ARMY RESEARCH LABORATORY

Human Factors Evaluation of the Enhanced Portable Inductive Artillery Fuze Setter (EPIAFS)

by Orest Zubal

ARL-MR-0678 **October 2007**

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Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5425

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Orest Zubal
Human Research and Engineering Directorate, ARL

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14. ABSTRACT

The enhanced portable inductive artillery fuze setter (EPIAFS) is a product improvement of the portable inductive artillery fuze setter (PIAFS). The EPIAFS was designed to receive data manually and via cable and to inductively set all the fuzes set by the PIAFS and initialize the Excalibur ammunition. The EPIAFS system consists of the platform integration kit (PIK) installed in the howitzer's fire control system, a 15-foot cable to connect the EPIAFS to a PIK receptacle on the howitzer, and the setter which can function in an un-cabled mode, a cabled stand-alone mode, and the cabled mode. EPIAFS is a system that consists of the PIK, cable, and setter. The terms EPIAFS setter and setter are used interchangeably in this report to indicate the portable hand-held portion of the EPIAFS system.

Ten male Soldiers, ranging in rank from E1 to E6, arrived at Picatinny Arsenal, New Jersey, to serve as participants in a limited user test to allow for a human factors assessment of the EPIAFS. The testing centered on the ability of the Soldiers to set up the EPIAFS, use the EPIAFS to set inert fuzes, and secure the EPIAFS after use. Soldiers were taken into the outside sunlight and a no-light room to assess their ability to read the un-cabled display of the setter. The Soldiers wore their battle dress uniform (BDU) or modified mission-oriented protective posture (MOPP) equipment, which consisted of their mask and gloves with inserts, for alternating trials.

The overall times for the Soldiers to set up the EPIAFS, which consisted of unpacking the EPIAFS and cable and connecting one end of the cable to the howitzer connector and the other end to the EPIAFS, were 0.8 minute in BDUs and 0.9 minute in the modified MOPP equipment. To set the first multi-option fuze, artillery (MOFA) required 5.0 seconds in BDUs and 4.5 seconds in the modified MOPP equipment. To set three more MOFAs required 7.7 seconds in BDUs and 7.9 seconds in the modified MOPP. To interrogate (i.e., evaluate) one additional MOFA fuze required 2.2 seconds in BDUs and 2.1 seconds in modified MOPP. To set one excalibur fuze required 11.6 seconds in BDUs and 10.5 seconds in modified MOPP. To secure the EPIAFS after use required 1.3 minutes in BDUs and 1.6 minutes in modified MOPP. None of the Soldiers had any problems reading the EPIAFS display in the sunlight or in the dark room.

The conclusions reached at the end of the trials were that the EPIAFS presented no problems in the ability of Soldiers to unpack, use, secure, and read the EPIAFS in the sun or a dark room. It was recommended that the EPIAFS proceed to its next acquisition cycle.

15. SUBJECT TERMS

artillery; enhanced; fuze; inductive; portable; setter

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1. Background

The portable inductive artillery fuze setter (PIAFS) is an inductive fuze setter that is used to transfer mode and time of flight to fuzes that comply with Standard NATO (North Atlantic Treaty Organization) Agreement (STANAG) 4369 and Allied Ordnance Publication (AOP) AOP-22. The PIAFS has been type classified, produced, and received full materiel release.

The successor to PIAFS is the enhanced portable inductive artillery fuze setter (EPIAFS). Like PIAFS, the pre-planned product improvement EPIAFS interfaces with inductively settable fuzes such as the M762, M782 multi-option fuze for artillery (MOFA) and other fuzes listed in Annex E of AOP-22, but EPIAFS can also be used to set the XM982 Excalibur projectile. The EPIAFS consists of a setter (figure 1), cable for connecting the EPIAFS to the weapon (figure 2), and platform integra-tion kit (PIK) (figure 3).

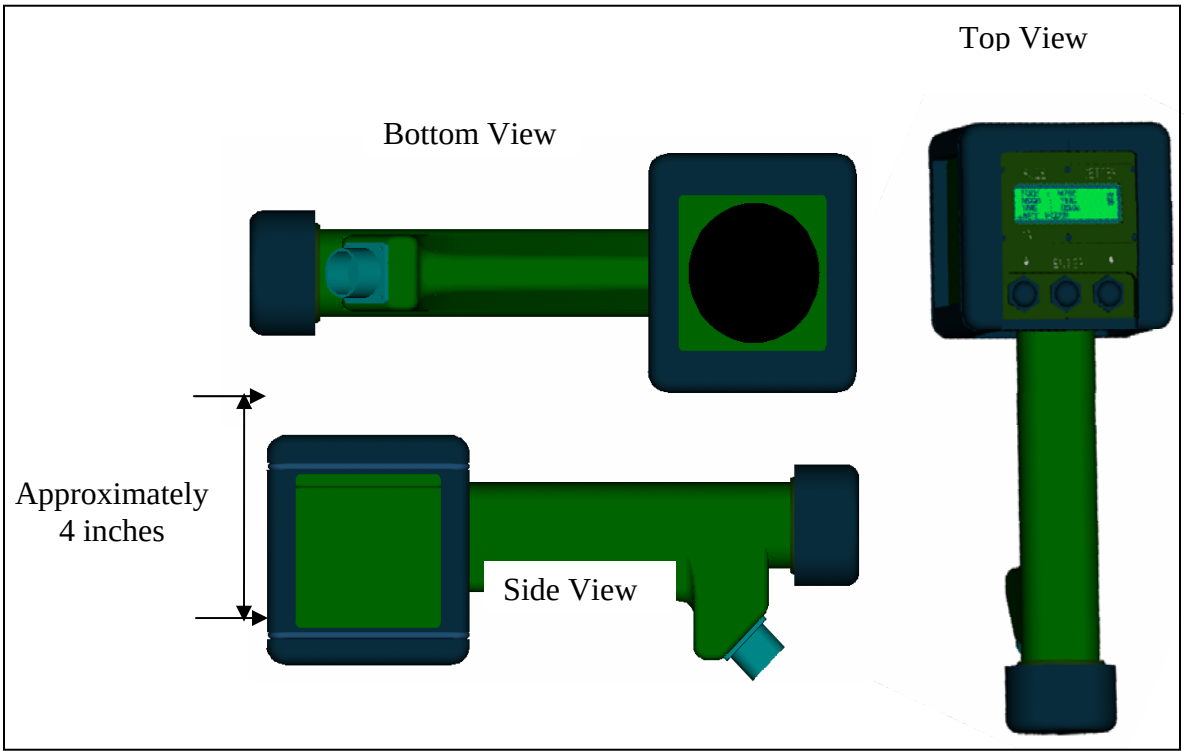

Figure 1. Three views of the EPIAFS setter.

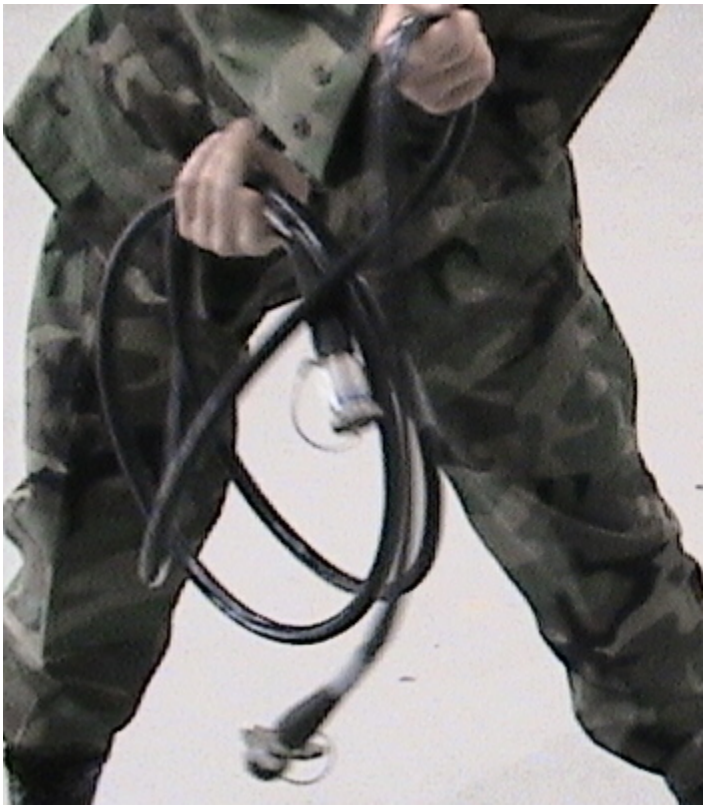

Figure 2. The participant coiling the cable used to connect the setter to the weapon for securing at the end of a trial.

Figure 3. View of the PIK that was integrated in the weapon's fire control system.

The setter can be used in the stand-alone mode (un-cabled) and can set all munitions that can be set by the PIAFS. In the cabled mode, the setter can receive pertinent data through the PIK, and it can be used to set munition, including the Excalibur. The EPIAFS is being integrated onto the joint lightweight howitzer, with future requirements to integrate it onto the Paladin 155-mm self-propelled howitzer.

2. Objectives

The objectives were to investigate the ability of Soldiers to

a. unpack and put into use the EPIAFS,

b. use the received data to set fuzes,

c. interrogate (i.e., ascertain the setting) fuzes,

d. secure the EPIAFS after fuzes are set,

e. read the setter display in various lighting conditions.

3. Methodology

3.1 Participants

Ten Soldiers (all male) arrived at Picatinny Arsenal, New Jersey, from Fort Stewart, Georgia, to participate in the study. The prospective participants were welcomed to the test site and presented with an explanation of the study and the duties they were to perform. They were then presented with the volunteer form (see appendix A). All questions were answered and explained, and the participants were asked to sign the form. After signing the forms, they were randomly divided into two groups, and testing began. One group was to start testing in battle dress uniforms (BDUs); the second group was to start testing in the modified mission-oriented protective posture (MOPP) gear consisting of the mask and gloves with inserts.

3.2 Equipment

The equipment used in the study consisted of the following items:

a. Several items employed to help store the system:

   (1) An old rucksack (figure 4) was used to store the setter and the cable as it would be carried between missions.

   (2) A used flight bag (figure 4) was used to hold the cable for inclusion into the rucksack.

   (3) A converted ammunition box (figure 5) was used to house the setter for inclusion into the rucksack.

b. The PIK was installed in the fire control system of the weapon that will be using the EPIAFS. The PIK receives fire control data and formats them to be sent to the setter for setting the XM982 and other fuzes for firing.

Figure 4. Participant opening flight bag while ammunition box sits in rucksack.

Figure 5. Participant opens the modified ammunition box to extract the EPIAFS setter for this phase of testing.

c. The 15-foot cable is designed to connect the PIK to the EPIAFS setter and provide the physical path for carrying the data and power to the EPIAFS setter. The EPIAFS setter is designed to receive data and power from the PIK and to use them to set the fuze for firing. The EPIAFS setter is designed to operate in three modes which consist of the

(1) un-cabled manual mode, used with standard NATO fuzes only, allows the EPIAFS to operate without receiving data from the PIK and requires the operator to enter the data manually by pushing the control buttons.

(2) cabled manual mode, used with NATO standard inductive fuzes only, with the PIK not communicating and sending data. The Soldier enters the data manually for setting the fuze.

(3) cabled remote mode, for NATO standard fuzes and the Excalibur, with the EPIAFS receiving data from the PIK to set the inductive fuzes for firing.

d. A hand-held stopwatch was used to time all the events that were performed by the Soldiers. The original test plan fuze setting schedule was modified to include only the MOFA M762A1 and the Excalibur fuzes. Also, the times remained the same for each fuze setting, but the order was alternated to between setting the Excalibur and setting the MOFA fuze, setting the three additional MOFA fuzes, and interrogating one MOFA fuze.

3.3 Study Location

The study was conducted in the high bay area in building 31 at Picatinny Arsenal. The weapon and all support equipment were contained in the building; however, the ability of Soldier to read the EPIAFS in bright sunlight or outside light was evaluated by having the Solider step outside and read another EPIAFS display (figure 6).

The ability to read the setter in the dark was conducted in a room with all the lights turned off. The Soldier was given approximately 5 minutes to adapt to the dark and was then asked to read another EPIAFS display.

3.4 Questionnaires and Surveys

A sample of the surveys and questionnaires is shown in the appendices. Appendix B presents the demographic survey with complete results; appendix C presents the sample of the questionnaire presented to the participant at the end of a trial with complete results regarding the participant's sense of using the EPIAFS. Average descriptive results are presented in section 5.3.

Figure 6. Participant stepped outside and demonstrated the ability to read the EPIAFS setter display in existing sunlight.

4. Procedures

After the participants received an introductory briefing, the testing was explained, the participants signed the volunteer form, and the testing began with one Soldier at a time. The Soldier being tested positioned himself over the rucksack and got ready to emplace the EPIAFS. Upon the word "go," a stopwatch was started and he opened the rucksack and extracted the box containing the setter and the flight bag containing the connecting cable. He opened the box and inspected the setter. He then removed the cable from the flight bag, inspected the cable end connectors to ensure that there was no damage, and connected the cable, one end at the howitzer, the other end to the setter, and hit an "ON" button on the setter. The test director was watching the setter and stopped the watch when the setter lit and recorded the time.

For the fuze setting phase, the MOFA fuze was set up on an inert projectile, and three MOFA fuzes were set together in a row on a table top, and one additional MOFA fuze was set on the table. The Excalibur fuze was set up on a chair to elevate it approximately to the level of the MOFA on the projectile.

For testing, 12 trials were designed for the participant to execute. The trials alternated between the MOFA and Excalibur fuzes. For the MOFA fuze, when the data came through the PIK, the participant set the EPIAFS on the projectile fuzed MOFA and announced "set" when the fuze was set. Although the initial plans called for different times to be set at the MOFA fuze, the test support engineer explained that it would be too time consuming to change the time to be set each time a fuze was to be set. He further explained that since the participant did not have to enter the time himself, the same time could be used for all MOFA and Excalibur settings (figure 7).

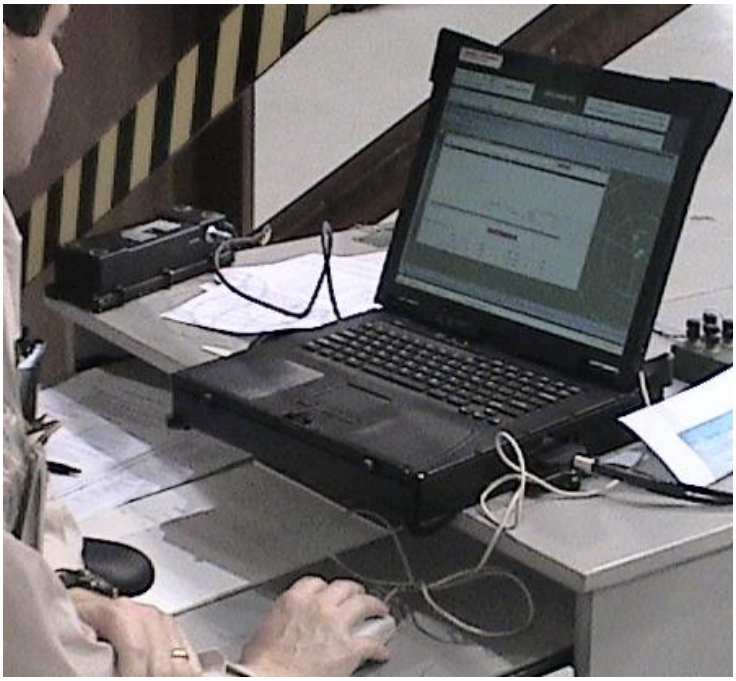

Figure 7. Support engineer getting ready to send data to the EPIAFS setter through the PIK.

Since the availability of the Excalibur fuze was very limited, only one fuze was available for the test (figure 8). When the data were sent by the PIK, the test director started the stopwatch and the participant placed the setter on the Excalibur fuze and pushed the set button. When the Excalibur was set, the participant announced "set," and the test director stopped the watch and recorded the time.

For the MOFA fuze setting (figure 9), the test director started the watch when the PIK sent the data to the setter; he stopped the watch when the participant announced "set". There was no difference in the procedure during this test for setting the MOFA and the Excalibur rounds.

After removing the setter from the fuze, the participant positioned himself next to the three MOFA fuzes and held the setter next to the first fuze. Upon the word "go," the test director started the stopwatch and the participant set the three fuzes by placing the setter on each fuze and hitting the

set button on the EPIAFS setter and announcing “set” when the last fuze was set. The test director stopped the stopwatch and recorded the time. Then the participant positioned himself next to the final MOFA fuze and awaited the signal to interrogate the fuze. Upon the word “go,” the participant placed the EPIAFS setter on the fuze and hit the interrogate button. When the participant announced that he had the data, the test director stopped the watch and recorded the time.

Figure 8. EPIAFS setter being held on excalibur fuze for setting.

Figure 9. Participant, while wearing modified MOPP IV equipment, setting the second MOFA fuze after setting the first MOFA fuze on the left.

When the 12 test runs were completed, the participant was offered a short break and then had to secure the equipment back into the rucksack. The participant could position the equipment any way he pleased before timing started. Upon the word "go," the participant disconnected the cable from the EPIAFS and from the howitzer, replaced the cable end covers, wound the cable and placed it inside the flight bag. Then he placed the EPIAFS in the box, replaced the top cover, and placed the box and flight bag into the rucksack. Time was stopped and recorded when the participant closed the rucksack by pulling the cable, thus closing the rucksack.

The Soldiers not being tested were taken outside to read another EPIAFS display in bright sunlight or were taken into the dark room to test their ability to read the display during dark conditions.

5. Results and Analysis

5.1 Basic Equipment Weight Results

The weight of the EPIAFS and its support equipment as it was used in the study included

a. Weight of rucksack with the EPIAFS setter, box, cable, and flight bag was 30.0 pounds.

b. Weight of the cable with flight bag was 6.7 pounds.

c. The weight of the EPIAFS setter without its carrying container averaged 4.4 pounds, for three separate setters that were available during testing. The setter was weighed without batteries.

5.2 Participants Results

The average participant results are presented in tables 1, 2, and 3.

Table 1. Average basic participant's results.

	Mean	**SD**
Age	28.7 years	7.70 years
Service time	6.3 years, 4.8 months	5.40 years, 3.05 months
Time in rank	1.3 years, 6.2 months	1.57 years, 3.94 months
Time in MOS	6.3 years, 4.4 months	5.40 years, 3.41 months

Table 2. Number of participants in ranks.

Rank	**Number**
E4	4
E5	3
E6	2
E7	1

Table 3. Number of participants reporting crew station positions they held.

Crew Position	Number
Driver	3
No. 1 Cannoneer	1
Gunner	2
Chief of Section	2
Gunnery Sergeant	2

All participants reported 13B as their main military occupational specialty. One participant reported needing glasses while reading, and one reported needing glasses while driving. The remaining eight did not report a requirement for glasses.

5.3 Average Times Results

The average times for setting up and securing the system are shown in table 4. The average times for setting the fuze, setting three more MOFAs, and interrogating one additional MOFA are presented in table 5.

Table 4. Average basic times recorded during setup and securing of the system.

Condition	Setup (min)	SD	Secure (min)	SD
Overall	0.9	0.16	1.5	0.26
BDUs	0.8	0.19	1.3	0.18
MOPP	0.9	0.11	1.6	0.23
BDUs first	0.9	0.21	1.4	0.12
BDUs second	0.8	0.19	1.2	0.15
MOPP first	0.9	0.08	1.6	0.17
MOPP second	0.9	0.13	1.7	0.29

Table 5. Average results of setting the first, setting three more MOFA, and interrogating the MOFA fuze.

	Mean	SD
Condition	(sec)	
Set excalibur overall	11.0	2.37
Set first MOFA overall	4.7	1.59
Set three MOFAs overall	7.8	1.91
Interrogate MOFA overall	2.2	0.39
Set excalibur in BDUs	11.6	2.60
Set first MOFA in BDUs	5.0	1.65
Set three MOFAs in BDUs	7.7	1.98
Interrogate MOFA in BDUs	2.2	0.37
Set excalibur in MOPP	10.5	1.98
Set first MOFA in MOPP	4.5	1.51
Set three MOFAs in MOPP	7.9	1.85
Interrogate MOFA in MOPP	2.1	0.42

A t-test was used to see if the order of the wearing of the uniforms had an influence on the average results. The results indicate that the only significant difference was in securing the system while the BDUs were worn. A complete t-test comparison is provided in appendix D. The complete time results are presented in appendix E.

The time to set and interrogate the MOFA fuze results were subjected to a t-test to see if there was a difference in the order of wearing the uniform on the ability to set one fuze, set multiple fuzes, and interrogate a fuze. The t-test results indicated that there was a significant difference between the first and second times for setting the three additional fuzes in BDUs. Similarly, the t-test revealed a significant difference between setting the Excalibur while BDUs and the limited MOPP gear were worn. No other differences were found. The complete t-test results are presented in appendix D.

5.4 Other Results

It was noted that the EPIAFS would not set a fuze at first attempt when data were sent to it from the PIK. However, applying the EPIAFS a second time and pressing the set button resulted in the fuzes being set. This anomaly was noted occasionally but was covered by the user's manual in its description of procedures to be used when the data were applied to the fuzes.

The transcribed results of the questionnaires and the written comments are presented in appendix C.

6. Conclusions

It was concluded that the EPIAFS was an acceptable item to set up, set fuzes, and secure. Also, it was noted that having the system read in bright sunlight or complete darkness presented no problems.

7. Recommendations

It is recommended that the EPIAFS proceed to full material release phase in its life cycle.

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Appendix A. Volunteer Agreement Affidavit

ID#_____

VOLUNTEER AGREEMENT AFFIDAVIT:
ARL-HRED Local Adaptation of DA Form 5303-R. For use of this form, see AR 70-25 or AR 40-38

The proponent for this research is:	**U.S. Army Research Laboratory Human Research and Engineering Directorate Aberdeen Proving Ground, MD 21005**

Authority:	Privacy Act of 1974, 10 U.S.C. 3013, [Subject to the authority, direction, and control of the Secretary of Defense and subject to the provisions of chapter 6 of this title, the Secretary of the Army is responsible for, and has the authority necessary to conduct, all affairs of the Department of the Army, including the following functions: (4) Equipping (including research and development), 44 U.S.C. 3101 [The head of each Federal agency shall make and preserve records containing adequate and proper documentation of the organization, functions, policies, decisions, procedures, and essential transactions of the agency and designed to furnish the information necessary to protect the legal and financial rights of the Government and of persons directly affected by the agency's activities]
Principal purpose:	To document voluntary participation in the Research program.
Routine Uses:	The SSN and home address will be used for identification and locating purposes. Information derived from the project will be used for documentation, adjudication of claims, and mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State, and local agencies.
Disclosure:	The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this data collection.

Part A • Volunteer agreement affidavit for subjects in approved Department of Army research projects

Note: Volunteers are authorized medical care for any injury or disease that is the direct result of participating in this project (under the provisions of AR 40-38 and AR 70-25).

Title of Research Project:	Title: Human Factors Evaluation of the Enhanced Portable Artillery Fuze Setter (EPIAFS).	
Human Use Protocol Log Number:	ARL--	
Principal Investigator(s):	Orest Zubal US Army Research Laboratory Human Research and Engineering Directorate	Phone: (410) 278-5841 E-Mail: zubal@arl.army.mil
Location of Research:	Picatinny Arsenal, New Jersey	
Dates of Participation:		

Part B • To be completed by the Principal Investigator
Note: Instruction for elements of the informed consent provided as detailed explanation in accordance with Appendix C, AR 40-38 or AR 70-25.

Purpose of the Research

You are being invited to participate in a study designed to evaluate the setting-up, .fuze setting, and securing the Enhanced Portable Inductive Artillery Fuze Setter (EPIAFS) in an artillery environment; as well as reading the screen under various conditions.

Procedures

You will be assigned a participation number and will be asked to complete a demographics questionnaire. You will wear your normal uniform and in another phase you will be asked to wear your MOPP IV mask and gloves.

You will be trained in the setting up, using, and securing the system.

After training, you will be required to perform the tasks on the Light Weight Howitzer. The tasks will be performed, and timed, while you wear BDUs and while you wear you mask and gloves of your MOPP IV gear and will include:

a. Time to set up the system.
b. Time to set the first inert fuze.
c. Time to set up three (3) more inert fuzes.
d. Time to interrogate one inert fuze.
e. Time to secure the system for travel.
f. Readability in dark or sunlit locations
g. Questionnaire answers provided at end of session.

It estimated that your entire involvement should take about 1.5 to 2 hours. You may ask for a break any time; but, you will get a break between training sessions and test run sessions.

Pictures may be taken during your turn and you agree to have your picture taken.

Benefits

You will receive no benefits for participating in this effort, other than the personal satisfaction of supporting research efforts in the development of enhancing the system.

Risks

Risks associated with this effort are minimal. The risks are not unlike those that face soldiers setting fuzes for missions with the Light Weight howitzer. You may choose to withdraw from participating in this assessment at any time without penalty.

Confidentiality

All data and information obtained about you will be considered privileged and held in confidence. Photographic or video images of you taken during this data collection will not be identified with any of your personal information (name, rank, or status). All examinations will be recorded using a volunteer identifier code and a separate file with your consent form and the Principal Investigator will keep your assigned volunteer identifier code in a locked cabinet. Complete confidentiality cannot be promised, particularly if you are a military service member, because information bearing on your health may be required to be reported to appropriate medical or command authorities. In addition, applicable regulations note the possibility that the U.S. Army Medical Research and Materiel Command (MRMC-RCQ) officials may inspect the records.

Disposition of Volunteer Agreement Affidavit

The Principal Investigator will retain the original signed Volunteer Agreement Affidavit and forward a photocopy of it to the Chair of the Human Use Committee after the data collection. The test administrator will provide a copy to the volunteer

Volunteer Statement

I do hereby volunteer to participate in the research project described in the table above. I have full capacity to consent and have attained my 18th birthday. The implications of my voluntary participation, duration, and purpose of the research project, the methods and means by which it is to be conducted, and the inconveniences and hazards that may reasonably be expected have been explained to me. I have been given an opportunity to ask questions concerning this research project. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights or project related injury, I may contact the ARL-HRED Human Use Committee Chairperson at Aberdeen Proving Ground, Maryland, USA by telephone at 410-278-0612 or DSN 298-0612. I understand that any published data will not reveal my identity. If I choose not to participate, or later wish to withdraw from any portion of it, I may do so without penalty. I understand that military personnel are not subject to punishment under the Uniform Code of Military Justice for choosing not to take part as human volunteers and that no administrative sanctions can be given me for choosing not to participate. I may at any time during the course of the project revoke my consent and withdraw without penalty or loss of benefits. However, I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examinations if, in the opinion of an attending physician, such examinations are necessary for my health and well being.

Your signature below indicates that you: (1) are at least 18 years of age, (2) have read the information on this form, (3) have been given the opportunity to ask questions and they have been answered to your satisfaction, and (4) have decided to participate based on the information provided on this form.

Printed Name of Volunteer (First, MI., Last)	
Social Security Number (SSN)	***Permanent Address of Volunteer***
Date of Birth (Month, Day, Year)	
Today's Date (Month, Day, Year)	***Signature of Volunteer***
Signature of Administrator	

Contacts for Additional Assistance

If you have questions concerning your rights on research-related injury, or if you have any complaints about your treatment while participating in this research, you can contact:

Chair, Human Use Committee	**OR**	Office of the Chief Counsel
U.S. Army Research Laboratory		U.S. Army Research Laboratory
Human Research and Engineering Directorate		2800 Powder Mill Road
Aberdeen Proving Ground, MD 21005		Adelphi, MD 20783-1197
(410) 278-0612 or (DSN) 298-0612		(301) 394-1070 or (DSN) 290-1070

Date of preparation of current version: 1 May 2006
Expiration Date: 31 July 2006 Volunteer Initials_____ Administrator Initials_____

Appendix B. Demographic Form and Results

DATE_____ **ID#_____**

1. Date of Birth (YYYY-MM-DD) _____

2. Time in Service Years_____ Months_____

3. Rank _____ Time in Rank Years_____ Months _____

4. Primary MOS _____ Time in MOS Years_____ Months _____

5. Secondary MOS _____

6. Duty Position/Title _____

7. Time in position Years_____ Months_____

8. Are you (circle) Left Handed Right Handed

10. Do you wear glasses/contact No___ Yes___

    If YES, Explain: Reading___ Driving___

    Other(specify)_____

11. Do you have Any problems hearing No___ Yes___

    If YES Explain Hearing Problem_____

_____

12. Vehicle Experience & Crew Positions you have had (Check all that apply)

	COS	Gunner	Asst. Gun.	Driver	Other (Please ID)
M109 Series	[ ]	[ ]	[ ]	[ ]	_____[ ]
Light Weight	[ ]	[ ]	[ ]	[ ]	_____[ ]
M198 Series	[ ]	[ ]	[ ]	[ ]	_____[ ]
Other(Identify)[ ]	[ ]	[ ]	[ ]	[ ]	_____[ ]
	[ ]	[ ]	[ ]	[ ]	_____[ ]

13. Have you ever used the EPIAFS, or PIAFS, before Yes___ No____

    If yes, extent of use; _____

14. Education level (circle) GED High School Some College

Degrees: Associate Bachelor Masters Ph.D. Other>Specify_____

15. Any specialty civilian/military training you received_____

_____

_____

Demographic Results

No.	Birth Date	Age	Service Time Yrs	Service Time Mos		Rank	Rank Time Yrs	Rank Time Mos	MOS	MOS Time Yrs	MOS Time Mos	Sec. MOS		Duty Pos.	Postn Time Yrs	Postn Time Mos		Handed	Wear Glases Yes	Wear Glases No.	Hearing Problem No.
1	1985 01 17	21	2	4		E4	0	10	13B	2	4	NONE		Driver	2	0		Rt		N	N
2	1982 02 27	24	2	4		E4	0	9	13B	2	4	NONE		#1 Man	0	4		Rt		N	N
3	1984 02 05	22	2	4		E4	0	6	13B	2	4	NONE		Driver	1	3		Rt		N	N
4	1980 01 19	26	2	6		E4	0	10	13B	2	6	NONE		Driver	2	3		Rt	Read		N
5	1982 06 03	24	2	1		E5	0	5	13B	2	1	NONE		Gunner	0	5		Rt		N	N
6	1962 12 03	44	9	7		E5	4	6	13B	9	7	NONE		COS	0	3		Lt	Driving		N
7	1970 12 21	36	15	8		E6	3	0	13B	15	8	NONE		Gun Sgt	0	6		Rt		N	N
8	1983 07 28	23	4	10		E5	1	11	13B	4	10	11B		Gunner	2	0		Rt		N	N
9	1970 08 02	36	14	0		E7	3	0	13B	14	0	NONE		COS	0	6		Lt		N	N
10	1975 06 15	31	11	4		E6	2	5	13B	11	0	NONE		Gun Sgt	0	5		Rt		N	N
	Average	28.7	6.3	4.8	E4	4	1.3	6.2	13B	6.3	4.4	1=11B	D	3	0.7	3.5	R	8	Read	1	10
	s.d.	7.70	5.40	3.05	E5	3	1.57	3.94		5.40	3.41		#1	1	0.95	2.17	L	2	Driving	1	
					E6	2							G	2					No	8	
					E7	1							COS	2							
													G S	2							

No.	Vehicle Experince M109 Pos	LWH Pos	M198 Pos	Other M992 Pos		Prev Exp Yes	Prev Exp No	Education	Degree	Special Education
1	Driver			Driver			N	Some College	NONE	CLS (Combat Logistic Support)
2	Driver			NONE			N	Some College	NONE	CLS
3	Driver			NONE			N	High School	NONE	CLS
4	AG,Dr,#1			NONE			N	High School	NONE	CLS
5	G,AG			NONE			N	Some College	NONE	NONE
6	COS			NONE			N	High School	NONE	NONE
7	G,AG,COS			NONE			N	High School	NONE	NONE
8	G			NONE			N	High School	NONE	HAZMAT
9	COS	G,AG,D	COS	NONE			N	College	Associate	NBC,CBL, DS(Defence Support)
10	COS			NONE			N	Some College	NONE	NONE
D	4	1		M992	1	Prev		S C	4	Associate	CLS	4
AG	3	1				Expr	0	H S	5		HAZ	1
G	3	1						C	1		NBC	1
COS	4		1								CBL	1
#1	1										DS	1

Appendix C. Post-Test Questionnaire With Participant Results and Written Comments

ID No. _____ Date _____ Time_____ BDUs or Mask & Gloves

1. The EPIAFS is 1 2 3 4 5
   Very Heavy O.K. Very Light

2. Reading choices in the menu is 1 2 3 4 5
   Very Easy O.K. Very Difficult

3. Verifying that data is correct 1 2 3 4 5
   Very Easy O.K. Very Difficult

4. The buttons are 1 2 3 4 5
   Too Small O.K. Too Large

5. Placing the system on a fuze is 1 2 3 4 5
   Very Easy O.K. Very Difficult

6. Transmitting data to the fuze is 1 2 3 4 5
   Very Easy O.K. Very Difficult

7. Verifying that the fuze is set is 1 2 3 4 5
   Very Easy O.K. Very Difficult

8. Using the system while wearing MOPP IV mask and gloves was
   1 2 3 4 5
   Very Easy O.K. Very Difficult

9. What do you like about the EPIAFS?_____

_____

10. What do you dislike about the EPIAFS?_____

_____

11. What would you change about the EPIAFS?_____

_____

12. Any comments about the study?_____

_____

End of Testing Results

			QUESTION							
	BDU	Part.	1	2	3	4	5	6	7	8
		1	5	1	1	3	1	1	1	NA
		2	1	1	1	3	1	1	1	NA
		3	4	2	1	3	1	1	1	NA
		4	3	2	2	3	1	1	2	NA
		5	4	2	2	3	2	2	2	NA
		6	3	1	1	3	1	1	1	NA
		7	3	1	1	3	1	2	1	NA
		8	4	1	1	3	1	1	1	NA
		9	2	1	2	2	1	1	1	NA
		10	3	2	2	3	2	3	3	NA
	MOPP	1	5	1	1	3	1	1	1	2
		2	5	1	1	3	1	1	1	2
		3	3	3	1	3	1	1	1	3
		4	3	3	1	3	1	1	3	2
		5	4	2	2	3	2	2	2	2
		6	3	1	1	1	1	1	1	1
		7	3	3	2	3	2	1	1	3
		8	4	1	1	3	1	1	1	2
		9	1	1	1	3	1	1	1	2
		10	2	1	2	3	1	1	2	3
Overall	Average		3.3	1.6	1.4	2.9	1.2	1.3	1.4	2.2
	s.d.		1.16	0.76	0.49	0.49	0.41	0.55	0.68	0.63
BDU	Average		3.2	1.4	1.4	2.9	1.2	1.4	1.4	NA
	s.d.		1.14	0.52	0.52	0.32	0.42	0.70	0.70	NA
MOPP	Average		3.3	1.7	1.3	2.8	1.2	1.1	1.4	2.2
	s.d.		1.25	0.95	0.48	0.63	0.42	0.32	0.70	0.63

Transcription of Participant Comments Provided At The End of Each Test Run.

Participant rating comments, regardless of order.

Part.	Unif	Q	ANSWER
1	BDU	9	It was easy to use and quick
		10	There wasn't anything I disliked
		11	There's nothing, I think, that has to be changed
		12	No comments
	MOP	9	Its quick and easy to use
		10	There's nothing that I dislike
		11	I wouldn't change anything
		12	No comments
2	BDU	9	easy, light weight, fast
		10	everything was better than I expected
		11	nothing I thought it was excellent and would recommend it
		12	good study, replaced easy to learn
	MOP	9	easy to use, light weight, easy to train on
		10	nothing that I trained on or came across while using it was bad
		11	nothing, I was very impressed with the EPIAFS
		12	good, relaxed and useful
3	BDU	9	Its simple and you don't have to mess with any other tools
		10	Time it takes to receive data
		11	The strength of the cord it easily bends
		12	It's great to be a part of it and would like to do more research so that the soldier help you to decide whether the equipment is suitable for the field
	MOP	9	Its Easy to use
		10	The cord screws a little fragile
		11	Nothing I think it's great
		12	I'm glad I could be a part of this study
4	BDU	9	Simple and easy to use 3 buttons makes it less confusing, fast to set, easy to verify
		10	cable gets bound at times, data needs to be resent on occasion
		11	The data wire needs to swivel or pivot more while connected to prevent binding
		12	Good familiarization of new rounds and fuzes. Very good hands-on training
	MOP	9	Very simple design. Easy to read and not too many buttons to push. Buttons are placed
		10	Data wire gets bound up at times. If in a live NBC-R environment will Electro Magnetic interference disrupt operation of EPIAFS so an
			mechanical fuze might still be needed
		11	Smaller data cord
		12	None
5	BDU	9	Light weight, User friendly
		10	It is an odd shape

Table C2. Continued

		11	Make screen bigger
		12	Good training
	MOP	9	Versatile, Convenient, Makes our job much easier and effective
		10	No flaws I could see
		11	NONE
		12	Great program, It is good to see the Army is utilizing the latest technology
6	BDU	9	Makes job a lot easier
		10	Maybe a minor problem with a connection viable to EPIAFS system
		11	Not athing
		12	The study is needed to get feedback from us the military who will be using their equipment
	MOP	9	It is very exact and precise, makes setting fuzes very easy for a demanding tasks while operating during combat situations
		10	Nothing to dislike about the new system makes the tasks for us and our soldiers very easy
		11	Only the connection cable into the EPIAFS is a little awkward
		12	I think the study gives us as soldiers a firs hand look at what actually goes on here in the stages just before we receive this vital piece of equipment
7	BDU	9	it's easier to set fuzes
		10	nothing
		11	nothing
		12	NO RESPONSE
	MOP	9	Easier setting fuzes
		10	nothing
		11	nothing
		12	NO RESPONSE
8	BDU	9	that its faster setting the times and it wont set the wrong fuze
		10	nothing
		11	Make connecters easier to connect
		12	Looks like field artillery will have a bright future
	MOP	9	I like that its accurate in setting the fuzes and if you have the wrong fuze it wont set
		10	Nothing
		11	Make the wires easy to connect to it
		12	Great job, and its looks like a bright future for filed artillery
9	BDU	9	Everything is one fuze wrench, its faster
		10	What is the secondary check, one man operator
		11	make it lighter some way to keep the time on to verify
		12	NOTHING
	MOP	9	Less fuze wrenches
		10	No secondary check
		11	weight
		12	Very good

			Table C2. Continued
10	BDU	9	Its easy to work with
		10	nothing
		11	nothing
		12	nope
	MOP	9	It went down on the time using dealing with setting the fuze with the setter
		10	cost too much
		11	nothing
		12	It’s a good experiment that we went through

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Choose al al=0.05

Look up z_{1-al} 1.645

Compute: $u=z_{1-al}SQRT(sig^2a/na + sig^2b/nb)$

Setting the fuzes	Uniform 1st					Uniform 2nd						
Uniform	Condition	Aver a	s.d.^2 a	n a		Aver b	s.d.^2 b	n b		u		Aver a-Aver b
BDUs	Set Excalibur	11.9667	10.6990	30		11.2583	2.7812	30		1.1027		0.7084
	Set MOFA	4.6697	2.2029	30		5.2343	3.2036	30		0.6983		-0.5646
	Set 3 MOFA	8.9320	4.4143	30		6.4647	0.4041	30		0.6593		2.4673
	Inter. MOFA	2.2430	0.1531	30		2.098	0.1078	30		0.1534		0.1450
Mask & Gloves	Set Excalibur	10.7227	5.4448	30		10.2001	2.2745	30		0.8344		0.5226
	Set MOFA	4.8500	3.0151	30		4.2283	1.4467	30		0.6344		0.6217
	Set 3 MOFA	8.1283	5.3411	30		7.6383	1.4695	30		0.7838		0.4900
	Inter. MOFA	2.1597	0.1255	30		2.1030	0.2275	30		0.1784		0.0567

Comparing the two uniforms		BDU				MOPP						
		Aver a	s.d.^2 a	n a		Aver b	s.d.^2 b	n b		u		Aver a-Aver b
Combined	Set Excalibur	11.6125	6.7534	60		10.4167	3.8635	60		0.6920		1.1958
	Set MOFA	4.9520	2.7385	60		4.5392	2.2913	60		0.4763		0.4128
	Set 3 MOFA	7.6983	3.9161	60		7.8833	3.4086	60		0.5748		-0.1850
	Inter. MOFA	2.1705	0.1336	60		2.1313	0.1743	60		0.1178		0.0392

Set-up & Secure		Uniform First				Uniform Second						
Uniform	Condition	Aver a	s.d.^2 a	n a		Aver b	s.d.^2 b	n b		u		Aver a-Aver b
BDUs	Set-up	0.8564	0.0444	10		0.7876	0.0370	10		0.1484		0.0688
	Secure	1.4338	0.0154	10		1.2072	0.0230	10		0.1019		0.2266
Mask & Gloves	Set-up	0.9426	0.0064	10		0.8994	0.0177	10		0.0808		0.0432
	Secure	1.5917	0.0304	10		1.6895	0.0845	10		0.1763		-0.0978

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Appendix E. Overall Time Results to Set Fuzes, With Test Director Comments

			Min utes		MOFA Seconds				Excal Seconds		
No.	Uniform	Order	Set UP	Secure	Trial	set 1st	Set 3	Inter	Trial	Set 1st	Comments
1	BDU	1	0:52.97	1:33.03	2	1.47	11.63	2.41	1	11.59	Problem with host cable and
					4	4.56	8.22	2.41	3	10.82	Flight bag during Secure
					6	4.13	6.97	2.13	5	10.19	
					8	4.41	7.97	2.12	7	10.53	
					10	3.10	6.78	2.37	9	10.84	
					12	4.47	6.63	1.84	11	9.03	
	MOPP	2	0:50.53	1:28.37	2	3.12	6.50	2.31	1	8.07	
					4	3.06	6.53	2.38	3	11.31	
					6	3.62	6.93	1.84	5	11.19	
					8	5.71	7.57	1.88	7	10.47	
					10	3.03	6.50	1.75	9	10.10	
					12	5.75	6.50	1.69	11	10.31	
2	BDU	1	1:11.06	1:25.63	2	3.90	6.87	1.75	1	10.37	Failed to inspect cable pins
					4	5.41	7.00	1.88	3	10.47	Wrong orientation of EPIAFS
					6	4.37	6.38	2.32	5	12.00	
					8	5.05	6.93	1.50	7	17.06	
					10	2.37	7.00	1.60	9	10.69	
					12	4.97	6.59	1.56	11	14.53	
	MOPP	2	1:02.47	2:09.75	2	3.78	10.34	1.87	1	10.62	Failed to inspect EPIAFS pins
					4	4.02	7.96	1.85	3	4.84	Problem connecting EPIAFS
					6	2.56	8.31	2.22	5	7.60	
					8	2.66	9.56	2.13	7	10.69	
					10	4.43	7.63	2.31	9	11.47	
					12	3.56	7.06	1.59	11	11.38	
3	BDU	2	0:37.28	1:06.53	2	4.40	7.44	1.91	1	13.59	*Failed on 1st try
					4	3.03	6.78	1.87	3	14.25	** Failed twice 1st time
					6	4.09	6.25	2.19	5*	14.09	Zipper problem on closure
					8	5.44	6.06	2.06	7**	14.35	
					10	3.41	6.81	2.18	9	12.99	
					12	3.34	5.93	2.13	11	12.59	
	MOPP	1	0:53.50	1:17.34	2	2.59	7.66	2.06	1	9.75	
					4	3.94	6.62	2.16	3	8.56	
					6	2.62	6.97	1.85	5	9.69	
					8	4.72	6.38	2.15	7	11.10	
					10	4.65	6.03	2.75	9	8.32	
					12	3.16	6.19	1.97	11	10.53	
4	BDU	2	0:44.87	1:04.04	2	3.32	6.59	2.50	1	13.50	&Computer problem and
					4	4.76	5.65	2.09	3	11.31	General Izzo commentary
					6	7.00	6.06	2.19	5	9.68	
					8	8.75	6.22	1.97	7	9.87	

					10[&]	8.09	6.03	2.12	9	9.91	
					12	6.66	6.19	2.09	11	12.54	
	MOPP	1	0:52.19	1:43.19	2	5.94	7.88	2.21	1*	12.93	Participant took off glasses
					4	5.56	6.69	1.97	3	10.88	* Computer problem
					6	3.84	6.31	2.38	5	10.19	
					8	7.31	7.10	2.13	7	11.63	
					10	7.18	7.43	2.19	9	9.94	
					12	6.25	7.91	2.39	11	10.56	
5	BDU	1	0:48.03	1:30.84	2	7.31	9.84	2.69	1	12.00	Failed check cable pins set-up
					4	4.37	9.12	2.38	3	13.41	
					6	2.78	8.57	2.91	5	11.84	
					8	8.38	9.40	2.90	7	20.68	
					10	5.50	9.68	2.87	9	11.75	
					12	4.53	8.57	2.35	11	12.72	
	MOPP	2	0:51.72	1:45.90	2	6.66	9.94	2.84	1*	11.28	*Computer problem
					4	5.21	7.87	2.85	3	10.59	
					6	4.09	7.62	2.22	5	10.47	
					8	5.86	8.07	2.87	7	9.96	
					10	5.71	9.28	2.50	9	8.62	
					12	4.72	7.60	2.22	11	11.31	
6	BDU	2	0:41.07	1:25.94	2	3.68	7.69	2.54	1	11.84	
					4	6.53	7.37	2.19	3	11.60	
					6	4.00	7.59	2.91	5	8.38	
					8	5.10	7.06	2.21	7	8.90	
					10	3.63	6.88	1.84	9	10.03	
					12	3.37	6.82	1.91	11	9.78	
	MOPP	1	1:00.56	1:38.41	2	1.35	13.65	2.21	1	13.66	Took glasses off
					4	3.69	14.69	2.15	3*	17.81	*Computer problem
					6	5.53	12.37	2.06	5	9.22	
					8	4.66	8.81	2.69	7	7.87	
					10	8.19	10.63	2.94	9	11.31	
					12	4.46	10.31	2.40	11	14.12	
7	BDU	1	0:48.68	1:26.84	2	6.56	11.78	2.28	1	11.72	*Short stop after 1st
					4*	7.03	13.88	2.44	3	16.34	** Redo
					6	5.41	10.03	2.07	5	11.90	
					8**	3.48	12.21	2.09	7	9.16	
					10	3.56	8.25	1.90	9	11.34	
					12	6.22	6.91	1.82	11	9.97	
	MOPP	2	0:55.50	1:34.44	2	5.59	6.69	1.94	1	11.72	
					4	4.22	6.35	1.78	3	10.54	
					6	5.88	6.25	1.38	5	11.97	
					8	5.12	5.94	1.28	7	10.21	
					10	3.72	6.81	1.47	9	12.09	
					12	3.06	6.28	1.62	11	10.59	
8	BDU	2	1:06.94	1:17.47	2	4.15	6.93	2.12	1	11.59	Convention
					4	3.69	5.78	1.91	3	10.60	*Computer problem
					6	4.59	6.32	1.84	5	9.47	

					8	4.46	5.35	1.56	7	11.56	
					10	4.32	7.37	1.37	9	10.03	
					12	9.16	5.21	1.72	11*	11.19	
	MOPP	1	1:02.84	1:36.82	2	3.85	9.31	2.47	1	16.00	
					4	5.35	7.78	2.07	3	8.75	
					6	3.75	7.31	1.59	5	10.94	
					8	3.47	6.31	1.66	7	9.84	
					10	3.78	5.88	1.78	9	8.40	
					12	5.37	6.47	1.56	11	8.54	
9	BDU	1	0:36.19	1:13.81	2	3.78	13.47	2.60	1	21.69	
					4	4.91	10.88	2.38	3	6.33	
					6	5.69	9.09	2.44	5	11.46	
					8	4.44	10.28	2.28	7	9.85	
					10	4.75	8.85	2.78	9	9.22	
					12	3.18	8.18	2.22	11	9.50	
	MOPP	2	0:40.59	1:28.38	2	4.00	10.06	2.44	1	8.93	Disconnect before light off
					4	3.19	8.06	3.38	3	10.62	
					6	2.65	7.28	2.10	5	9.32	
					8	2.44	8.13	2.10	7	9.34	
					10	4.09	8.28	2.00	9	9.10	
					12	5.34	7.25	2.28	11	11.31	
10	BDU	2	0:46.13	1:08.19	2	5.03	6.38	2.32	1	12.00	*Pick EPIAFS up too fast
					4	6.00	6.25	2.03	3	10.87	
					6	5.00	6.09	1.84	5	10.72	
					8*	8.75	6.22	2.09	7	8.81	
					10	6.53	6.28	2.37	9	11.28	
					12	6.75	6.34	2.87	11	10.43	
	MOPP	1	0:53.68	1:41.75	2	8.72	7.78	2.72	1*	8.47	*Restart
					4	3.75	10.57	2.66	3	11.60	**Computer prob
					6	4.62	6.16	1.97	5	8.97	
					8	7.99	9.47	1.84	7**	8.91	
					10	4.43	6.56	2.03	9	12.31	
					12	4.78	6.62	1.78	11	10.88	

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