the DCT if it could not be calibrated because they have no spare boards for the DCT. They would have to manually try to isolate a fault and then repair it, which could be rather time consuming. The suggested solution to this problem was to make provisions for the DCT to be tested by the AN/MSM-105(V)1 itself in the event that it could not be calibrated.

2.3.5 Analysis

2.3.5.1 Electronic Test Facility

2.3.5.1.1 Environment

The internal environment of the ETF appears to pose no serious problems from a human factors point of view. Illumination levels met the minimum standards (Military Standard 1472B, Section 5.8.2) of 30 footcandles at console surfaces and 50 footcandles at business machine operation surfaces (such as the VDT keyboard and the DCT). Noise levels did not exceed the limits specified in Military Standard 1474A, Section 5.1.1.2, and although the operators complained about the related problem of vibration as causing variable resistors to need frequent readjustment, this problem did not appear to substantially interfere with their work. Finally, temperature and humidity were at acceptable levels (Military Standard 1472B, Section 5.8.1).

2.3.5.1.2 Equipment in the ETF.

No serious human engineering problems were uncovered with the individual pieces of equipment in the ETF. While one operator complained of difficulty in opening UUT test station panels when cables are hooked up to it, and another operator complained of not being able to see the card slot numbers in the PIU universal test point drawer, these were not reported as insurmountable problems, but rather as minor annoyances that could be dealt with.

2.3.5.1.3 Overall Configuration of the ETF.

A number of serious problems occurred in the area of the overall configuration of the ETF. First, it is extremely difficult to pass between the VDT and the PIU when a large ICD is hooked up to the PIU and a board is undergoing testing. The operator sitting at the VDT is thus precluded from getting to the printer, the power station, or the control station if he needs to. Consequently, two men have to be present in order to conduct testing. While the nature of testing printed circuit boards is such that it is more efficient with two individuals anyway, and one would normally want two individuals on duty for such work, there undoubtedly will be times when only one individual will be available and it would be useful if he could conduct PCB testing alone, even if he did have to proceed at a slower rate than with two individuals. For this reason a solution to the above problem would be useful. One solution proposed by one of the operators, which would appear to be feasible, is to simply interchange the positions of the PIU and UUT test stations. This would allow an operator to have free access to both the VDT and the control station, printer, etc., even when a large ICD was installed on the PIU.

Perhaps the most serious problem in the ETF is the lack of storage space for test program sets as well as personal gear. Rough estimations indicate that there is enough room for storing the ICD's, tapes and manuals of about ten test program sets in the ETF van. Since the system is anticipated to have far more sets than that, then an additional mobile storage facility will have to be assigned to the system. With one exception, there simply is no more room in the ETF van for adding storage facilities. The one exception is the area where the file cabinet is currently located. By rotating the file cabinet 90°, another

file cabinet could be added to increase the storage space for manuals. By adding a mobile storage facility to the system, the problem of storage space for personal gear would also be solved. In an actual combat situation each individual would have at least two duffel bags of personal gear to take along with him, and there simply is not enough room in the air conditioner rooms for storing all of that gear, as is now done when each individual takes just one duffel bag with him during field exercises.

Another human engineering problem concerns the location of the DCT. The current location of this piece of equipment on a work table near the front of the van presents a problem in that operators cannot sit up close to it because there are cabinets underneath the work table. Consequently, there is no knee room and an operator has to either stand or sit in an awkward position to operate the DCT, both of which are very tiring over a prolonged period of time. Locating the DCT on the work desk adjacent to the VDT is not a good solution since that area is needed for administrative paper work. Perhaps the most viable solution would be to leave the DCT at its current location, but remove a portion of the cabinets underneath that work table to provide the operator with knee room when sitting at the table. This solution would be feasible if additional storage space were provided with the system as mentioned above.

An additional human engineering problem concerns the stair ladder and platform at the rear of the van. Several of the dimensions of the stair ladder, such as the riser height, ladder width, and handrail diameter do not meet military standards. The riser height is too high, the ladder width too narrow, and the handrail too small. In addition, there is no hand rail or chain around the rear platform as military standards require. This latter problem was discussed in the section of this report concerned with safety. These problems need to be corrected, especially so that individuals who are carrying large items, like ICD's, can safely enter and exit the ETF.

The other comments made in this area, such as the preference for sliding doors rather than swinging doors on the storage cabinets, and having a drawer location for each tool rather than a tool box for all tools, are a function of individual preference, have advantages as well as disadvantages, and thus merit far less consideration than the other problems in this area.

2.3.5.1.4 Job Procedures

Two major problems were uncovered in the area of job procedures. The first area concerns the use of the DCT. Basically, operators felt that the manuals which accompanied it were not very clear with respect to both operating and maintenance instruction. The DCT was inoperational for a substantial portion of the test, however, and use of it was therefore limited. Consequently, it is possible that if the operators had spent more time working with it they might not have commented as they did. Evaluation of the DCT might best remain reserved at this point.

The other major problem in the area of job procedures concerns the performance of administrative procedures. Operators felt that the team chief had a particularly difficult job in supervising the organization's activities, especially since neither he nor they had received training on the various administrative procedures required for the successful operation of the system.

2.3.5.1.5 Computer Software.

The computer software appeared to be adequate from a human engineering perspective. The only comment made about it was by one operator who indicated that he had encountered a message instructing him to disconnect a terminal that he had never been instructed to connect. This did not appear to cause any problems in running the test, though.

2.3.5.2 Electronic Repair Facility

2.3.5.2.1 Environment.

There appear to be no serious human engineering problems with respect to noise and temperature levels. Noise levels are below limits specified in Military Standard 1474A, Section 5.1.1.2, and measured temperature levels were in the acceptable range. Some complaints about vibration of the van from individuals walking up and down the rear stair ladder as a source of potential interference of repair procedures warrants some consideration, although no repairer cited a specific example of when his work was seriously degraded by such vibration. This potential problem could be partially solved by providing adjustable supports for the rear platform.

Illumination levels in the ERF were generally adequate, with the exception of the level at the microscope inspection station. Measured illumination at this location was 60 footcandles, which is below the minimum of 100 footcandles required by Military Standard 1472B (Section 5.8.2) for fine inspection tasks. This latter problem could be easily solved, however, by installing a desk lamp of the same type as those over the individual repairer work stations. This would raise the illumination levels at the microscope inspection station to about 120 footcandles.

2.3.5.2.2 Work Areas, Equipment, Tools and Parts

Problems at the individual repairer work stations involved the amount of work space available at the work station and the amount of knee room present. Although the amount of work space meets military specifications, repairers still felt that it was inadequate when they were fully engaged in repairing boards. Substantially expanding the amount of space at the work stations in the current configuration appears to be rather difficult, if not impossible, to do though. There simply is not enough room available for expansion. Furthermore, although some of the repairers would prefer more workspace, it was not observed that a lack of space was ever the cause of failing to accomplish all of their repair work.

The related problem of inadequate knee room is one which can be more easily solved. The presence of a trash can mounted on the wall at the back of the knee space under the repairer work stations was the subject of complaints by several repairers and reduces the knee room to 15 inches, which falls short of the 18 inch standard specified in Military Standard 1472B. The width of the knee space (27.5 inches) however, is much greater than required in military standards (20 inches). By installing a narrow trash can on the side of the knee space, rather than at the back of the space, military standards would be met and the trash can would be in a more accessible location for the individual repairer.

Although several comments were made about the low height of all of the work stations and the chairs, these comments came from the tallest repairer (6 foot 4 inches tall) who also said that he preferred a work bench (which is typically 36 inches high) with a stool rather than the current work desks (which are the standard 30 inches high) with a chair. Since none of the other operators made similar comments, however, the current configuration with work desks and chairs appears to be adequate.

As with the ETF, storage space in the ERF is a serious problem. Storage of personal gear during movement appears to be the main problem. Adding the additional mobile storage facility mentioned previously for storing test program sets and personal gear would solve this problem.

Operating the oven received several adverse comments in the sense of not knowing how long and at what temperature to bake the conformal coating on repaired printed circuit boards. This is a problem of which the solution needs to be incorporated into the training program. If guidelines exist in this area, then they need to be published in the repair manual. If they do not exist, then repairers need to be instructed, via the repair manual, that they must use their judgement and experience in determining the temperature and time limits for baking conformal coating.

Finally, the major complaint directed toward tools and repair parts at this point was in the amount of time required to obtain them. This is a logistics rather than a human engineering problem.

2.3.5.2.3 Overall Configuration of the ERF

Two areas of concern emerge with respect to overall configuration of the ERF. First, the eyewash station is located behind one of the end repairer work stations. Good human engineering would more centrally locate it, however, so that the distance any given repairer would have to traverse to get to it in an emergency would be minimized. A better location for the eyewash station is between the microscope inspection station and the eyeletting station. By cutting in two the table on which these stations rest and moving the microscope inspection station so that it is adjacent to the oven, space would become available for locating the eyewash station centrally with respect to the repairer work stations.

The other major problem in this area concerns the lack of a handrail on the rear platform and the failure of the stair ladder to meet military standards. The same comments and suggestions made with respect to this problem on the ETF apply here.

2.3.5.2.4 Job Procedures.

In the area of job procedures, it appears that having schematics of printed circuit boards that are to be repaired would be of great help in locating a bad component on a board after it has been identified as bad by the computer. The repairers reported using schematics in their training and felt that they would also be useful in their actual work situation.

Some comments were made with respect to needing training on how to perform PMCS on the DCT, although , as mentioned earlier, the lack of use of the DCT precludes one from making any recommendations concerning it at this time.

One area which needs to be incorporated into the training program involves setting up administrative procedures for maintaining records of parts and repair activities. This process was in disarray for a good portion of the test and several repairers complained that they had received no training in this area.

Finally, although several repairers commented on the difficulty in performing certain repair procedures, such as removing and replacing conformal coating, replacing flat packs, and repairing internal runs, it must be realized that these are simply difficult tasks to do and the repairers did not have extensive practice doing them. On the job training and practice would be expected to result in the mitigation of these comments.

2.3.5.3 Emplacement/Displacement

Emplacing and displacing the system while wearing NBC protective clothing is definitely the most serious problem in this area. The NBC gloves are simply too large and ill fitting to permit efficient emplacement and displacement of the system. Additionally, the fact that they were easily torn substantially reduced their effectiveness in an NBC environment. This problem was discussed earlier in the report in the section on safety. It would appear that the time allowed for preparing the system for emplacement or displacement will have to be somewhat longer in an NBC environment than in a non-NBC environment, and that personnel will have to be trained to proceed at a deliberately slower work rate and with much more caution than usual in order not to tear their NBC gloves and expose themselves to a contaminated environment. In addition, a much better fitting glove than the current NBC glove, that allows for relatively fine finger movements, must be issued to at least one ETF operator so that the head restraint can be adequately installed in the disk drive during emplacement and displacement activities. It is quite difficult to get one's hand down into the disk drive while wearing the current style of NBC glove; it is impossible to then remove and reinstall the screws and washers that hold the head restraint in place.

Another problem which merits attention concerns raising and securing the front platform into position during displacement. As the player comments and test team observations indicated, this is primarily a problem for individuals of relatively short stature. The distance from the ground to the bottom of the platform when in its raised position is around 80 inches. Anthropometric data (see Military Standard 1472B, Table XVII) indicates that this exceeds the overhead reach height of 5% of all soldiers (78.6 inches). More importantly, the 95th percentile overhead reach height of soldiers is 87.6 inches, indicating that even the tallest soldiers can reach up on the platform only 7 or 8 inches to hold it in place so that bolt holes can be aligned and it can be secured in the raised position. The platform is relatively large (roughly 3 feet deep by 8 feet wide) and heavy, and somewhat difficult to get bolted into the upright position. Consequently, individuals are not able to apply much leverage to it when securing it in its upright position and consequently do not have a lot of control over it. This is particularly true for short individuals, but is also true for taller individuals. The evaluators observed that typically three or four individuals would be involved in raising the platform, in addition to an individual for aligning the bolt holes, and they would typically show signs of arm fatigue while holding it in place by using just one arm to hold the platform upright and letting the other arm rest for awhile, and then switching arms, and so forth until it was secured in place. All in all it appears that the potential exists for losing control of the platform and having it fall back into the down position with the possible risk of personal injury. A reasonable solution to this problem is to simply install a hand operated wench on the front of the van that can be used for raising and lowering the platform. It is recommended that this solution be applied to both the ETF and the ERF vans.

Removing the six foot system ground rod is another problem that needs to be solved. When the rod has been driven into rocky ground it is very difficult and time consuming to remove it. On the field exercises the soldiers used a pick as a lever and a set of wooden blocks to progressively pry it out of the ground. This procedure took approximately twenty minutes in one instance and

resulted in a bent rod. This procedure could be speeded up if a set of pulleys (block and tackle) and a sturdy tripod, or some sort of support apparatus, were issued with the system. This would allow the ground rod to be pulled out vertically (thus precluding bending it) rapidly, and effectively. This apparatus could also be used to remove the shorter ground rods that are used to ground the generators.

A procedural problem whose solution needs to be incorporated into the training program concerns the removal of the rear landing jack plates when displacing the system. Several instances were observed in which soldiers struggled to rotate the rear landing jacks in order to raise them, without first substantially lowering the front of the van and taking pressure off of the rear landing jacks. This is a problem that can be easily solved through training.

A final problem concerned the doors to the outside storage boxes under the vans. When personnel open the doors to the storage boxes, the doors typically fall completely open (180°) such that they are parallel to the sides of the van. Other personnel then proceed to begin emplacing and leveling the van. At one particular field site this process required lowering that side of the van where the storage box doors were open and consequently the doors became caught between the van and the earth. One door was bent in this process and had to be straightened at a later time. This problem could be easily solved by installing a support chain on one or both ends of each door in order to restrict the opening to something like 160° and thus precluding repeat occurrences of the above incident.

2.3.5.4 Team Chief Duties

One of the most serious problems the team chief had was learning what the administrative duties of the team chief were, and then learning how to execute them. This problem is obviously not unique to this system, and is related in a larger sense to the training of NCO's in general. However, the problem could be ameliorated in this system by providing some instruction about supply procedures and forms in the initial training for system repairers. Evidence of the lack of such knowledge on the part of the test players occurred repeatedly during the test and is a problem which could be easily rectified during the initial training process.

2.3.5.5 System Repair/Calibration Procedures

Few problems were encountered by calibrators in calibrating parts of the AN/MSM-105(V)1 system. The problem of missing sentences in the modulation analyzer manual were corrected using a DA Form 2028. The suggestion of testing the DCT with the AN/MSM-105(V)1 when it cannot be calibrated is merely a matter of establishing local standard operating procedures to that effect.

2.3.6 Conclusions

Criterion 2.3.2.1.a was met for the ETF but not for the ERF.

Criterion 2.3.2.1.b was not met for either the ETF or the ERF.

Criterion 2.3.2.1.c was met for the ETF and the ERF

Criterion 2.3.2.1.d was not met for the ETF (applies only to the ETF

Criterion 2.3.2.1.e was met for the ERF (applies only to the ERF).

Criterion 2.3.2.1.f was not met for the ETF or the ERF.

Criterion 2.3.2.1.g was not met for the ETF, but was met for the ERF.

Criterion 2.3.2.1.h was met for the ETF (applies only to the ETF).

References

- MIL-STD-454E, Military Standard General Requirements for Electronic Equipment, 1 March 1976.
- MIL-STD-882A, Military Standard System Safety Program Requirements, 28 June 1977
- MIL-STD-1472B, Military Standard Human Engineering Design Criteria for Military Systems, Equipment and Facilities, 31 December 1974 .
- MIL-STD-1473A (MI), Military Standard General Requirements for Color and Marking of Army Materiel, 10 February 1976
- MIL-STD-1474A (MI), Military Standard Noise Limits for Army Materiel, 3 March 1975

APPENDIX A

TABLE A-1

TEST PLAYER SAFETY QUESTIONNAIRES

1. Responses to ETF Safety Questionnaire for ETF Operators
(Number of responses at 4th week/8th week/15th week)

Did you experience or nearly experience any of the following safety hazards while operating the ETF?

	Experienced	Nearly Experienced	Neither Experienced Nor Nearly Experienced But is a Hazard	Not A Hazard
1. Electrical Shock	<u> / / </u>	<u> / / </u>	<u> 2 / 2/ 2 </u>	<u> 1 / 1/ 1 </u>
2. Burns	<u> / / </u>	<u> / / </u>	<u> 2 / 2/ 2 </u>	<u> 1 / 1/ 1 </u>
3. Cut or Abrasions	<u> 1 / / 1 </u>	<u> / / </u>	<u> 2 / 2/ 1 </u>	<u> / 1/ 1 </u>
4. Extreme Brightness	<u> / / </u>	<u> / / </u>	<u> / 2/ 1 </u>	<u> 3 / 1/ 2 </u>
5. Extreme Loudness	<u> 1 / 1/ </u>	<u> / / </u>	<u> / / 1 </u>	<u> 2 / 1/ 2 </u>
6. Noxious Fumes	<u> / / </u>	<u> / / </u>	<u> 1 / 2/ 1 </u>	<u> 2 / 1/ 2 </u>
7. Other (specify)	<u> </u>	<u> </u>	<u> </u>	<u> </u>

Comments to ETF Safety Questionnaire for ETF Operators

COMMENT	Occurence	4th Wk	8th WK	15th WK
1. Generally speaking, there are a lot of electrical components in the system, and one needs to be careful around electricity.	2	X		X
2. The UUT sticks out and one can bump against it and possibly cut or bruise himself. A lot of sharp edges on pieces of equipment.	2	X		

COMMENT	Occurence	4th Wk	8th WK	15th WK
3. Knuckle got caught between lock and handle on door and was cut.	1			X
4. Air conditioners are too noise.	2	X	X	
5. If someone smokes, you have noxious fumes.	1	X		

2. Responses to ERF Safety Questionnaire for ERF Operators
(Number of responses at 4th week/8th week/15th week)

Did you experience or nearly experience any of the following safety hazards while operating the ERF?

	Experienced	Nearly Experienced	Neither Experienced Nor Nearly Experienced But is a Hazard	Not A Hazard
1. Electrical Shock	/ /	/ /	/ / 2	4 / 3/ 2
2. Burns	1/ 1/ 1	/ /	/ / 2	3 / 2/ 1
3. Cut or Abrasions	/ / 1	1/ /	/ /	3 / 3/ 3
4. Extreme Brightness	/ /	/ /	/ /	4 / 3 / 4
5. Extreme Loudness	/ /	/ /	/ /	4 / 3/ 4
6. Noxious Fumes	1/ 2/ 3	/ /	/ / 1	3 / 1/
7. Other (specify)				
	/ /	/ /	/ /	/ /

Comments to ERF Safety Questionnaire for ERF Repairers

COMMENT	Occurrence	4th Wk	8th WK	15th WK
1. Received small burns on hand from accidently touching soldering iron.	3	X	X	X
2. Small burns possible from touching soldering iron.	1			X
3. One has to be careful since there are a number of tools that have sharp edges and points.	1	X		

COMMENT	Occurence	4th Wk	8th Wk	15th Wk
4. Fumes from conformal coating can be annoying at times.	2	X		X
5. Fumes from applying conformal coating are very strong and give one a headache once in awhile.	1		X	
6. Fumes from applying conformal coating make one feel dizzy sometimes.	1			X
7. Fumes from burning off conformal coating do not smell good and sometimes makes you feel "queezy."	3		X	X

3. Responses to Section I of the Emplacement/Displacement Safety Questionnaire for Operators and Repairers (number of responses at 8th week/15th week).

Did you experience or nearly experience any of the following safety hazards while emplacing or displacing the AN/MSM-105(V) 1 system?

	Experienced	Nearly Experienced	Neither Experienced Nor Nearly Experienced But is a Hazard	Not A Hazard
1. Electrical Shock	<u>/</u>	<u>/</u>	<u>2/3</u>	<u>4/4</u>
2. Burns	<u>/</u>	<u>/</u>	<u>2/3</u>	<u>4/3</u>
3. Cut or Abrasions	<u>2/2</u>	<u>/1</u>	<u>1/3</u>	<u>3/1</u>
5. Extreme Loudness	<u>/</u>	<u>/</u>	<u>2/2</u>	<u>4/5</u>
6. Noxious Fumes	<u>/2</u>	<u>/</u>	<u>2/2</u>	<u>4/3</u>
7. Other (specify)	<u>/</u>	<u>/</u>	<u>/</u>	<u>/</u>

Comments to Emplacement/Displacement Safety Questionnaire for Operators and Repairers

COMMENT	Occurrence	8th WK	15th WK
1. Smashed middle finger when opening tool box underneath ERF.	1	X	
2. Cut finger on buckle; just need to be more careful.	1	X	
3. Received small cut when setting up back ramp. Finger got caught and index finger of NBC glove was ripped off.	1	X	

COMMENT	Occurrence	8th Wk	15th Wk
4. Cut NBC gloves when adjusting jacks at rear of trailer, and hooking cables up to generator.	2		X
5. Emplacing and displacing is generally a dangerous activity.	1	X	
6. Noxious fumes are a problem with conformal coating. This does not occur during emplacement and displacement, though.	2	X	

4. Responses to Section II of the Emplacement/Displacement Safety Questionnaire for Operators and Repairers (number of responses at 8th week/15th week).

Were any of the procedures you were required to perform during emplacement or displacement of the system unsafe in that you risked personal harm or, damage to the facility by performing them?

YES

NO

0/0

6/7

Comments to Section II of the Emplacement/Displacement Safety Questionnaire

None provided.

Appendix A

Table A-2

Illumination and Sound Levels in the ETF and ERF

TABLE A-2. Illumination and Sound Levels Inside The ETF and ERF

ILLUMINATION LEVELS (fc = footcandles)
(measured with all four rows of florescent lights on)

<u>ETF</u>		<u>ERF</u>	
VDT Keyboard	60 fc	Work Station #1	50 fc
PIU Front Panel	30 fc	(with desk lamp)	120 fc
UUT Front Panel	60 fc	Work Station #2	58 fc
Line Printer	58 fc	(with desk lamp)	120 fc
Front panel of:		Work Station #3	58 fc
DC Power Station	40 fc	(with desk lamp)	120 fc
Control Station	33 fc	Work Station #4	60 fc
Tape Station	45 fc	(with desk lamp)	120 fc
Work Desk By:		Eyeletting Station	70 fc
VDT	60 fc	Microscope Station	60 fc
UUT	60 fc	Black Light Station	50 fc
Air Conditioner Room	60 fc	Oven Control Panel	48 fc
		Eyewash Station	60 fc

SOUND LEVELS (dB(A) = decibels on A weighted scale)

<u>ETF</u>			<u>ERF</u>		
Front	-	72 dB (A)	Front	-	60 dB (A)
Middle	-	72 dB (A)	Middle	-	62 dB (A)
Rear	-	74 dB (A)	Rear	-	68 dB (A)

APPENDIX A

TABLE A-3

ETF OPERATORS' HUMAN FACTORS QUESTIONNAIRE
(n=3 at each administration)

1. Responses to Section I of the ERF Operators (n=3) Human Factors Questionnaire(number of responses at 4th week/8th week/15th week)

I. ENVIRONMENT

Indicate the adequacy of the following environmental conditions in the ETF:	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Temperature	<u>1/1/1</u>	<u>1/2/2</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Ventilation	<u>1/1/</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Noise	<u>2/ /</u>	<u>/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>
4. Vibration	<u>1/ /</u>	<u>1/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>
5. Illumination	<u>2/1/</u>	<u>1/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section I of the ETF Operators' Human Factors Questionnaire.

COMMENT	Occurence	4th Wk	8th Wk	15th Wk
1. If temperature is not stable one cannot operate the equipment; must shut down when over 80°F.	1	X		
2. Air conditioners make a lot of noise. Should be detachable, like the generators.	3	X	X	X
3. Air conditioners make too much vibration; seem to cause variable resistors in UUT to go out of adjustment.	4	X	X	X

2. Responses to Section II-A of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II. EQUIPMENT CHARACTERISTICS

A. VIDEO DISPLAY UNIT

Indicate how adequate the
Video Display Terminal is in
each of the following areas:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. DISPLAY					
a. Display brightness	<u>2/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Absence of glare	<u>1/2/1</u>	<u>2/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Absence of flicker	<u>/1/</u>	<u>3/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Letter discrimination	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Viewing distance	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Angle of view	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Location of display	<u>/1/</u>	<u>3/2/2</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>
h. Other (specify) <u>Generator power</u>	<u> </u>	<u> </u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
2. INDICATOR PANEL					
a. Display brightness	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Absence of glare	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Absence of flicker	<u>2/2/</u>	<u>1/1/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Viewing distance	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Angle of view	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Correct labels	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Location of indicators	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Other (specify) <u> </u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-A continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
3. KEYBOARD AND CONTROLS					
a. Size	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>3/ /1</u>	<u>/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Correct labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>1/1/1</u>	<u>2/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>1/1/1</u>	<u>2/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-A continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequately
q. Control type (type of control is appropriate for type of function)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-A of the ETF Operator Human Factors Questionnaire

COMMENT	Occurence	4th Wk	8th Wk	15th Wk
1. One sometimes gets a wavy image in display when power is coming from the generator. Comes and goes. One can still make out the message on the display, though.	1		X	
2. When an ICD is on the PIU, it is really cramped. One might need to get to the powr station to turn something off, and it is difficult to pass between the video display and the PIU, especially with a large ICD.	1			X

3. Responses to Section II-B of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II.B. LINE PRINTER

Indicate how adequate the Line Printer is in each of the following areas:		Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1.	INDICATOR LIGHTS					
a.	Brightness	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b.	Absence of glare	<u>1/1/1</u>	<u>2/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c.	Absence of flicker	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d.	Viewing distance	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e.	Angle of view	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f.	Correct Labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g.	Location of indicators	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h.	Indicators inform you of what you need to know					
	(1) in a timely manner	<u>2/ /1</u>	<u>1/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
	(2) with enough precision	<u>2/ /1</u>	<u>1/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
	(3) with relevant information	<u>2/ /1</u>	<u>/3/2</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>
i.	Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2.	CONTROLS					
a.	Size	<u>1/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b.	Shape	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c.	Spacing between controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d.	Resistance (too easy to turn or push, or too hard to turn or push)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

SECTION II-B Continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
e. Correct labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>1/1/1</u>	<u>2/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) <u>Printer paper</u>	<u>/ /</u>	<u>/ /</u>	<u>1 /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-B of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurence	4th Wk	8th Wk	15th WK
1. There is no indicator to tell one when the paper in the line printer is jammed versus being out. This can be determined visually, though.	1	X		
2. Sometimes it is difficult to read the print on the heat sensitive paper.	1	X		
3. Have learned to live with the difficulty in reading the print on the heat sensitive paper.	1		X	

4. Responses to Section II-C of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15 th week)

II.C. CONTROL STATION

Indicate how adequate the Control Station is in each of the following areas:	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. COUNTERS AND INDICATORS					
a. Brightness	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Absence of glare	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Absence of flicker	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Viewing distance	<u>2/ /2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
e. Angle of view	<u>2/ /2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
f. Correct labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Location of indicators	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Counters and Indicators inform you of what you need to know					
(1) in a timely manner	<u>2/ /1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
(2) with enough precision	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
(3) with relevant information	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Other (specify _____)	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. CONTROLS					
a. Size	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>1/1/2</u>	<u>2/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Correct labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-C continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
f. Understandable labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>2/ /2</u>	<u>1/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>2/ /2</u>	<u>1/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>1/1/2</u>	<u>2/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-C of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurence	4th Wk	8th Wk	15th Wk
1. It would be easier if one could see every piece of equipment from the VDT, especially when booting up, but also when testing. The job would go faster then. For example, the line printer has a light that comes on when it runs out of paper, but one can easily overlook this when operating the VDT.	1		X	

5. Responses to Section II-D of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II.D. POWER STATION

Indicate how adequate the DC Power Station is in each of the following areas:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. METERS AND INDICATORS					
a. Brightness	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Absence of glare	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Absence of flicker	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Viewing of distance	<u>3/1/1</u>	<u>/1/2</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
e. Angle of view	<u>3/1/1</u>	<u>/1/2</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
f. Correct labels	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Location of meters and indicators	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Meters and Indicators inform you of what you need to know					
(1) in a timely manner	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
(2) with enough precision	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
(3) with relevant information	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Other (specify)	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. CONTROLS					
a. Size	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>3/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-D Continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
e. Correct labels	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>3/1/2</u>	<u>/1/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>3/1/2</u>	<u>/1/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>2/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>3/2/2</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-D of the ETE Operators' Human Factors Questionnaire

COMMENTS	Occurence	4th Wk	8th Wk	15th Wk
1. It would be easier if one could see every piece of equipment from the VDT, especially when booting up, but also when testing. The job would go faster then. For example, the line printer has a light that comes on when it runs out of paper, but one can easily overlook this when operating the VDT.	1		X	

6. Responses to Section II-E of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II.E. TAPE STATION

Indicate how adequate the Tape Station is in each of the following areas:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. INDICATOR LIGHTS					
a. Brightness	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Absence of glare	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Absence of flicker	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Viewing distance	<u>2/ /2</u>	<u>1/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
e. Angle of view	<u>2/ /2</u>	<u>1/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
f. Correct labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Location of indicators	<u>2/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Indicator lights inform you of what you need to know					
(1) in a timely manner	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
(2) with enough precision	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
(3) with relevant information	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. CONTROLS					
a. Size	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

SECTION II-E continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>2/2/2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Correct Labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>3/ /2</u>	<u>/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>3/ /2</u>	<u>/2/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify)	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-E of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurence	4th Wk	8th Wk	15th Wk
1. It would be easier if one could see every piece of equipment from the VDT, especially when booting up, but also when testing. The job would go faster then. For example, the line printer has a light that comes on when it runs out of paper, but one can easily overlook this when operating the VDT.	1		X	

7. Responses to Section II-F of the ETF Operators' (n=3) Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

II.F. UNIT UNDER TEST (UUT) STATION

Indicate how adequate the
UUT Station is in each of the
following areas:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. CONTROLS					
a. Size	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>2/1/1</u>	<u>/2/2</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Correct labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>2/1/2</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>2/1/2</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>2/1/2</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-F Continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
p. Functional grouping (controls with related functions are grouped together)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-F of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. The DIU panels are sometimes difficult to open all the way when cables are hooked up. This is a problem when running a self test and there is a need to get behind the top panel to interchange some cards.	1	X		

8. Responses to Section II-G of the ETF Operators, (n=3) Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

II.G. PROGRAMABLE INTERFACE UNIT (PIU)
STATION

Indicate how adequate the PIU Station is in each of the following areas:	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. CONTROLS					
a. Size	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Shape	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Spacing between controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Correct labels	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Understandable labels	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Size of labels	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
h. Location of labels	<u>1/2/1</u>	<u>1/1/1</u>	<u>/ /1</u>	<u>1/ /</u>	<u>/ /</u>
i. Absence of unrelated or confusing markings	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Visibility of controls	<u>2/2/1</u>	<u>/1/2</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>
k. Angle of view	<u>2/2/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
l. Location of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
m. Reach distance of <u>critical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
n. Location of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Section II-G Continued

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
p. Functional grouping (controls with related functions are grouped together)	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>2/1/2</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-G of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. Inside the A9A2 universal test point drawer of the PIU the cards are numbered (A1, A2, etc.) but the numbers are covered by a metal plate. One can figure out the number of each card by counting from A1, but one wastes time having to do this each time.	2	X		X
2. Sometimes one has to tweek a resistor in the PIU, and some of them are difficult to get to. Has learned to live with the problem, though.	1	X		

9. Responses to Section III-A of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

III. OVERALL CONFIGURATION OF ETF

A. EQUIPMENT LOCATION

Indicate the adequacy of the location within the ETF of each of the following pieces of equipment.	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Video Display Terminal	<u>2/1/1</u>	<u>/ /</u>	<u>1/1/2</u>	<u>/1/</u>	<u>/ /</u>
2. Printer	<u>3/ /</u>	<u>/2/2</u>	<u>/ /1</u>	<u>/1/</u>	<u>/ /</u>
3. UUT Station	<u>3/1/</u>	<u>/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. PIU Station	<u>2/2/</u>	<u>/ /1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>
5. DC Power Station	<u>3/1/</u>	<u>/1/3</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
6. Control Station	<u>3/1/</u>	<u>/1/3</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
7. Tape Station	<u>3/1/</u>	<u>/1/3</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>
8. Storage Racks	<u>2/ /</u>	<u>1/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>
9. Storage Cabinets	<u>2/ /</u>	<u>1/2/1</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>
10. Work Bench	<u>2/ /</u>	<u>1/3/2</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>
11. Work Desk	<u>2/1/</u>	<u>1/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
12. Cables	<u>3/1/</u>	<u>/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
13. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section III-A of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. The VDT and the PIU are too close together. When an ICD is on the PIU it is difficult to pass between the two. Same problem occurs when one needs to open the PIU drawer.	4	X	X	X
2. The PIU and UUT stations should be interchanged. Then, when an ICD is on the PIU, as is always the case when testing a board, the operator can move about easier. One person could operate the system then, since extender boards would not prevent the VDT operator from getting to the printer or power station if he needed to.	1			X
3. It would be easier for the VDT operator if the VDT were located such that the operator could see everything from the location of the VDT.	1		X	
4. The storage cabinets, especially the overhead ones, should have sliding doors rather than swinging doors. Sometimes when one is looking for something he leaves the overhead cabinet door open while looking below, forgets that it is open, and bangs his head when he raises up. Sliding doors would also not have to have metal latches like swinging doors do.	2		X	X
5. The file cabinet needs to be changed. Two of the drawers will not stay locked and they have to be taped shut during movement.	1			X

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
6. The work bench (near the front of the van) is not a good place for the DCT. It is the wrong height and is uncomfortable for working long hours. One cannot get the chair close enough to the bench and the overhead cabinets are in the way. Putting the DCT on the work table next to the VDT is not good because that space is needed for paper work.	1			X
7. There is not enough space to store TPS's and manuals. A separate van is needed to store TPS's, although the possibility of losing track of a TPS increases when there are two storage places for TPS's (e.g. ETF and an additional van).	2		X	X

10. Responses to Section III-B of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week).

II.B. WORKSPACE

Indicate the adequacy of the Workspace and Storage Space within the ETF:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Amount of workspace	/ /	2/1/1	1/2/2	/ /	/ /
2. Amount of storage space for tools	/ /	2/2/2	1/ /1	/ /	/1/
3. Amount of storage space for manuals	/ /	2/1/	/1/2	1/ /1	/1/
4. Amount of storage space for personal gear	/ /	2/1/	/1/3	1/ /	/1/
5. Amount of storage space for other items <u>TPS's</u>	/ /	/ /	1/2/2	2/ /	/1/1

Comments to Section III-B of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. The space between the VDT and PIU is too narrow to pass through (when an ICD is installed).	3	X	X	X
2. There is no place to tie down tool boxes when moving. Since they have no designated location they just sit anywhere one puts them and sometimes they get in the way.	1	X		
3. It would be helpful if each tool has a designated location in a drawer, rather than just being dumped in a tool box. It would be easier to tell if a tool was missing.	1			X

COMMENTS	Occurence	4th Wk	8th Wk	15th Wk
4. Slings for strapping down the equipment are stored inside the van, where they are taking up needed space. They should be stored in the storage boxes underneath the van, but the storage boxes are not water tight and the slings lose their strength when they get wet.	1		X	
5. There is not enough space to store all of the manuals for the TPS's.	6	X	X	X
6. By rotating the position of the file cabinet in the ETF by 90° another file cabinet could be added for storing manuals.	1			X
7. There is no good place for storing personal gear. Currently put it in the air conditioner room when moving to field, but this is not enough space for all personal gear, and this space is also needed for storing ICD's.	4	X	X	X
8. Personal gear can be stored in the air conditioner room or next to file cabinets when moving. This works out well enough.	2			X
9. There is not enough storage space for ICD's and not enough places to tie all of them down when moving.	8	X	X	X

11. Responses to Section IV-A of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV. JOB PROCEDURES

Indicate how easy or difficult it is to perform each of the following procedures:

A. POWER-UP THE EQUIPMENT

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Prepare the ETF for operation	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Cable the system for operation	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Power up to standby power-on	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Power up to control and display subsystem power-on	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Power up to full power-on	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
6. Recover from loss of power	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
7. Other procedures (specify)	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-A of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurence	4th Wk	8th Wk	15th Wk
NONE				

12. Responses to Section IV-B of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 5th week/8th week/15th week)

IV.B. MAGNETIC TAPE AND DISK CARTRIDGE HANDLING	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Load the magnetic tape	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Unload the magnetic tape	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Install the disk cartridge	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Remove the disk cartridge	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Prepare a new disk for use						
a. Format the disk	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Initialize the disk	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Install a system bootstrap loader	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Transfer OS software from tape to disk	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Build a duplicate disk	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
6. Verify a disk	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
7. Other procedures	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-B of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
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NONE

13. Responses to Section IV-C of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV.C. COMPUTER START-UP	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Normal start up from disk	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Start up from duplicate disk	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Start up from magnetic tape	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Restart system	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Other procedures (speciify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments on Section IV-C of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
NONE				

14. Responses to Section IV-D of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-D. DATA HANDLING	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. System release	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Tape release	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Load UUT program from tape to disk	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Duplicate disk file	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Delete disk file	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
6. Search file name	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
7. Display file content on VDT	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
8. Print file content on printer	<u>2/1/2</u>	<u>/2/1</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
9. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-D of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. It is difficult to read the print on the printer paper. The blue color does not show up too well.	1	X		

15. Responses to Section IV-E of the ETF Operators' (n=3) Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

IV-E. TESTING THE UUT	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Test line replaceable units (LRUs) using the 410	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Identify the UUT to determine the hardware and software necessary to test it	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Select and install the correct memory pack	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Determine the required mode of equipment operation	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Connect the UUT to the 410 while following the display diagrams on the VDT	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
6. Follow the TPS program instructions	<u>3/1/1</u>	<u>/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
7. Probe and test the UUT while following the computer instructions	<u>2/1/1</u>	<u>1/2/1</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
8. Test UUTs with 465 DCT	<u>/1/1</u>	<u>2/1/2</u>	<u>1/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
9. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-E of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. One has to be careful when using a probe to test a board. Connector pins on the boards are close together and one can slip and touch a nearby pin and short things out. Testing has to be a two man operation.	1			X
2. Problems with procedures in loading programs on the DCT. Not enough memory for a long test program.	1	X		
3. Don't really use the DCT that much. Some of the software is not clear; instructions are not in enough detail.	1		X	

16. Responses to Section IV-F of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-F. SELF TESTING AND ALIGNING

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Control and display subsystem testing						
a. Perform the DDOS self test	<u>2/1/1</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Perform the DTOS self test	<u>2/1/1</u>	<u>1/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/1/</u>
c. Perform the video terminal self test	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Perform the line printer self test	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Self Testing						
a. Perform the full ILSSST.IC self test	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Perform the UUT Test Survey Leader self test	<u>2/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Systems Alignment Run the SYSCAL Program						
a. Manual Mode	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Automatic Mode	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Run all Mode	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Information Mode	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Perform the 465 DCT self test	<u>2/1/2</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Other procedures using support equipment	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-F of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
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NONE

17. Responses to Section IV-G of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV.G. OPERATING THE TEST EQUIPMENT	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Operate the computer using the command line printer (CLI)	<u>2/ /2</u>	<u>1/3/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Store and maintain Test Program Sets (TPSs)	<u>2/ /1</u>	<u>/1/1</u>	<u>1/1/1</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>
3. Load paper in the line printer	<u>2/1/1</u>	<u>1/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Use the oscilloscope	<u>1/ /</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

17. Responses to Section IV-G of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. There is not enough room to store all of the TPS's.	4	X	X	X
2. The disk storage cabinet is too small and it is hard to remove the disks.	1		X	

18. Responses to Section IV-H of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-H. POWER DOWN	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. From full power-on to control and display subsystem power-on	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. From control and display subsystem power-on to standby power-on	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. From standby power-on to full power-off	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. From any power-on state to emergency power-off	<u>3/1/2</u>	<u>/2/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
5. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-H of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
NONE				

19. Responses to Section IV-I of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-I. ADMINISTRATIVE AND OTHER PROCEDURES	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Assist the team chief in organizing the workload for the 105 facility	<u> / / </u>	<u> 1/1/2 </u>	<u> 1/1/ </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2. Perform duties of team chief when the team chief is absent	<u> / / </u>	<u> / /1 </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/ </u>
3. Keep up-to-date log on the 410 and 465 run times	<u> / / </u>	<u> 1/3/3 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> 1/ / </u>
4. Advise team chief of improperly handled or abused items	<u> 1/ / </u>	<u> 1/2/2 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
5. Route faulty modules through the fault isolation and repair process	<u> / / </u>	<u> 2/3/2 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
6. Prepare and maintain the required forms, records and reports	<u> / / </u>	<u> 2/3/3 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
7. Assist maintenance technicians in preventative maintenance and repair of the 410	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
8. Use the technical manuals to operate and maintain the test equipment	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
9. Other procedures (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section IV-I of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. Team chief's job is difficult. He has to be in too many places at the same time and everyone wants him at the same time.	3	X	X	X
2. I (assistant team chief) was not trained as a team chief and therefore find it difficult to perform his duties when he is gone, but I can figure some of it out by watching the team chief.	2	X	X	
3. I (team chief) am still learning to prepare and maintain forms, records and reports.	1	X		

20. Responses to Section IV-J of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-J. MAINTENANCE	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Perform preventive maintenance checks and services on the ETF	<u>1 / /</u>	<u>1/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>
2. Repair the 410 by replacing assemblies and PCBs	<u>1 / /1</u>	<u>1/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>
3. Perform preventative maintenance checks and services on the oscilloscope	<u>/ /</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
4. Assist the maintenance technician in performing preventive maintenance and repairs on the 410	<u>/ /</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
5. Remove and replace a power supply	<u>/ /</u>	<u>2/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/2/2</u>
6. Replace test operators panel lamp	<u>1 / /1</u>	<u>1/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>
7. Perform maintenance on the individual stations						
a. DC Station	<u>2 / /</u>	<u>/3/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /1</u>
b. Control Station	<u>1 / /</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/1</u>
c. UUT Station	<u>1 / /</u>	<u>1/2/3</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>
d. PIU Station	<u>2 / /</u>	<u>/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>
e. Tape Station	<u>1 / /</u>	<u>1/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/1</u>
f. 465 DCT	<u>/ /</u>	<u>1/2/3</u>	<u>1 / /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
8. Other procedures (specify)	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-J of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. Making sensitive adjustments (on variable resistors) in UUT station takes too much time. They are too sensitive; adjust them just a little and it is too much.	1		X	
2. The manual for performing maintenance on the DCT is not very clear.	1	X		

21. Responses to Section V of the ETF Operators' (n=3) Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

V. COMPUTER SOFTWARE

Indicate the adequacy of the computer software in each of the following areas:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Type of user-software dialogue	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2. Consistence of display formats	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
3. Clarity of prompts	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
4. Usefulness of prompts	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
5. Timeliness of prompts	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
6. Clarity of error messages	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
7. Usefulness of error messages	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
8. Timeliness of error messages	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
9. Clarity of test procedures listed in the software	<u> / / </u>	<u> 3/2/3 </u>	<u> /1/ </u>	<u> / / </u>	<u> / / </u>
10. Requirements for remembering related information while executing a program	<u> / / </u>	<u> 3/3/3 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
11. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section V of the ETF Operators' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. The software contains a few flaws, e.g., sometimes it will tell you to disconnect a terminal that you have never been told to connect.	1		X	

APPENDIX A

Table A-4

ERF Repairers' Human Factors Questionnaire
(n=4 at 4th and 15th week administrations; n=3 at 8th week administration)

1. Responses to Section I of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

I. ENVIRONMENT

Indicate the adequacy of the following Environmental conditions in the ERF:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Temperature	<u>2/2/3</u>	<u>1/ /</u>	<u>/1/1</u>	<u>1/ /</u>	<u>/ /</u>
2. Ventilation	<u>2/ /</u>	<u>1/3/3</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>
3. Noise	<u>1/ /</u>	<u>3/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Vibration	<u>/ /</u>	<u>2/3/3</u>	<u>2/ /</u>	<u>/ /1</u>	<u>/ /</u>
5. Illumination	<u>2/1/1</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section I of the ERF Repairers' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. We keep the temperature at 65°F, but this is too cool for personal comfort.	2	X	X	
2. Temperature varies a lot from time to time. It will get too hot or too cold, and then one has to adjust the controls on the air conditioners.	1			X
3. If people smoke in the van, it gets smokey after awhile.	2	X		X
4. When someone walks up the back steps of the van the whole van vibrates and can cause problems if you are doing some repair work.	4	X	X	X

2. Responses to Section II-A-1 of the ERF Repairers Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II. WORK AREAS, EQUIPMENT, TOOLS AND PARTS

A. WORK AND STORAGE AREAS

Indicate how adequate the following areas are:

1. WORK STATIONS

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
a. Amount of workspace	<u>1 /</u>	<u>1/2/1</u>	<u>3/1/2</u>	<u>/ /1</u>	<u>/ /</u>
b. Depth (front to rear) of work surface	<u>/ /</u>	<u>2/2/2</u>	<u>2/ /1</u>	<u>/1/1</u>	<u>/ /</u>
c. Width (side to side) of work surface	<u>1/ /</u>	<u>1/2/3</u>	<u>2/1/</u>	<u>/ /1</u>	<u>/ /</u>
d. Height from work surface from floor	<u>1/ /</u>	<u>1/3/3</u>	<u>1/ /1</u>	<u>1/ /</u>	<u>/ /</u>
e. Organization of work station	<u>1/ /</u>	<u>2/2/3</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>
f. Number of electrical outlets	<u>2/2/1</u>	<u>2/1/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Amount of leg room	<u>/ /</u>	<u>2/3/2</u>	<u>/ /2</u>	<u>2/ /</u>	<u>/ /</u>
h. Seating height adjustment	<u>1/ /</u>	<u>1/3/4</u>	<u>2/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Seating backrest	<u>2/ /</u>	<u>1/3/4</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-A-1 of the ERF Repairers' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. There is not enough room on the work desk when one gets tools and parts all spread out.	5	X	X	X

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
2. The work desk gets cluttered with things like all the wires and cords from the equipment. If one is not careful he can burn a cord if it rubs against the soldering iron.	1			X
3. It gets crowded when there are other people in the van; not enough elbow room.	3	X		
4. Legs bump against the trash can under the work desk. Not enough leg room.	4	X		X
5. The work desk is too low.	2	X		
6. The seat at the work desk is too low.	2	X		X
7. The backrest of the chair is too low.	1	X		
8. Lack of leg room is no longer a problem now that I have worked at the work desk for awhile.	1		X	

3. Responses to Section II-A-2 of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II-A-2. INSPECT STATION WITH MICROSCOPE	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
a. Amount of workspace	<u>1 /</u>	<u>3/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
b. Depth (front to rear) of work surface	<u>/ /</u>	<u>4/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Width (side to side) of work surface	<u>/ /</u>	<u>4/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Height of work surface from floor	<u>/ /</u>	<u>2/3/3</u>	<u>2/ /1</u>	<u>/ /</u>	<u>/ /</u>
e. Organization of inspect station	<u>/1/</u>	<u>2/2/4</u>	<u>2/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Number of electrical outlets	<u>1/1/</u>	<u>3/2/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Amount of leg room	<u>2/ /</u>	<u>1/3/4</u>	<u>/ /</u>	<u>1/ /</u>	<u>/ /</u>
h. Seating height adjustment	<u>1/ /</u>	<u>1/3/4</u>	<u>2/ /</u>	<u>/ /</u>	<u>/ /</u>
i. Seating backrest	<u>2/ /</u>	<u>/3/4</u>	<u>2/ /</u>	<u>/ /</u>	<u>/ /</u>
j. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. Inspection station is too low.	3	X		X
2. Not enough leg room.	1	X		
3. The chair backrest is too low.	1	X		
4. For me, everything is too low. I am always bending over, bumping knees, hitting head on ceiling when stepping up on elevated floor at head of van.	1	X		
5. Prefer a work bench with a stool.	1			X

4. Responses to Section II-A-3 of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II-A-3. EYELETING WORK DESK	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
a. Amount of workspace	<u>1 /</u>	<u>4/3/4</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>
b. Depth (front to rear) of work surface	<u>1 /</u>	<u>3/3/4</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>
c. Width (side to side) of work surface	<u>1 /</u>	<u>3/3/4</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>
d. Height of work surface from floor	<u>1 /</u>	<u>2/3/3</u>	<u>2 / 1</u>	<u>1 /</u>	<u>1 /</u>
e. Organization of work bench	<u>1 /</u>	<u>3/3/3</u>	<u>1 / 1</u>	<u>1 /</u>	<u>1 /</u>
f. Number of electrical outlets	<u>1/2/</u>	<u>4/1/4</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>
g. Amount of leg room	<u>1 /</u>	<u>2/3/4</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>
h. Seating height adjustment	<u>1 /</u>	<u>1/3/4</u>	<u>2 /</u>	<u>1 /</u>	<u>1 /</u>
i. Seating backrest	<u>2 /</u>	<u>1/3/4</u>	<u>2 /</u>	<u>1 /</u>	<u>1 /</u>
j. Other (specify) _____	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>	<u>1 /</u>

Comments to Section II-A-3 of the ERF Repairers' Human Factors Questionnaire

COMMENTS	Occurrence	4th Wk	8th Wk	15th Wk
1. Work desk is too low.	3	X		X
2. Not enough leg room	1	X		
3. Kind of cramped	1	X		
4. Seating is too low.	1	X		
5. Prefer a work bench with a stool	1			X

5. Responses to Section II-A-4 of the ERF Repairers Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

II-A-4. BLACK LIGHT INSPECTION STATION	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
a. Amount of workspace	<u>1 /</u>	<u>2/3/4</u>	<u>1 /</u>	<u>/ /</u>	<u>/ /</u>
b. Depth (front to rear) of work surface	<u>/ /</u>	<u>4/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
c. Width (side to side) of work surface	<u>/ /</u>	<u>4/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
d. Height of work surface from floor	<u>/1/</u>	<u>3/2/4</u>	<u>1 /</u>	<u>/ /</u>	<u>/ /</u>
e. Organization of work desk	<u>/1/</u>	<u>4/2/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Number of electrical outlets	<u>/1/</u>	<u>4/2/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-A-4 of the ERF Repairer's Human Factors
Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. The work surface space is o.k., but there are a lot of cabinets around it.	1	X		
2. The height of the work surface is too low; it would be better if it were chest high since all you do is examine a board under the light.	1	X		
3. No seating here. A stool would be useful.	3	X	X	X

6. Responses to Section II-A-5 of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II-A-5. EYEWASH STATION	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
a. Amount of head room	<u>1 / 1</u>	<u>3 / 3 / 3</u>	<u>1 / /</u>	<u>/ /</u>	<u>/ /</u>
b. Depth (front to rear) of station	<u>1 / 1</u>	<u>3 / 3 / 3</u>	<u>1 / /</u>	<u>/ /</u>	<u>/ /</u>
c. Width (side to side) of station	<u>/ /</u>	<u>3 / 3 / 4</u>	<u>1 / /</u>	<u>/ /</u>	<u>/ /</u>
d. Height of eye washers from floor	<u>/ /</u>	<u>4 / 3 / 4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
e. Separation distance of eye washers	<u>/ /</u>	<u>/ 3 / 4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
f. Ease of installing eyewash fluid container	<u>/ 1 /</u>	<u>/ 2 / 4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
g. Other (specify) <u>location</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / /</u>	<u>/ /</u>

Comments to Section II-A-5 of the ERF Repairers' Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. Eyewash station is not easily accessible. It would be better to locate it directly across from the work stations.	1	X		

II-A-6. STORAGE SPACE

Comments to Section II-A-6 of the ERF Repairers' Human Factors Questionnaire

A-4-8

Section II-A-6 continued

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
4. We just stuff the manuals wherever we can.	1		X	
5. When moving, we put our personal gear in the air conditioner room, but there is not enough room to get it all in if each person has several duffel bags as he would in a real combat situation.	10	X	X	X

8. Responses to Section II-B of the ERF Repairers' Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

II-B. EQUIPMENT

Indicate how adequate the
oven is in each of the
following areas:

1. INDICATORS

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate	Did Not Use
a. Brightness	<u>2/1/</u>	<u>/2/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
b. Absence of glare	<u>1/ /</u>	<u>1/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
c. Absence of flicker	<u>1/ /</u>	<u>1/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
d. Viewing distance	<u>2/ /</u>	<u>/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
e. Angle of view	<u>1/ /</u>	<u>1/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
f. Correct labels	<u>2/ /</u>	<u>/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
g. Location of indicators	<u>1/ /</u>	<u>1/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
h. Counters and Indicators inform you of what you need to know						
(1) in a timely manner	<u>/1/</u>	<u>2/2/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
(2) with enough preci- sion	<u>/ /</u>	<u>2/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
(3) with relevant information	<u>/ /</u>	<u>2/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
i. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

2. CONTROLS	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate	Did Not Use
a. Size	<u>/ /</u>	<u>2/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
b. Shape	<u>/ /</u>	<u>2/3/3</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
c. Spacing between controls	<u>/ /</u>	<u>2/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
d. Resistance (too easy to turn or push, or too hard to turn or push)	<u>/ /</u>	<u>2/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
e. Correct labels	<u>/ /</u>	<u>2/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
f. Understandable labels	<u>1/ /</u>	<u>1/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
g. Size of labels	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
h. Location of labels	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
i. Absence of unrelated or confusing markings	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
j. Visibility of controls	<u>1/ /1</u>	<u>1/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
k. Angle of view	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
l. Location of critical controls	<u>1/ /1</u>	<u>1/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
m. Reach distance of <u>critical</u> controls	<u>/1/1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
n. Location of <u>noncritical</u> controls	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
o. Reach distance of <u>noncritical</u> controls	<u>/1/1</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
p. Functional grouping (controls with related functions are grouped together)	<u>/ /1</u>	<u>2/3/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
q. Control type (type of control is appropriate for type of function)	<u>/ /1</u>	<u>2/2/3</u>	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>	<u>2/ /</u>
r. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section II-B of the ERF Repairers' Human Factors
Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. Having trouble finding the right heat setting on the oven. Seven is too high (conformal coating starts to bubble) and four is too low (one board took six days to cure). Some boards cure adequately, though. There are no instructions as to what setting is appropriate.	1		X	
2. It is difficult for me to see the controls and indicators on the bottom of the oven when I am standing.	1			X
3. I would prefer a toggle switch to the present ("rocker") on-off switch. It would be easier to operate.	1			X

9. Responses to Section II-C of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

II-C. TOOLS AND PARTS

Indicate the adequacy of the following:

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Type of tools issued for performing repairs	<u>1/1/1</u>	<u>3/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Ease in using the tools	<u>/ /</u>	<u>4/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
3. Availability of the tools	<u>/ /</u>	<u>3/3/3</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>
4. Availability of repair parts	<u>/ /</u>	<u>1/2/</u>	<u>2/ /2</u>	<u>/1/2</u>	<u>/ /</u>
5. Other (specify) <u>parts manual</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>

Comments to Section II-C of the ERF Repairers' Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. A parts manual is needed to help match a part designated as bad by the computer with the actual location of the part on the board.	1	X		
2. We have the right tools, but not enough to set the system up (e.g. wrenches, pliers, allen wrenches) Don't have any repair parts for the boards yet.	1	X		
3. We have to wait up to a week for some IC chips. It would seem that some chips (e.g., those that are used a lot on TACFIRE boards) could be stockpiled in the ERF.	1	X		

Section II-C continued

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
4. It takes a long time to get repair parts.	3			X
5. It takes awhile to get wheels and brushes for use with the PACE machine. Have not received them even though they were ordered 1 or 2 months ago.	1			X
6. We need somebody with a supply MOS who has some experience in this area. A repairman could handle the job, but if there are a lot of parts that need to be ordered then it takes a lot of time.	1			X
7. We do not necessarily need a separate parts man. The repairers can handle it themselves.	1			X

10. Responses to Section III-A of the ERF Repairers' Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

III. OVERALL CONFIGURATION OF ERF

Indicate the adequacy of the
Location within the ERF of
each of the following pieces
of equipment.

	Completely Adequate	Mostly Adequate	Borderline	Mostly Inadequate	Completely Inadequate
1. Work stations	<u> / / </u>	<u> 4/3/4 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2. Storage cabinets	<u> / / </u>	<u> 4/3/4 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
3. Eyeletting work desk	<u> / / </u>	<u> 4/3/4 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
4. Inspect station with microscope	<u> / / </u>	<u> 4/3/4 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
5. Oven	<u> / / </u>	<u> 2/3/4 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>
6. Eyewash station	<u> / / </u>	<u> 3/3/3 </u>	<u> 1/ /1 </u>	<u> / / </u>	<u> / / </u>
7. Black light inspection station	<u> / / </u>	<u> 4/3/4 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
8. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section III-A of the ERF Repairers' Human Factors
Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. The trays in the oven are too small. One can only put one tray of boards in the oven at once, instead of stacking in three like one should be able to.	1	X		

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
2. The eyewash station is located behind the last work station. Recommend cutting the adjacent table in half, moving the inspection station down to where the eyewash station is and putting the eyewash station in between the inspection station and eyeletting station.	2	X		X

11. Responses to Section IV-A of the ERF Repairers' Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

IV. JOB PROCEDURES

Indicate how easy or
difficult it is to
perform each of the
following procedures:

A. GENERAL DUTIES

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Prepare the ERF for operation	<u>1/1/2</u>	<u>3/2/2</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Locate and identify the faulty component of the PCB	<u>/ /1</u>	<u>1/3/3</u>	<u>/ /</u>	<u>1/ /</u>	<u>1/ /</u>	<u>1/ /</u>
3. Test digital circuit boards using the 465 DCT	<u>/ /</u>	<u>3/ /2</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/2/1</u>
4. Use the digital multimeter	<u>1/1/</u>	<u>1/2/4</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>
5. Inspect repaired PCBs	<u>/ /1</u>	<u>2/3/3</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>
6. Maintain records on repaired PCBs	<u>/ /</u>	<u>1/2/3</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>2/ /</u>
7. Use technical manuals	<u>1/ /</u>	<u>2/3/3</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
8. Operate the 60 KW generator	<u>1/ /</u>	<u>1/2/3</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>2/1/1</u>
9. Operate the van vehicle	<u>/1/</u>	<u>/1/2</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>3/1/1</u>
10. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-A of the ERF Repairers' Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. We need a schematic of each board in order to determine what the faulty component number from the ETF print out is with respect to a given component's location on the board. We had good schematics at school, but don't have them here.	2	X		
2. Was not trained to operate the DCT, but was able to figure it out in order to test a board on it.	2	X		X
3. It is difficult to understand the PMCS manual for the DCT.	1			X
4. Not completely familiar with the digital multimeter.	1	X		
5. At school there was no training on how to maintain records on repairing PCB's and other related administrative matters. Still learning how to do it.	2	X	X	
6. A good system for maintaining records is needed; it is not well laid out right now.	1			X
7. Problems with the technical manuals. Sometimes you look up a part number in the table of contents, and the stock number is not listed. Sometimes the manual does not tell you where something is located.	1			X
8. Backing up the tractor and trailer is difficult. To get the driver's license I only needed to take the test with a five-ton tractor.	1	X		

12. Responses to Section IV-B of the ERF Repairers' Human Factors
Questionnaire (number of responses at 4th week/8th week/15th week)

IV-B. REPAIRING PCB/MODULE	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Remove conformal coating	<u> / /</u>	<u> 2/2/3</u>	<u> 1/1/1</u>	<u> 1/ /</u>	<u> / /</u>	<u> / /</u>
2. Replace conformal coating	<u> / /1</u>	<u> 1/1/2</u>	<u> 1/1/1</u>	<u> /1/</u>	<u> / /</u>	<u> 2/ /</u>
3. Replace defective double lead component	<u> / /</u>	<u> 2/2/3</u>	<u> 2/ /</u>	<u> / /</u>	<u> / /</u>	<u> /1/1</u>
4. Replace defective IC (integrated circuit) DIP (dual-inline package)	<u> / /</u>	<u> 4/3/4</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>
5. Replace defective Flat Pack	<u> /1/</u>	<u> 1/ /3</u>	<u> 3/1/1</u>	<u> / /</u>	<u> / /</u>	<u> /1/</u>
6. Replace defective component on multilayer PCB	<u> / /</u>	<u> 3/1/4</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>	<u> 1/2/</u>
7. Replace defective terminal	<u> / /</u>	<u> 2/1/3</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>	<u> 2/2/1</u>
8. Repair damaged conductor	<u> / /</u>	<u> 3/1/3</u>	<u> / /1</u>	<u> / /</u>	<u> / /</u>	<u> 1/2/</u>
9. Plate damaged pin-type edge connector	<u> / /</u>	<u> 2/1/2</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>	<u> 2/2/2</u>
10. Replace damaged edge connector	<u> / /</u>	<u> 2/1/1</u>	<u> / /</u>	<u> / /</u>	<u> / /</u>	<u> 2/2/3</u>
11. Repair internal run in multilayer PCB	<u> / /</u>	<u> 1/ /4</u>	<u> 2/ /</u>	<u> / /</u>	<u> / /</u>	<u> 1/3/</u>
12. Solder stranded wire to turret terminal	<u> / /</u>	<u> 3/2/4</u>	<u> 1/ /</u>	<u> / /</u>	<u> / /</u>	<u> /1/</u>
13. Solder stranded wire to "J" hook terminal	<u> 1/ /</u>	<u> 2/2/4</u>	<u> 1/ /</u>	<u> 1/ /</u>	<u> / /</u>	<u> /1/</u>
14. Solder stranded wire to pierced terminal	<u> / /</u>	<u> 2/1/4</u>	<u> 1/ /</u>	<u> / /</u>	<u> / /</u>	<u> 1/2/</u>
15. Solder stranded wire to bifurcated terminal	<u> 1/ /</u>	<u> 2/2/4</u>	<u> 1/ /</u>	<u> / /</u>	<u> / /</u>	<u> /1/</u>

Section IV-B continued

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
16. Solder stranded wire to hollow terminal	<u>/ /</u>	<u>2/1/4</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/2/</u>
17. Make wire connections using the wrapping tool	<u>1/ /1</u>	<u>2/1/3</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/2/</u>
18. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-B of the ERF Repairers' Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. It is difficult to remove conformal coating without damaging the board.	1	X		
2. At first I would burn conformal coating off of a board using the soldering iron, but sometimes make a mistake and burn other parts of the board. But I have the procedure down now that I have practiced.	2		X	X
3. Have not really had experience yet in putting on conformal coating.	1	X		
4. There is nothing in the manuals to indicate how much conformal coating to put on; you just have to guess.	1		X	
5. Putting conformal coating on is very sloppy. Using cotton swabs seems to be easiest way.	1		X	

Section IV-B continued

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
6. It is difficult to bind the leads up to military standards when replacing a double lead component like a resistor, even though one can get the component to work.	1	X		
7. Replacing a flat pack is a difficult procedure. Needs a steady hand and practice.	4	X	X	X
8. Sometimes I just lose my patience when repairing a damaged conductor.	1			X
9. Repairing an internal run in a multilayer PCB is just a difficult process. One can hit another run when drilling.	2	X		
10. When soldering terminals, it is difficult to get the right amount of solder on the wire.	1	X		

13. Responses to Section IV-C of the ERF Repairers' Human Factors Questionnaire (number of responses at 4th week/8th week/15th week)

IV-C. MAINTENANCE	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Perform preventative maintenance checks on the ERF	<u>1 /</u>	<u>2/3/4</u>	<u>1 /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Perform preventative maintenance checks on the 465 DCT	<u>/ /</u>	<u>2/1/2</u>	<u>/1/2</u>	<u>/ /</u>	<u>/ /</u>	<u>2/1/</u>
3. Perform preventative maintenance on the Pace Kit	<u>1 /</u>	<u>3/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
4. Perform preventative maintenance on the 60 KW Generator	<u>1 /</u>	<u>2/3/4</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 /</u>
5. Perform preventative maintenance on the vehicle	<u>1 /</u>	<u>/3/3</u>	<u>1 /</u>	<u>/ /</u>	<u>/ /</u>	<u>2 /1</u>
6. Other procedures (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section IV-C of the ERF Repairers' Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. Did not receive training on PMCS.	1	X		
2. I only performed PMCS on the DCT once. I had to figure out what to do. Some things I just did not understand how to do.	2		X	X

Section IV-C continued

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
3. The PMCS manual for the DCT is sometimes difficult to understand.	1			X
4. This was the first time I ever pulled PMCS on the 5 ton.	1	X		

APPENDIX A

TABLE A-5

AN/MSM-105(V)1 Emplacement/Dispalcement Questionnaire
(n=6 at 8th week administration; n=7 at 15th week administration)

1. Responses to Section I of the AN/MSM-105(V)1 Emplacement/Displacement Questionnaire (number of responses at 8th week/15th week)

I. DISPLACEMENT

Indicate how easy or difficult it is to perform the following procedures:

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Sorting out equipment tie-down straps	<u>1/2</u>	<u>4/4</u>	<u>/</u>	<u>/</u>	<u>/</u>	<u>1/1</u>
2. Strapping down equipment	<u>1/2</u>	<u>4/4</u>	<u>/</u>	<u>/</u>	<u>/</u>	<u>1/1</u>
3. Preparing van for movement	<u>/1</u>	<u>6/6</u>	<u>/</u>	<u>/</u>	<u>/</u>	<u>/</u>
4. Performing displacement procedures while wearing NBC protective clothing	<u>/</u>	<u>/</u>	<u>/3</u>	<u>/3</u>	<u>/1</u>	<u>6/</u>
5. Other (specify) _____	<u>/</u>	<u>/</u>	<u>/</u>	<u>/</u>	<u>/</u>	<u>/</u>

Comments to Section I of the AN/MSM-105(V)1 Emplacement/Displacement Questionnaire

COMMENT	Occurrence	8th Wk	15th Wk
1. The NBC gloves are not suitable for grabbing metal objects because they tear, e.g., when lowering jacks, the constant movement back and forth, and jagged metal edges, cut the gloves. Other problem areas include emplacing the catwalk, emplacing the ground straps and rods, and hooking up the cables to the switch box and the generators. We ended up taking the gloves off to do these things.	1		X

Section I continued

COMMENT	Occurrence	8th Wk	15th Wk
2. Tying down some of the support equipment with straps, particularly when threading the buckles, is difficult while wearing NBC gloves. There was no problem tying down equipment with the big "tie-down" straps.	2		X
3. It is impossible to secure the disk drive head in preparation for movement when wearing NBC gloves. One cannot get the screws to the head restraint in or out while wearing NBC gloves.	1		X
4. Installing the ground rod was a problem while wearing NBC protective clothing. It is difficult to see with the mask on and the gloves are just too big.	1		X
5. It is very difficult to do many things while wearing NBC gloves, such as adjusting or tearing down the landing jacks, threading nuts and bolts when assembling or disassembling the passageway, pushing snaps together on the passageway and fastening butterfly nut to ground rod. Most people took off gloves to do this.	3		X
6. My right glove got two holes in it, possibly from catching it on cabinet door latches.	1		X
7. With the mask on, it is harder to see, especially at night. You have to look directly at things. This is a problem for things like driving in the ground rod and getting on top of the van with a ladder.	2		X
8. Raising the platform near the air conditioners at the front of the van is a problem for short people.	2		X

Section I continued

COMMENT	Occurence	8th Wk	15th Wk
9. There was no problem in raising the platform near the air conditioner at the front of the van.	3		X
10. Aligning the front platform holes with the holes in the trailer frame in order to insert a pin and secure the frame during movement was a problem.	3		X
11. Wearing NBC protective clothing takes a lot of energy from you.	1		X

2. Responses to Section II of the AN/MSM-105(V)1 Emplacement/Displacement Questionnaire (number of responses at 8th week/15th week)

II. EMPLACEMENT	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
Indicate how easy or difficult it is to perform the following procedures;						
1. Leveling the van	<u>1</u>	<u>3/6</u>	<u>3/1</u>	<u>1</u>	<u>1</u>	<u>1</u>
2. Unstrapping equipment	<u>2/1</u>	<u>3/6</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1/1</u>
3. Storing Tie-down straps	<u>1/1</u>	<u>4/6</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1/1</u>
4. Checking for equipment damage	<u>1/2</u>	<u>4/5</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1/1</u>
5. Recalibrating equipment after movement	<u>1/1</u>	<u>3/4</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>2/2</u>
6. Performing emp'acement procedures while wearing NBC protective clothing.	<u>1</u>	<u>1/1</u>	<u>1/2</u>	<u>1/4</u>	<u>1</u>	<u>6/1</u>
7. Other (specify) _____	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>

Comments to Section II of the AN/MSM-105(V)1 Emplacement/Displacement Questionnaire

COMMENT	Occurrence	8th Wk	15th Wk
1. A carpenter's level, rather than the bubbles on the side of the van, are used to level the vans. After van is level according to carpenter's level, then adjustments are made until doors open and close easily.	2	X	
2. In soft dirt it is hard to keep the vans level. On last field problem we had to releve after about an hour.	1	X	
3. The problems involved in emplacing while wearing NBC protective clothing are similar to those involved in displacing. See previous section.	7		X

APPENDIX A

TABLE A-6

AN/MSM-105(V)1 Team Chief Human Factors Questionnaire
(n=1 at each administration)

1. Responses to Section I of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

Indicate how easy or difficult it is to perform each of the following procedures.

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
I. ADMINISTRATIVE DUTIES						
1. Organize the workload for efficient use of the test and repair facilities	<u> / / </u>	<u> /1/1 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2. Supervise work and training of 410 operators	<u> / / </u>	<u> /1/1 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
3. Supervise work and training of ERF repairman	<u> / / </u>	<u> /1/1 </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
4. Keep maintenance officer informed of workload	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
5. Familiarize NCOIC's from supported units with 410 capabilities	<u> / / </u>	<u> 1/1/ </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / /1 </u>
6. Identify supported units with high turn-in rate of improperly identified faults	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
7. Inform maintenance officer of units which turn in quantities of improperly handled boards	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
8. Keep maintenance officer informed as to the status and capability of the 410	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
9. Correct work habits of repairers who consistently do unsatisfactory repairs	<u> / / </u>	<u> /1/ </u>	<u> / /1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
10. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section I of the AN/MSM-105(V)1 Team Chief Human Factors
Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. Inexperience makes it somewhat difficult to do team chief's job.	1	X		
2. I find it easier to run the system after doing it for a number of weeks. I understand procedures and forms now. I have started to make better use of the repairers, such as having them order parts, but this takes away from repair time. It would be better to have a parts clerk to handle the ordering of repair parts; one who is familiar with supply forms.	1		X	
3. I feel that it would be useful to receive training on how to set up and tear down the system before having to actually supervise it.	1		X	

2. Responses to Section II of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

Indicate how easy or difficult it is to perform each of the following procedures:

II. OTHER DUTIES	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Monitor performance of 410 self test	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2. Periodically perform function of operator	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
3. Certify that repaired PCBs meet standards set for each item	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
4. Use the technical manuals	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
5. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section II of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

NONE

3. Responses to Section III-A of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III. MAINTENANCE

A. GENERAL

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Insure that OP/ORG maintenance is performed on 5-ton truck	<u> / / </u>	<u> / / 1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/ </u>
2. Insure that OP/ORG maintenance is performed on 60 KW generator	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
3. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section III-A of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT

Occurrence 4th Wk 8th Wk 15th Wk

NONE

4. Responses to Section III-B of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III-B. TAPE STATION	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Remove/replace magnetic tape system	<u> / / </u>	<u> / / </u>	<u> / / 1 </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/ </u>
2. Remove/replace blower assembly	<u> / / </u>	<u> / / 1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/ </u>
3. Remove/replace	<u> / / </u>	<u> / / 1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/ </u>
4. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section III-B of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. It is difficult to get the allen head screw removed in order to remove the B1 assembly from the tape station.	1			X

5. Responses to Section III-C of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III-C. CONTROL STATION	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Remove/replace cartridge disk drive	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
2. Remove/replace computer	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
3. Remove/replace expansion chassis	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
4. Remove/replace blower assembly	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
5. Remove/replace time meter	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/1</u>
6. Remove/replace pushbutton switch	<u>/ /</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>
7. Repair pushbutton switch	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>
8 Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section III-C of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
NONE				

6. Responses to Section III-D of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III.D.	DC STATION	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1.	Troubleshoot power supply control assemblies	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
2.	Repair power supply control assemblies	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
3.	Remove/replace power supplies	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
4.	Remove/replace DC control assembly	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
5.	Repair DC control assembly	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
6.	Remove/replace AC voltage standard	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>
7.	Remove/replace DC voltage standard	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>
8.	Remove/repair/replace AC control panel assembly	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
9.	Troubleshoot DC power station wiring harness	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
10.	Repair AC control basket assembly	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1/1</u>
11.	Other (specify) _____	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>	<u>1/1</u>

Comments to Section III-D of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
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NONE

7. Responses to Section III-E of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III-E.	465 DIGITAL CARD TESTER (DCT)	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1.	Troubleshoot DCT	<u> / / </u>	<u> 1/1/1 </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>
2.	Repair power supply control assemblies	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/1 </u>
3.	Remove/replace frequency counter assembly	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/1 </u>
4.	Remove/replace power meter assembly	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/1 </u>
5.	Remove/replace harmonic frequency converter	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/1 </u>
6.	Remove/replace frequency standard	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> 1/1/1 </u>
7.	Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section III-E of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
NONE				

8. Responses to Section III-F of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III-F. UNIT UNDER TEST STATION (UUT)	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Remove/replace basket assembly	<u>/ /</u>	<u>/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /1</u>
2. Repair wiring harness harness	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/1</u>
3. Troubleshoot wiring harness	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
4. Troubleshoot the DIU subsystem	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
5. Repair the DIU subsystem	<u>/ /</u>	<u>/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/1/</u>
6. Troubleshoot clock subsystem	<u>/ /</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/1/1</u>
7. Troubleshoot RF synthesizer subsystem	<u>/ /</u>	<u>1/1/</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /1</u>
8. Troubleshoot frequency sampling unit subsystem	<u>/ /</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
9. Troubleshoot high speed voltage sampling subsystem	<u>/ /</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
10. Troubleshoot low speed voltage sampling subsystem	<u>/ /</u>	<u>1/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
11. Troubleshoot pulse generator	<u>/ /</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/1/</u>
12. Troubleshoot wave form generator	<u>/ /</u>	<u>/ /1</u>	<u>1/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/1/</u>
13. Troubleshoot low frequency stimulus subsystem	<u>/ /</u>	<u>1/ /1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/1/</u>
14. Adjust power supplies	<u>/ /</u>	<u>/1/1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1/ /</u>

Section III-F continued

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
15. Perform pushbutton switch self test	<u> / / </u>	<u> 1/ / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> /1/1 </u>
16. Other (specify) _____	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>	<u> / / </u>

Comments to Section III-F of the AN/MSM-105 (V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
1. This is just a long difficult procedure.	1	X		

9. Responses to Section III-G of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire (response at 4th week/8th week/15th week)

III-G. PROGRAMABLE INTERFACE UNIT (PIU)	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Troubleshoot the PIU	<u>1 / /</u>	<u>/ 1 / 1</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>
2. Troubleshoot the wiring harness	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / 1 / 1</u>
3. Repair the wiring harness	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>1 / 1 / 1</u>
4. Other (specify) _____	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>	<u>/ /</u>

Comments to Section III-G of the AN/MSM-105(V)1 Team Chief Human Factors Questionnaire

COMMENT	Occurrence	4th Wk	8th Wk	15th Wk
NONE				

APPENDIX A

TABLE A-7

AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator
Human Factors Questionnaire
(n=4)

1. Responses to Section I of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

I. ADMINISTRATIVE PROCEDURES FOR SERVICING THE 410 SYSTEM

Indicate how easy or difficult it is to perform each of the following procedures:

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Maintain technical manuals	—	—	—	—	—	4
2. Use technical manuals	1	1	1	—	—	1
3. Prepare maintenance forms, records and reports	2	1	—	—	—	1
4. Maintain adequate replacement parts	—	—	—	—	—	4
5. Maintain adequate repair and calibration tools	1	1	—	—	—	2
6. Other (specify) _____	—	—	—	—	—	—

Comments to Section I of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

COMMENT

Occurrence

1. Several sentences were missing in the technical bulletin of the modulation analyzer.

1

2. Responses to Section II-A of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

II. REPAIR AND CALIBRATION PROCEDURES FOR THE 410 EQUIPMENT

Indicate how easy or difficult it is to perform each of the following procedures:

A. REPAIR

	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. Power supply	—	—	—	—	—	4
2. DC Voltage standard	—	—	—	—	—	4
3. AC Voltage standard	—	—	—	—	—	4
4. Power sensor	—	—	—	—	—	4
5. Harmonic frequency counter	—	—	—	—	—	4
6. Power meter	—	—	—	—	—	4
7. Frequency counter	—	—	—	—	—	4
8. Network analyzer	—	—	—	—	—	4
9. Other (specify)	—	—	—	—	—	—

Comments to Section II-A of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

COMMENT

NONE

3. Responses to Section II-B of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

B. CALIBRATE	Very Easy	Easy	Borderline	Difficult	Very Difficult	Did Not Perform
1. DC Voltage standard	<u>1</u>	—	—	—	—	<u>3</u>
2. AC voltage standard	—	<u>2</u>	—	—	—	<u>2</u>
3. Harmonic frequency converter	—	—	—	—	—	<u>4</u>
4. Power meter	—	<u>1</u>	—	—	—	<u>3</u>
5. Frequency counter	—	—	—	—	—	<u>4</u>
6. Modulation analyzer	—	—	<u>1</u>	—	—	<u>3</u>
7. Other (specify) <u>465A Digital Card Tester</u>	<u>1</u>	—	—	—	—	—

Comments to Section II-B of the AN/MSM-105(V)1 Electronics Instrument Repairer/Calibrator Human Factors Questionnaire

COMMENT	Occurrence
1. As mentioned earlier, several sentences were omitted from the technical bulletin for the modulation analyzer 82. The problem was corrected using DA Form 2028.	2
2. A potential problem exists with maintaining the DCT. If it is sent to calibration and fails to be calibrated, the calibration personnel will have a very difficult time isolating faults in it because they have no spare boards for it. They would have to try to manually isolate a fault. However, if the DCT is assigned to F level maintenance (i.e. repair in the unit) then the AN/MSM-105 system itself could be used to isolate a fault.	1