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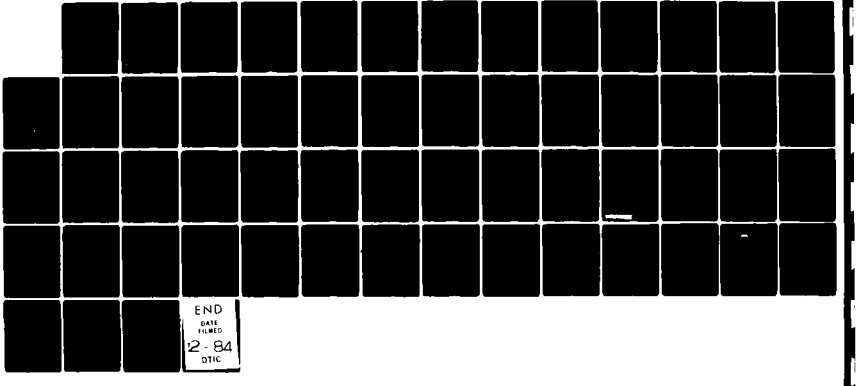

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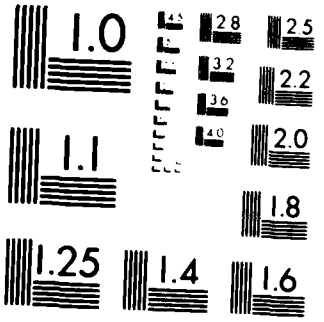

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A136535
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) ABBREVIATED INDEPENDENT EVALUATION REPORT ON THE SURVEY ELECTRONIC DISTANCE MEASURING EQUIPMENT - MEDIUM RANGE (SEDME-MR)	5. TYPE OF REPORT & PERIOD COVERED Final Report December 1979 - June 1983
	6. PERFORMING ORG. REPORT NUMBER NA
7. AUTHOR(s) Roy E. Penepacker	8. CONTRACT OR GRANT NUMBER(s) NA
9. PERFORMING ORGANIZATION NAME AND ADDRESS Directorate of Combat Developments US Army Field Artillery School ATTN: ATSF-CMS, Fort Sill, OK 73503	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NA
11. CONTROLLING OFFICE NAME AND ADDRESS Cdr, US Army Training and Doctrine Command ATTN: ATCD-FA, Fort Monroe, VA 23651	12. REPORT DATE November 1983
	13. NUMBER OF PAGES 52
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE NA

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Prepared to support type classification of the Survey Electronic Distance Measuring Equipment - Medium Range (SEDME-MR).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Distance Measuring Equipment, Infrared Distance Measuring Equipment, Survey Electronic Distance Measuring Equipment - Medium Range (SEDME-MR), Field Artillery Survey Equipment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides the results of the evaluation of four candidate commercial distance measuring equipments to determine the capability of nondevelopmental equipment to satisfy the Letter Requirement for the Survey Electronic Distance Measuring Equipment - Medium Range (SEDME-MR). The report addresses mission performance, operational concepts, and training. Information used in compiling the report was obtained from a Market Survey conducted by USAMERADCOM in 1979-1980 and field evaluations conducted by the 82d Airborne Division Artillery and the US Army Field Artillery School in 1983.

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AD No.
SYSTEMS CATEGORY 4-NDI
TRADOC ACN 68218

INDEPENDENT EVALUATION REPORT ON THE SURVEY ELECTRONIC DISTANCE MEASURING EQUIPMENT - MEDIUM RANGE

(SEDME-MR)

NOVEMBER 1983

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United States Army Field Artillery School

Fort Sill, OK 73503

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PREFACE

This Independent Evaluation Report (IER) is on the Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR). In accordance with TRADOC Reg 71-9, 25 January 1982 and TRADOC Pamphlet 71-13, 9 September 1983, the IER is organized as follows: Executive Summary, Purpose and scope, System description, Adequacy of testing, Test description, Test limitations, Threat, Issues bearing on the decision, Major conclusions, Overall evaluation, General, Authority, Purpose and scope, Background, Adequacy of testing and other data sources, Threat, Issue Analysis, Operational Issues analysis, Organizational issues analysis, Training issues analysis, Other considerations, Summary of Results, and Overall Evaluation.

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EXECUTIVE SUMMARY

a. Purpose and Scope. This evaluation of the SEDME-MR, a non-developmental item, was conducted to support a type classification decision. The objectives included evaluations of mission performance, proposed party organization and the training program.

b. System Description. The SEDME-MR performs the distance measuring function for conventional survey parties. The major components of the system are a distance meter and a reflector set. The function of the distance meter is to measure the slope distance to the reflector set. The sole function of the reflector set is to reflect the light beam transmitted by the distance meter. The SEDME-MR is used in conjunction with angle-measuring equipment, used to determine horizontal and vertical angles. The vertical angles are used to convert the slope distance measured by the SEDME-MR to a horizontal distance required to compute the grid coordinates of survey stations and critical points such as battery centers, sensor positions, etc.

c. Adequacy of Testing.

(1) Test Description. The Market Survey (appendix B) was conducted by MERADCOM during the period December 1979 to June 1980 at Fort Belvoir and Tooele Army Depot. The survey considered two systems capable of meeting the 10 km distance requirement (K&E Uniranger and the Hewlett-Packard HP3808A systems). The HP3808A was subsequently withdrawn from the market. A user field evaluation (appendix C) of the Wild Heerbrugg DI4L Distomat was conducted by two battalion survey parties, 82d Airborne Division Artillery, during the period 7 January-22 April 1983. The USAFAS conducted an evaluation (appendix D) of four candidate systems (Wild Heerbrugg DI4L and DI20, Keuffel and Esser (K&E) Uniranger and Autoranger) from 13 May to 2 June 1983. The USAFAS evaluation included utilization of MOS 82C survey personnel from Battery C, 25th Field Artillery (Target Acquisition Battery), to conduct field surveys as well as other performance checks by subject matter experts from the School and Center.

(2) Test Limitations. USAFAS was unable to make planned comparisons of survey operations with current microwave distance measuring equipment and the candidate systems due to nonavailability of operational microwave equipment. This did not impact the evaluation results since the significant difference between the two parties, the time required to measure distances, was available from literature (microwave) and the field evaluation (SEDME-MR).

(3) Test Observations. None.

d. Threat. Predominantly tank-oriented forces, coupled with numerically superior support artillery, pose the major threat to our forces. The SEDME-MR assists in countering this threat through its contribution to the survey function. The accurate, relative location of weapons and sensors is a significant contributor to the effectiveness of field artillery fires against the threat.

e. Issues Bearing on the Decision.

(1) Can the SEDME-MR perform the survey distance measuring function in an operational environment?

(2) Is the planned survey party organization adequate to effectively employ the SEDME-MR?

(3) Does the proposed training program adequately prepare MOS 82C personnel to effectively employ, operate, and maintain the SEDME-MR in an operational environment?

f. Major Conclusions.

(1) The Market Survey and User Evaluations are adequate to answer the evaluation issues and to support the type classification decision.

(2) A summary of conclusions for each issue and criterion is as follows.

Summary of Conclusions

Objective/Issue/Criteria	System Met Criteria (Yes/No) DI4L	DI2O	Uniranger	Autoranger	Remarks
Mission Performance					
Slope Distance	No	Yes	No	No	See para (3)
Accuracy	Yes	Yes	Yes	Yes	
Internal Battery Life	Yes	Yes	Yes	Yes	
Battery Replacement	Yes	Yes	Yes	Yes	
External Power	Yes	Yes	Yes	Yes	
NBC Operations	Yes	Yes	Yes	Yes	
O&O Plan					
Survey Time Reduction	Yes	Yes	Yes	Yes	
Survey Closure	Yes	Yes	Yes	Yes	
Training					
Level 1 Task	Yes	Yes	Yes	Yes	
Reading Grade Level					
Operator's Manuals	Yes	No	Yes	No	See para (4)
USAFAS Supplemental Material	No	No	No	No	See para (4)

(3) The operational impact of the failure of three candidate systems to satisfy the 10 km slope distance measuring criteria was assessed and the evaluation concluded that the LR performance requirement is not valid and that an instrument capability of 7 km in excellent atmospheric conditions is satisfactory for FA survey operations.

(4) The RGL of operator's manuals and USAFAS training material is listed at Table 8 and discussed at paragraph 2.3.3.1.1.7. The failure of some training materials to meet the RGL criteria had no significant impact on the ability of MOS 82C10 personnel to satisfy Soldier's Manual Level 1 task requirements or the capability of the survey parties to close surveys in accordance with doctrinal standards.

(5) The evaluation also showed that the theodolite telescope mounting system used by some candidate systems is not feasible for FA survey operations and that a yoke type must be utilized.

(6) The USMC has adopted the DI4L for use in the Artillery Battalion Survey Set SL-3, NSN 6676-01088-3179. The evaluation found that the DI4L is also suitable for use in Army FA survey and that adoption of this equipment can provide expedited fielding of the SEDME-MR, result in common training requirements for both services, and utilize common logistical support.

(7) The evaluation also found that the training package for the SEDME-MR must include a discussion of command and control procedures for the TAB CSP.

f. Overall Evaluation.

(1) The use of nondevelopmental equipment to satisfy the SEDME-ME requirement is valid.

(2) The performance of the candidate systems in an operational environment satisfies the Letter Requirement performance requirements with the exception that three of the four candidates could not measure slope distance of 10 km. The evaluation considered the operational environment and recommends that the FA accept a slope distance measuring capability of 7 km.

(3) The candidate systems were operated in an operational environment by representative MOS 82C personnel at Fort Bragg, NC, and Fort Sill, OK. Survey scenarios typical of FA battalion and target acquisition battery operations were conducted and closed (completed) within prescribed doctrinal limits.

(4) The proposed training program, the use of manufacturer's operator's manuals supplemented by USAFAS instructional aids, is satisfactory for fielding but should be supplemented by a discussion of command and control procedures for the target acquisition battery conventional survey party.

(5) The SEDME-MR program is ready for advancement to the procurement phase. This phase can be expedited by Army adoption of the Wild Heerbrugg DI4L, a component of the USMC Artillery Battalion Survey SL-3. Adoption of the DI4L would also provide common training equipment for Army and USMC surveyors at USAFAS and simplify logistics planning in that the USMC has established a depot repair facility for this equipment.

1.0 GENERAL.

1.1 Authority. The authority for this evaluation is the Independent Evaluation Plan (IEP) for the Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR) approved by USACAC on 21 July 1983.

1.2 Purpose and Scope. This evaluation of the SEDME-MR, a non-developmental item, was conducted to support a type classification decision. The objectives included evaluations of mission performance, proposed survey party organization and the training program.

1.3 Background.

1.3.1 Requirement. The Letter Requirement for the SEDME-MR was approved by HQ TRADOC on 2 September 1982 and by HQ DARCOM on 9 November 1982. The LR is at appendix A.

1.3.2 System Description. The SEDME-MR performs the distance measuring function for conventional survey parties. The major components of the system are a distance meter and a reflector set, illustrated at Figure 1.

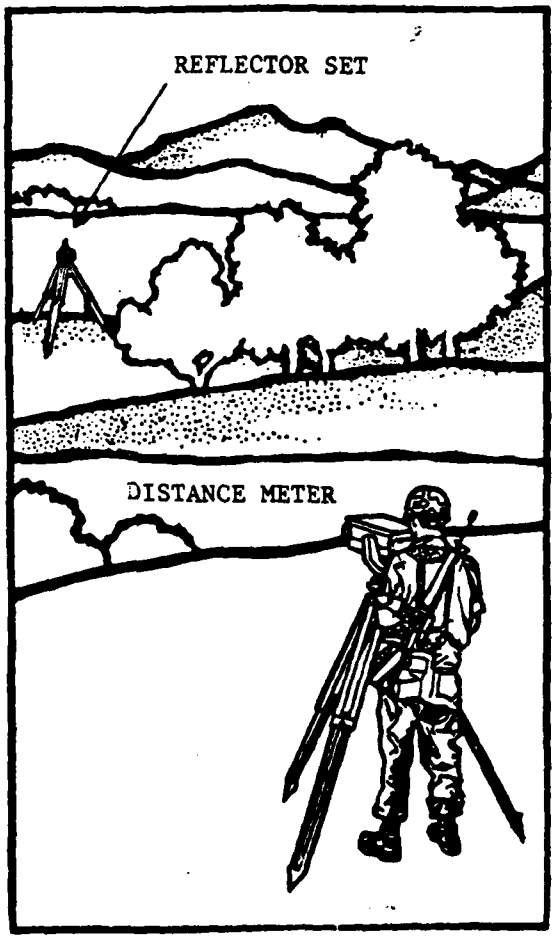

Figure 1. SEDME-MR System Components.

1.3.3 Intended Capability. The SEDME-MR will become the standard distance measuring equipment for FA survey parties. It will initially replace the Survey Instrument Distance Measuring Microwave (SEDME-MW), U69357, on a 1-3 ratio and the Survey Set DME: Infrared (DM-60), U69174, on a 1-1 ratio.

1.3.4 Current Status. Staffing of the LR and the associated Basis of Issue Plan (BOIP) and Qualitative and Quantitative Personnel Requirements Information (QQPRI) have been completed. The LR will be published by HQ TRADOC during November 1983.

1.3.5 Summary of Testing. The Market Survey (appendix B) was conducted by MERADCOM during the period December 1979 to June 1980 at Fort Belvoir and Tooele Army Depot. The survey considered two systems capable of meeting the 10 km distance requirement (K&E) Uniranger and the Hewlett-Packard HP3808A systems. The HP3808A was subsequently withdrawn from the market. A user field evaluation (appendix C) of the Wild Heerbrugg DI4L Distomat was conducted by the two battalion survey parties, 82d Airborne Division Artillery, during the period 7 January-22 April 1983. The USAFAS conducted an evaluation (appendix D) of four candidate systems (Wild Heerbrugg DI4L and DI20, Keuffel and Esser (K&E) Uniranger and Autoranger) from 13 May to 2 June 1983. The USAFAS evaluation included utilization of MOS 82C survey personnel from Battery C, 25th Field Artillery (Target Acquisition Battery), to conduct field surveys and other performance checks by subject matter experts from the School and Center.

1.4 Adequacy of Testing. The primary data sources for the evaluation are informal user evaluations and the market survey. These evaluations do not provide sufficient information to derive statistical data but are adequate to determine whetehr or not a nondevelopmental item (NDI) can be utilized to satisfy the Letter Requirement (appendix A). USAFAS was unable to make planned comparisons of survey operations with current microwave distance measuring equipment and the candidate systems due to nonavailability of operational microwave equipment. This did not impact the evaluation results since the significant difference between the two parties, the time required tc measure distances, was available from literature (microwave) and the field evaluation (SEDME-MR).

1.5 Threat. Predominantly tank-oriented forces, coupled with numerically superior support artillery, pose the major threat to our forces. The SEDME-MR assists in countering this threat through its contribution to the survey function. The accurate, relative location of weapons and sensors in a significant contributor to the effectiveness of field artillery fires against the threat.

2.0 ISSUES AND ANALYSIS.

2.1 Objective 1. Mission Performance.

*2.1.1 Issue. Can the SEDME-MR perform the survey distance measuring functions in an operational environment?

2.1.1.1 Scope.

2.1.1.1.1 This issue addresses the use of the SEDME-MR as the distance measuring equipment in survey parties. The equipment was operated by representative MOS 82C

*Denotes critical issue.

personnel performing instrument operator duties. It was transported in survey party vehicles and with load bearing equipment, when required. The equipment was subject to specific evaluations on known base lines to determine the maximum range and measurement accuracy of each candidate evaluated. The specific areas of interest for this issue include the capacity to measure slope distances of a specified length to a required accuracy, interfaces with other survey equipment such as the standard military tripod, the use of internal/external power sources and operation in a CBR environment.

2.1.1.1.2 Field evaluations were conducted in ambient (existing) weather conditions. Since atmospheric conditions significantly affect infrared measurement capability, it is necessary to define a set of conditions. The following definitions are used in this evaluation.

TERM	DESCRIPTION
Excellent	Overcast, no haze, visibility about 30km, no heat shimmer.
Average	Light haze with visibility about 15km, or moderate sunlight with light heat shimmer.
Poor	Strong haze with visibility about 3km, or very bright sunlight with severe heat shimmer.

2.1.1.1.3 Most distance measuring equipment manufacturers state distance measuring capabilities in relation to excellent atmospheric conditions, and it is assumed that the LR requirement is so stated. Atmospheric conditions were recorded during the USAFAS field evaluations to assist in the preparation of this report.

2.1.1.1.4 The SEDME-MR accuracy requirement stated in this issue differs from that stated in the LR. The LR expresses a technical requirement common to most infrared instruments, whereas the issue criterion states a less stringent comparative accuracy which will satisfy all FA survey operational requirements.

2.1.2 Data Sources.

2.1.2.1 User Evaluation Report for SEDME-MR, USAFAS, July 1983, reference number one.

2.1.2.2. Letter, 82d Airborne Division Artillery, 15 May 1983, subject: "User Evaluation for Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR)," reference number two.

2.1.2.3 Report 2320, Surveying Equipment, Distance Measuring, Electronic US Army MERADCOM, March 1981, reference number three.

2.1.3 Criteria, Analysis, and Conclusions.

2.1.3.1 Criterion. The SEDME-MR shall measure slope distances of 10km with an error of not more than one meter in 5km during day or night operations.

2.1.3.1.1. Analysis.

2.1.3.1.1.1 The DI20 was the only candidate instrument that met the 10km slope range criteria. (The HP3808A also met the requirements, but it has been withdrawn from the market.) A comparison of the manfacturer's stated range capability, the maximum

range obtained during the evaluations, atmospheric conditions (Fort Sill only), and the percent of manufacturer's range capability obtained are listed at Table 1. The failure of DI4L, Uniranger and Autoranger, to measure the maximum range stated by the manufacturer is attributed to atsmospheric conditions (see para 2.1.1.1.2 and 2.1.1.1.3). The significantly better performance of the DI20 is attributed to atmospheric conditions and peak instrument performance.

Table 1. SEDME-MR Distance Measuring Capability

	DI4L	DI20	UNIRANGER	AUTORANGER
Manufacturer's Maximum Range (km)	7	14	10	6.5
Maximum Range Obtained (km)				
USAFAS:	5.9	15	8.3	5.9
Market Survey:	N/A	N/A	8.0	N/A
Percent of Stated Capability				
USAFAS:	84.3	100.1	83.0	90.8
Market Survey	N/A	N/A	80.0	N/A
Atmospheric Conditions				
USAFAS:	Average	Average to Excellent	Average	Poor to Average
Market Survey:			Unknown	

2.1.3.1.1.2 The DI4L was selected for evaluation, even though its range capability does not meet the LR requirement, because it has been procured by the USMC for similar usage in survey parties. Selection by the Army would provide commonality in training and logistical tasks. The Autoranger was offered by the manufacturer and was selected because of its similarity to the DI4L. The impact of the range shortfall is discussed in subsequent paragraphs.

2.1.3.1.1.3 It became apparent to the evaluator during the USAFAS field evaluations that the 10km range requirement is not valid when considered in the context of both angle and distance measuring requirements during survey operations. The limiting factor in these operations is the visibility required to measure angles with optical instruments, particularly during hot weather when heat shimmer degrades visibility.

2.1.3.1.1.4 The 10km criterion was established based on the operational requirements for the fourth-order conventional survey teams at the division artillery level. The USAFAS field evaluation was representative of fourth-order survey operations while the 82d Airborne Division Artillery user evaluation was conducted at the FA battalion level. The average length of traverse legs at Fort Bragg was 548 meters with a range of 126-1319 meters, well within the range capability of all candidate systems. The length of traverse legs on the USAFAS field evaluation varied from 200 to 5900 meters. Ten of the twelve legs were less than 2km and nine of the twelve

were identified with permanent markers, approximately 15 feet in height. Instrument operators had no dfficulty measuring angles to target sets on traverse legs 2km or less in length and to the permanent markers on the 5.9km leg. The target set was not, however, identifiable on this long leg. The evaluator queried survey subject matter experts on this problem and concluded that the maximum traverse leg, given current fourth-order optical and station marking equipment, is approximately 4km. The SEDME-MR should have a slope distance measuring capability of 7km under excellent atmospheric conditions for a reasonable assurance of achieving 4km under poor conditions.

2.1.3.1.1.5 The evaluator could not rank the candidate systems with respect to distance measuring capability because of the significant impact of atmospheric conditions on system operation. These conditions varied during the evaluations (see table 1). All systems are considered acceptable for FA use.

2.1.3.1.1.6 The distance accuracy measuring error ratios obtained on the Fort Sill calibration base lines are listed in Table 2. Market survey data for the Fort Belvoir and Tooele Army Depot calibration lines are at Table 3.

Table 2. SEDME-MR Accuracy Ratios, USAFAS Evaluation

	ACCURACY RATIO (1/n)			
DISTANCE (METERS)	DI4L	DI20	UNIRANGER	AUTORANGER
149.997	74,999	149,998	3,061	5,555
600.083	15,001	120,008	20,012	13,637
649.994	46,428	72,221	18,570	21,666
799.990	66,666	133,331	18,604	133,332
1250.032	31,251	625,016	22,321	24,039
1400.029	48,277	700,007	21,213	23,729
AVERAGE	47,104	300,096	17,296	36,993

Table 3. SEDME-MR Accuracy Ratios, Market Survey

FORT BELVOIR		TOOELE ARMY DEPOT	
DISTANCE (METERS)	ACCURACY RATIO (1/n)	DISTANCE (METERS)	ACCURACY RATIO (1/n)
201.450	25,252	199.252	16,611
351.413	39,062	200.270	11,792
501.337	102,040	201.257	13,404
651.360	64,935	250.130	12,500
751.555	94,339	300.155	17,668
851.316	86,206	860.093	14,836
911.308	70,422	1501.299	33,333
AVERAGE	68,393		17,163

All measurements except one, the Uniranger, on the 149.997 distance at Fort Sill, met the criteria. This is 1 of 20 measurements for the Uniranger and 1 of 38 total measurements. There is a high probability that the Uniranger will satisfy the accuracy criteria on FA surveys. The low accuracy obtained on short distances is sufficient cause to rank it last among the candidate systems. The ranking, based on accuracy data, is: DI20, DI4L, Autoranger, and Uniranger.

2.1.3.1.2 Conclusions.

2.1.3.1.2.1 The DI20 is the only system that meets both the distance measuring and accuracy criteria.

2.1.3.1.2.2. The criterion is not valid with respect to the requirement to measure slope distances of 10km.

2.1.3.1.2.3. The SEDME-MR should have a slope distance measuring capability of 7km in excellent atmospheric conditions.

2.1.3.1.2.4 All candidate systems are satisfactory for survey use.

2.1.3.1.2.5 The Uniranger is the least preferred candidate based on system accuracy.

2.1.3.2 Criterion. Internal batteries shall provide at least 400 measurements per fully charged battery.

2.1.3.2.1. Analysis.

2.1.3.2.1.1. Battery life evaluations were conducted during the Market Survey in 1979-80 and the USAFAS user evaluation in 1983. The K&E Uniranger and the Hewlett-Packard HP3808A instruments were evaluated during the Market Survey. The HP3608A was subsequently discontinued and the Uniranger instrument is the same model evaluated at USAFAS. Uniranger internal components have been improved during the intervening period between the two evaluations; e.g., the measurement time was decreased from 20 seconds to 6 seconds.

2.1.3.2.1.2 The results of the USAFAS and Market Survey evaluations are shown at Table 4. The Uniranger Market Survey results can be disregarded based on the change in internal components discussed in the proceeding paragraph.

Table 4. SEDME-MR Internal Battery Life

EVALUATION	DI4L	DI2O	UNIRANGER	AUTORANGER
	Number of Rangings with Fully-Charged Battery			
USAFAS:	978	1,174	1,032	993
Market Survey:	N/A	N/A	260	N/A

2.1.3.2.2 Conclusion. All candidate systems satisfy the criterion.

2.1.3.3 Criterion. Internal batteries shall be replaceable within 5 minutes by the instrument operator.

2.1.3.3.1. Analysis. The time required to replace internal batteries was evaluated in the Market Survey and the USAFAS evaluation. The Uniranger batteries (two) were changed within 30 seconds during the Market Survey and the evaluator personally observed instrument operators changing batteries on all other candidates in less than 5 minutes during the USAFAS evaluation.

2.1.3.3.2 Conclusion. All candidate systems satisfy the criterion.

2.1.3.4 Criterion. The external power cable shall be configured to permit connection to military batteries.

2.1.3.4.1 Analysis. The capability of all candidate systems to operate from vehicle batteries was demonstrated during the USAFAS evaluation and the Market Survey. In addition, the Uniranger power cable was modified to permit operation from an AN/PRC-77 radio battery. The USAFAS evaluation noted that the length of the vehicle power cable should be at least 20 feet to facilitate vehicle positioning.

2.1.3.4.2 Conclusion. All candidate systems satisfy the criterion.

2.1.3.5 Criterion. The SEDME-MR shall be operable by personnel clothed in chemical/biological protective clothing.

2.1.3.5.1 Analysis. The criterion was evaluated during the USAFAS field evaluation. All candidate systems were operated by personnel clothed in the protective mask and protective gloves.

2.1.3.5.2 Conclusion. All candidate systems satisfy the criterion.

2.2 Objective 2. Organization.

*2.2.1 Issue. Is the planned survey party organization adequate to effectively employ the SEDME-MR?

2.2.1.1. Scope. This issue examines the validity of the O&O Plan for the Target Acquisition Battery (TAB) Conventional Survey Party (CSP) described at appendix E. The primary difference between the TAB CSP and the microwave DME party is that survey party operations can be conducted in less time with two less personnel. The primary purpose of the evaluation is to determine if the projected time savings are valid and that surveys can be completed (closed) in accordance with standards prescribed in FM 6-2, FA Survey.

2.2.2 Data Sources.

2.2.2.1 User Evaluation Report for SEDME-MR, USAFAS, July 1983, reference number one.

2.2.2.2. Letter, 82d Airborne Division Artillery, 25 May 1983, subject: "User Evaluation for Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR)," reference number two, FM 6-2, reference number four, and FM 6-82C1, reference number five.

2.2.3 Criteria, Analysis, and Conclusions.

2.2.3.1 Criterion. The TAB CSP shall permit completion of a given traverse in 30 percent less time than that required for a DME party.

2.2.3.1.1 Analysis.

2.2.3.1.1.1 The data for evaluation of this criterion was obtained from the USAFAS field evaluation. A direct comparison of the two types of survey parties (TAB CSP versus DME microwave) was not possible due to the nonavailability of microwave DMEs. The method used was to determine the time required to measure distances during the field evaluation and compare this time with that expected with the microwave measurement time as determined from task number 061-302-1009, FM 6-82C1 and FM 6-2. This time is 30 minutes. The delta time is then applied to an average survey time from the field evaluations to determine the time savings.

2.2.3.1.1.2 The time required to conduct the field evaluation surveys and the average time required to measure a distance with the candidate systems is shown at Table 5.

Table 5. Time Expended on Field Surveys and Distance Measurements

	SURVEY INTERATION			
Time	1st/Uniranger	2d/DI4L	3d/Autoranger	4th/DI20
Total	7 hrs/40 min	5 hrs/14 min	4 hrs/35 min	2 hrs/20 min*
Average/ per distance measurement	10 min	6 min	6 min	6 min

*shortened survey

2.2.3.1.1.3 The reduction in survey time with the SEDME-MR is shown at Table 6. The SEDME-MR time is the average of the time required for the 2d and 3d iterations. The average time required to measure distances with the SEDME-MR is 7 minutes; the time required to measure a distance with the DME microwave is 30 minutes. There are 11 traverse legs in the survey. The reduction in survey time is 23 minutes per distance measured. The total time savings is shown.

Table 6. Reduction in Survey Time.

Survey Time (min)		Time	Percent	
w/DME	w/SEDME-MR	Reduction	Reduction	Criterion
547	294	253	46	30

2.2.3.1.2 Conclusion. The SEDME-MR provides at least a 30 percent savings in the time required to conduct a traverse.

2.2.3.2 Criterion. Survey closure errors shall meet or exceed the criteria for fourth-order survey specified at appendix E, FM 6-2, FA Survey.

2.2.3.2.1. Analysis

2.2.3.2.1.1. Appendix E, FM 6-2, provides closing criteria for position (1:3000), height (the square root of the total length of the traverse), and azimuth (0.1 mils times the square root of the number of stations).

2.2.3.2.1.2. The position closing errors for the four surveys conducted at USAFAS are listed at Table 7. All closures were significantly better than the required 1:3000. Azimuth and height errors were not reported in the USAFAS User Evaluation Report; however, the evaluator personally verified that the errors were within the specified criteria.

Table 7. Survey Position Closure Error

SURVEY ITERATION	CANDIDATE DME	POSITION CLOSING ERROR
First	Autoranger	1:80,000
Second	DI4L	1:29,200
Third Autoranger	Autoranger	1:24,400
Fourth	DI20	1:9,500

2.2.3.2.1.3 Although the criterion address only fourth-order survey operations, data was collected from the 82d Airborne Division Artillery to determine if candidate SEDME-MR also met the less stringent fifth-order, (1:1000) position closing criteria. The average position closing error in the eleven surveys conducted by the Division was 1:2,800, well above the required accuracy.

2.2.3.2.2. Conclusion. Surveys conducted with candidate SEDME-MR will satisfy the closing criteria for fourth-and-fifth-order surveys specified by FM 6-2.

2.3 Objective 3. Training.

2.3.1 Issue. Does the proposed training program adequately prepare MOS 82C personnel to effectively employ, operate, and maintain the SEDME-MR in an operational environment?

2.3.1.1 Scope. This issue evaluates the adequacy of commercial equipment manuals for use in the training program. The scope includes training provided by manufacturer's representatives, operator manuals with candidate systems, supplemental training material developed by USAFAS, and the training program utilized to train equipment operators.

2.3.2 Data Sources.

2.3.2.1 User Evaluation Report for SEDME-MR, USAFAS, July 1983, reference number one.

2.3.2.2 Letter, 82d Airborne Division Artillery, 25 May 1983, subject: "User Evaluation for Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR)," reference number two.

2.3.2.3 Computer printouts ASVAB scores for MOS 82C10 personnel, Fort Sill and Fort Bragg and methodology for determining Reading Grade Levels, USA Soldier's Support Center, 22 June 1983, reference number five.

2.3.2.4 DF, ATSF-DA, USAFAS, 3 September 1982, subject: "Target Reading Grade Levels for Proponent MOS and Skill Levels," reference number six.

2.3.2.5 HQ, Department of the Army, FM 6-82C1/2, Soldier's Manual, Field Artillery Surveyor, Skill Level 1/2 November 1979, reference number seven.

2.3.2.6 Wild Heerbrugg, Ltd, Operator's Manual, Wild DISOMAT DI4L, undated, reference number eight.

2.3.2.7 Wild Heerbrugg, Ltd, Operator's Manual, Wild DISOMAT DI20, undated, reference number nine.

2.3.2 8 Keuffel and Esser Company, Operating Manual, Uniranger EDM Electronic Distance Measuring Equipment, undated, reference number ten.

2.3.2.9 Keuffel and Esser Company, Operating Manual, Autoranger EDM Electronic Distance Measuring Equipment, undated, reference number eleven.

2.3.3 Criterion, Analysis and Conclusions.

2.3.3.1 Criterion. Ninety percent of the operators trained with the proposed training package shall be able to perform the Soldier's Manual Level 1 task for SEDME-MR. The reading grade level (RGL) of the training equipment publications shall be within ±1 RGL of the target audience as specified in the proponent's target audience descriptions.

2.3.3.1.1 Analysis.

2.3.3.1.1.1 Since a Soldier's Manual Level 1 task was not available for the SEDME-MR, operator performance was compared against Soldier's Manual task 001-302-1020 for the DM-60, the present infrared distance measuring equipment authorized in FA battalion/battery survey parties. The operation of this equipment is very similar to the candidate systems in this evaluation. The task requires that

soldiers be able to successfully measure three distances (from the same location) within 10 minutes.

2.3.3.1.1.2 Reading Grade Levels (RGL) for operator's manuals and USAFAS supplemental material were determined using the Flesch-Kincaid method.

2.3.3.1.1.3 The initial two operators at the 82d Airborne Division Artillery were trained by the manufacturer's representative in a 30-minute class. Two additional operators were trained by MOS 82C supervisory personnel in the same manner. The only training material used was the equipment operator's manual. The evaluation report commented on the need for additional training material to supplement the operator's manual.

2.3.3.1.1.4 Manufacturer's representatives conducted training for USAFAS subject matter experts who then conducted 3 hours of instruction for two player personnel prior to the field evaluations. The instruction consisted of 20 minutes on the O&O plan, 40 minutes on the equipment, and a 2-hour practical exercise on distance measuring. The manufacturer's operator's manual and USAFAS supplemental material were used. The equipment training was repeated for each candidate system.

2.3.3.1.1.5 The average time required to measure three distances during the USAFAS field evaluation was 10 minutes for the Uniranger and 6 minutes for all other candidates. The average time required to measure three distances during the 82d Airborne Division Artillery evaluation was 2 minutes (Wild DI4L only). All six operators demonstrated Soldier's Manual Level 1 task proficiency with the candidate instruments.

2.3.3.1.1.6 The reading grade level of MOS 82C10 personnel at Fort Bragg and Fort Sill was determined to be 10.3, based on input from reference five. The RGL of the target audience for this evaluation was determined to be 10.1 years, based on reference six. The RGL of the target audience, equipment operators manuals, and USAFAS supplemental training material is compared at Table 8.

Table 8. Comparison of Reading Grade Levels for Target Audience and Training Materials

	Operator's Manual				USAFAS Training Material
	DI4L	DI20	Uniranger	Autoranger	
RGL	10.8	8.6	10.1	7.4	5.7
MOS 82C10	10.1	10.1	10.1	10.1	10.1
Difference	+0.7	-1.5	----	-2.7	-4.4
Criteria Met	Yes	No	Yes	No	No

2.3.3.1.1.7 The RGL of the DI20 and Autoranger operator's manuals and the USAFAS training material is more than one RGL below the target audience. In view of operator capability to determine distances within the prescribed time criteria and the capability of the parties to close surveys within prescribed doctrinal criteria, there is no significant impact on training caused by the failure to meet the ±1 RGL criteria.

2.3.3.1.1.8 The evaluator investigated further to determine why operators commented on the need for supplemental material, since some operator's manuals met the RGL criteria. Operators expressed a preference for the K&E operator's manuals because they contained far less discussion than the Wild Heerbrugg manuals. The Wild Heerbrugg manuals contained descriptions on many optional items of equipment not utilized in the USAFAS/Fort Bragg evaluations. Both the Wild and the K&E manuals contain discussion of environmental corrections which are not required for FA surveys. Thus, the USAFAS supplemental material is important in that it provides only what the operator needs to know to operate the equipment.

2.3.3.1.2 Conclusion. The proposed training package, consisting of the operator's manual and supplemental USAFAS material, is adequate to conduct operator training.

3.0 ADDITIONAL CONSIDERATIONS.

3.1 Equipment.

3.1.1 Interface Problems.

3.1.1.1 Discussion.

3.1.1.1.1 Candidate system distance meters were configured with two mounting methods. The K&E Uniranger utilizes a stand-alone yoke mount which can be inserted into the theodolite tribrach. The other candidate meters can be mounted on the theodolite with adapters, or a yoke can be utilized in the same manner as the Uniranger. Both mounting configurations were evaluated during the USAFAS field evaluation. The theodolite mount was used for the DI4L at Fort Bragg.

3.1.1.1.2 The evaluators noted interface problems with the theodolite mounting of the DI20 and Autoranger during the USAFAS evaluation. Both instruments interfered with the vertical movement of the theodolite telescope.

3.1.1.1.3 The DI4L and the Autoranger theodolite mounting systems will cause logistical problems in that a variety of mounts/adapters would be required to fit the several different models of theodolites in the inventory.

3.1.1.2 Conclusion. The SEDME-MR must utilize a yoke-mounting configuration.

3.1.2 Equipment Performance.

3.1.2.1 Discussion. Although all candidate systems satisfy the mission performance criteria for accuracy, the USAFAS evaluation noted that the K&E equipment was less accurate at short ranges (200-300 meters) and that they were difficult to calibrate during windy conditons.

3.1.2.2 Conclusion. Production acceptance tests for SEDME-MR should include checks on accuracy obtained on short distances of 300 meters or less and calibration under windy conditions.

3.1.3 USMC Equipment.

3.1.3.1 Discussion.

3.1.3.1.1 The DI4L equipment utilized during the USAFAS evaluation was obtained from the USMC and was retained by the School for the purpose of training USMC survey personnel. The equipment is a component of the USMC Artillery Battalion Survey Set

SL-3, NSN 6675-01-088-3179. The SL-3 components are not compatible with Army requirements for the SEDME-MR. For example, only one reflector is authorized and the Army will require three reflectors to measure longer distances. In addition, the DI4L will be mounted on the theodolite (only one model involved) versus the Army need for a yoke mount. The USMC has not type classified the DI4L as a separate TOE line item.

3.1.3.1.2 Army adoption of the DI4L as the SEDME-MR offers the following advantages: (1) Provides expedited fielding since the Army can transfer funds to USMC for non-competitive purchase of the item; (2) Results in common training equipment and instruction for Army and USMC survey personnel at the USAFAS; (3) Enhances logistical planning since the USMC has established a depot repair capability at the Marine Corps Depot, Albany, GA.

3.1.3.2 Conclusions.

3.1.3.2.1 Army adoption of the DI4L can provide expedited fielding, enhance training effectiveness, and enhance logistics planning.

3.1.3.2.2 The components of the DI4L must be reconfigured to support SEDME-MR requirements.

3.2 Doctrinal Literature.

3.2.1 Discussion.

3.2.1.1 The results of the USAFAS field evaluation disclosed a significant learning curve for the total time required to conduct the survey. The time required decreased from 7 hours and 40 minutes on the first interation to 4 hours and 35 minutes on the third iteration. Subject matter experts and the evaluator noted that most of the initial delays were caused by poor command and control procedures; i.e., failure to keep party elements informed of the plan and lack of an efficient plan to move reflectors.

3.2.1.2 A review of the Operational and Organizational (O&O) Plan and FM 6-2 indicates that command and control procedures are not discussed therein.

3.2.2 Conclusion. Supplemental training literature utilized for fielding should include command and control procedures for party operations.

4.0 SUMMARY OF RESULTS.

4.1 The Market Survey and User Evaluations are adequate to answer the evaluation issues and to support the type classification decision.

4.2 No additional testing is required.

4.3 A summary of conclusions for each issue and criterion is at Table 9.

Table 9. Summary of Conclusions

Objective/Issue/Criteria	System Met Criteria (Yes/No) DI4L	DI2J	Uniranger	Autoranger	Remarks
Mission Performance					
Slope Distance	No	Yes	No	No	See para 4.4
Accuracy	Yes	Yes	Yes	Yes	
Internal Battery Life	Yes	Yes	Yes	Yes	
Battery Replacement	Yes	Yes	Yes	Yes	
External Power	Yes	Yes	Yes	Yes	
NBC Operations	Yes	Yes	Yes	Yes	
O&O Plan					
Survey Time Reduction	Yes	Yes	Yes	Yes	
Survey Closure	Yes	Yes	Yes	Yes	
Training					
Level 1 Task	Yes	Yes	Yes	Yes	
Reading Grade Level					
Operator's Manuals	Yes	No	Yes	No	See para 4.5
USAFAS Supplemental Material	No	No	No	No	See para 4.5

4.4 The operational impact of the failure of three candidate systems to satisfy the 10km slope distance measuring criteria was assessed at paragraph 2.3.1.1.4. The evaluator concluded that the LR performance requirement is not valid and that an instrument capability of 7km in excellent atmospheric conditions is satisfactory for FA survey operations.

4.5 The RGL of operator's manuals and USAFAS training material is listed at Table 8 and discussed at paragraph 2.3.3.1.1.7. The failure of some training materials to meet the RGL criteria had no significant impact on the ability of MOS 82C10 personnel to satisfy Soldier's Manual Level 1 task requirement or the capability of the survey parties to close surveys in accordance with doctrinal standards.

4.6 The evaluation also showed that the theodolite telescope mounting system used by some candidate systems is not feasible for FA survey operations and that a yoke type must be utilized.

4.7 The USMC has adopted the DI4L for use in the Artillery Battalion Survey Set SL-3, NSN 6676-01088-3179. The evaluation found that the DI4L is also suitable for use in Army FA survey and that adoption of this equipment can provide expedited fielding of the SEDME-MR, result in common training requirements for both services, and utilize established logistical support.

4.8 The evaluation also found that the training package for the SEDME-MR must include a discussion of command and control procedures for the TAB CSP.

5.0 OVERALL EVALUATION.

5.1 The use of nondevelopmental equipment to satisfy the SEDME-MR requirement is valid.

5.2 The performance of the candidate systems in an operational environment satisfies the Letter Requirement performance requirements with the exception that three of the four candidates could not measure slope distance of 10km. The evaluation considered the operational environment and recommends that the FA accept a slope distance measuring capability of 7km.

5.3 The candidate systems were operated in an operational environment by representative MOS 82C personnel at Fort Bragg, NC and Fort Sill, OK. Survey scenarios typical of FA battalion and target acquisition battery operations were conducted and closed (completed) within prescribed doctrinal limits.

5.4 The proposed training program, the use of manufacturer's operator's manuals supplemented by USAFAS instructional aids, is satisfactory for fielding but should be supplemented by a discussion of command and control procedures for the target acquisition battery conventional survey party.

5.5. The SEDME-MR program is ready for advancement to the procurement phase. This phase can be expedited by Army adoption of the Wild Heerbrugg DI4L, a component of the USMC Artillery Battalion Survey SL-3. Adoption of the DI4L would also provide common training equipment for Army and USMC surveyors at USAFAS and simplify logistics planning. The USMC has established a depot repair facility for this equipment.

5.6 Logistics were not an issue in this evaluation because the LR states that nonoperational equipment will be replaced by an operational readiness float and evacuated to the depot level for repair pending completion of an analysis to determine if intermediate maintenance should be implemented.

APPENDIX A - Letter Requirement for Survey Electronic Distance Measuring Equipment - Medium Range (SEDME-MR)

LETTER REQUIREMENT (LR)
FOR
SURVEY ELECTRONIC DISTANCE MEASURING EQUPMENT-MEDIUM RANGE
(SEDME-MR)

1. TITLE OF THE ITEM: Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR).

2. STATEMENT OF NEED:

a. There is a need for survey electronic distance measuring equipment, medium range (SEDME-MR) (10 kilometers/6.1 miles) for use by FA survey parties. The time-frame for fielding the SEDME-MR is 3d quarter 1983.

b. CARDS Reference Number. 0406 R

3. JUSTIFICATION: The current inventory of SEDME-MW is technically obsolete, is susceptable to electronic interference by communications and radar equipment in the division area of operations, and requires operating personnel at the occupied and forward station while measurements are being made. Repair parts are difficult to obtain because of the age of the equipment (1963). Other justification includes:

a. Permits reduction in strength of the fourth-order, eight-man party to six personnel.

b. Decreases operator skill level requirements.

c. Reduces the time required for measurements; i.e., 5 minutes versus 15 minutes per measurement.

d. Provides a standardized SEDME which can be utilized in all SEDME parties thereby simplifying training requirements and operating procedures and improving logistical support.

e. Provides accelerated fielding since the requirement can be filled by off-the-shelf commercial equipment. Specifications can be met by candidate commercial systems.

4. BASIS OF ISSUE: The SEDME-MR will replace the SEDME-MW and SEDME-IR as shown below.

LIN	ITEM	REPLACEMENT RATIO
U69357	Survey Instrument Distance Measuring Microwave: Miniaturized, General Purpose (SEDME-MW)	1-3
U69174*	Survey Set DME: Infrared (DM-60)	1-1

*Replaced on a wear-out basis.

5. PRINCIPAL CHARACTERISTICS:

a. The SEDME-MR shall consist of an electro-optical package (distance meter) and transport case, two sets of retro-reflectors with carrying cases, an external power cable, two batteries and user's manual. Tripods and tribrachs required for

operation of the equipment shall be provided as government-furnished equipment. A winterization kit may be added for arctic operations, if required.

b. Distance measurements shall be done automatically under micro processor control.

c. The SEDME-MR shall be mountable to the standard military tripod. The SEDME-MR shall have an optical sighting telescope, automatic balance, audible aim, and tracking display.

d. Performance characteristics:

(1) Range - The SEDME-MR shall measure slope distances of 10 km (6.1 miles) during day or night operations.

(2) Accuracy - Slope distance accuracy shall be ± (.005 meters (0.016 ft) plus .005 meters (0.016 ft) per kilometer) root-mean-square error (rms) at temperatures -20° C to 55° C (-5° F to 130° F).

(3) Operation - The SEDME-MR shall be easily operated and maintained.

e. Physical characteristics:

(1) Weight and Size. Commercially available shapes are acceptable. The maximum weight of the distance meter, exclusive of tripods, but including primary power source, shall not exceed 25 pounds (22.7 kg).

(2) Power. The SEDME-MR shall operate from an internal battery or from an external 12 VDC vehicle battery. The internal batteries shall provide at least one hour of measurement time. The external power cable shall be at least 20 feet but less than 26 feet in length.

(3) Illumination. The SEDME-MR electro-optics package shall have adequate control panel illuminaton for both day and night operations as outlined in paragraph 5.2 of MIL-STD-1472.

f. Health/Safety and Human Engineering. Shall comply with applicable health, safety and human engineering design, performance and operational requirements and not present uncontrolled health and safety hazards to personnel throughout the life cycle of the system. As a minimum AR 40-14 and MIL-STDS 454, 882, 1472 and 1474 apply.

g. Portability. A means for transporting the SEDME-MR by backpacking shall be provided. The carrier shall conform to paragraph 5.11.1, Portability and Load Carrying, MIL-STD-1472B. The standard military theodolite backpack specified in MIL-T-52114 is acceptable as a SEDME-MR backpack.

h. Transportability. The SEDME-MR shall be transportable in stored configuration by standard army vehicles and an external load (in vehicle or A-22 Cargo Bag) on all Army helicopters. The system shall be air-droppable as cargo in Army 1 1/4-Ton vehicles. The system shall be air transportable as internal load on USAF C5, C130, and C141 aircraft.

i. Nuclear survivability. Nuclear survivability is not required.

j. Nonnuclear survivability. Hardening of the SEDME-MR against hostile fire, countermeasures, etc., is not required, due to the attendant cost and weight penalty. A back-up system is available which permits continued operations in a degraded mode.

k. NBC considerations. Chemical Agent Resistant Paints/Materials will be used to the maximum extent possible. NBC decontamination is required IAW AR71-14. The SEDME shall permit operation by personnel clothed in chemical/biological protective clothing.

l. ECM/ECCM. The system shall function in the electronic environment of an active battlefield. There are no other ECM/ECCM requirements.

m. Reliability, Availability, and Maintainability (RAM) Characteristics. RAM for this nondevelopment item must satisfy mission requirement.

n. Camouflage. Not applicable.

o. Climatic conditions. The SEDME shall operate in all Daily Cycles (table 2-1, AR 70-38) without assistance, except for Basic Cold, Cold, and Severe Cold, which may require use of an external winterization kit. The SEDME-MR shall permit operation when personnel are clothed in cold weather apparel. (NOTE: Survey operations cease when climatic conditions are too hot/cold to permit operation of accompanying angle measuring instruments).

p. Storage/Shelf Life. The SEDME shall not be adversely affected by storage under all climatic design types states in Table 2, AR 70-38, except severe cold. The SEDME is not stored in POMCUS or other stocks requiring extended shelf life.

6. Testing Required.

a. In addition to the established commercial market suitability, the following will be considered prior to type classification LCC-A: Supportability, bench handling (safety), and adequacy of commercial literature.

b. Milestone Schedule

LR approved	4QFY82
Type Classification	4QFY82
IOC	3QFY83

7. Logistics Support Implications.

a. The urgent operational need necessitates that the system be fielded initially with commercial training literature and an operational readiness float for use in replacing nonoperational equipment. During this initial period maintenance support will be provided by contract. It is anticipated that the maintenance concept will parallel that of the instrument being replaced. An analysis will be conducted to verify suitability of that concept.

b. A system support package will be available for validation prior to IOC.

8. Training Assessment.

a. Commercial manuals for operation of the SEDME will be used for initial fielding in lieu of standard technical manuals (TM) if determined acceptable for use subsequent to user representative (USAFAS) evaluation of the selected manufacturer's

manuals in accordance with (IAW) Chapter 8, Sections III and IV, AR 310-3, and MIL-M-7298. Upon completion of the LSA, generated IAW DARCOM Pam 750-16, for system operation and maintenance, TSARCOM and USAFAS will jointly evaluate the need for SPAS formatted system TM and Extension Training Materials (ETM) and identify requirements for new equipment training (NET). New equipment training should be conducted on site at MACOM installations. USAFAS will develop, or insure development, of any training products, or changes to existing ones, required against the SEDME IAW TRADOC Cir 351-8.

b. Training assessment relating to initial maintenance requirements is addressed in paragraph 7 above.

c. There are no training devices required for the SEDME-MR.

d. Training support package to be available prior to IOC.

9. MANPOWER/FORCE STRUCTURE ASSESSMENT: The combat developer, in coordination with the materiel developer, has done a manpower/force structure assessment of the developing system. The results of this assessment are:

a. Estimated manpower requirements per system: six enlisted.

b. Estimated manpower requirements per using unit: HHB, DIVARTY-6; TAB-12 (AA-6).

c. Total Army requirements, by component:

(1)	Active Army:	276
(2)	USAR:	0
(3)	National Guard:	144

d. Force structure implications resulting from system inclusion in the total force structure will be a reduction of four personnel in the Airborne Division Artillery; three personnel in each AIM Division Artillery; and one space in the Air Assault Division Artillery.

e. Manpower savings from replaced system: Active Army — 47
National Guard -- 24

10. Other Service or Allied Nation Interest: There is no Allied nation interest in this requirement. The USMC has expressed interest in this requirement.

/s/ JOHN B. OBLINGER, JR.
JOHN B. OBLINGER, JR.
Major General, GS
Deputy Chief of Staff
for Combat Developments
2 SEP 1982

/s/ ORLANDO E. GONZALES
ORLANDO E. GONZALES 9 NOV 82
Major General, GS
Director of Development
and Engineering

Appendix 1
LIFE CYCLE COST ASSESSMENT

1. Summary of estimated life cycle costs as expressed on constrant FY83 and inflated (this year) (inflated) ($K-thousands).

	CONSTANT DOLLARS			CURRENT DOLLARS		
	Low	Most Likely	High	Low	Most Likely	High
NDI						
INVESTMENT	1,729	1,820	2,093	1,945	2,048	2,355
O&S (7 yrs)	23,780	30,663	35,263			
TOTAL	25,509	32,483	37,356			

NOTE 1: Quantity of Prototype(s): (5).
NOTE 2: Sunk Costs (Excluded from paragraph 1).

a. NDI (Actual) $285. NDI (Constant) $325.

b. INVESTMENT (ACTUAL) $0. Investment (Constant) $0.

2. Quantity/unit costs, estimated unit/system flyaway and unit/system procurement costs expressed in constant FY83 dollars. ($K-thousands)

ITEM	QUANTITY	UNIT FLYAWAY	UNIT PROCUREMENT
SEDME-MR	100	$15.5	$17.2

3. Recommended funding profile in constant FY83 and inflated (then year) dollars ($K-Thousands):

	FY-82	FY-83	FY-	FY-	FY-	OYC	TOTAL
NDI PHASE							
Approved Program							
Estimate (Constant)	NONE	NONE					
Estimate (Inflated							
Variance							
INVESTMENT PHASE							
QPA							
Quantity	100						100
Approved Program	2,033						2,033
Estimate (Constant)	1,721						1,721
Estimate (Inflated)	1,940						1,940
Variance	+93						+93

Appendix 1 (Cont'd)

OMA

Approved Program	-	-
Estimate (Constant)	100	100
Estimate (Inflated)	108	108
Variance	-108	-108

Note 3: Source document for quantity is USAFAS Message R14153Z May 81.
Note 4: Inflation has been incorporated in accordance with Letter DRCCP-ER, Subject: Inflation Guidance, provided on 5 May 82.
Note 5: Source document for cost is BCE, dated 26 Jun 82, MERADCOM, Validation level II.
OYC - Out year costs.

TSARCOM COMPTROLLER VALIDATION
COST ANALYSIS DIVISION

CECDC REVIEW NO. 3077-82

V A L I D A T E D

Validation Level I II X III
Date validated 1 Jul 82 Expires 1 Jul 83

ANNEX A
COORDINATION ANNEX

ACTIVITY	CONCUR	NON-CONCUR	COMMENTS	NO COMMENTS
USADARCOM	X		X	
USAEUR	X			X
USAWESTCOM	X		X	
USAFORSCOM	X			
COMDT Health Forces Command	X			X
USMC				X

Note: All comments have been incorporated or resolved.

APPENDIX B, Market Survey Summary

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 2320	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SURVEYING EQUIPMENT, DISTANCE-MEASURING, ELECTRONIC-INFRARED (SEDME-IR)		5. TYPE OF REPORT & PERIOD COVERED Test Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Edward Hellwig		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Engineering Div, Camouflage & Topo Lab; US Army Mobility Equipment Research and Development Command; Fort Belvoir, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Mobility Equipment Research and Development Command; Fort Belvoir, VA 22060		12. REPORT DATE March 1981 13. NUMBER OF PAGES 44
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to US Government agencies; test and evaluation; September 1980. Other requests for this document must be referred to US Army Mobility Equipment Research and Development Command; ATTN: DRDME-RE; Fort Belvoir, VA 22060.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SEDME-IR
MACI
Slope distance
Retroreflective prism
Modulated-infrared lightwave

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Hewlett-Packard HP3808A and Keuffel & Esser UniRanger were evaluated by MERADCOM to determine conformance to military requirements for Surveying Equipment, Distance-Measuring, Electronic-Infrared (SEDME-IR). It was concluded that the HP4308A met the requirements for SEDME-IR and that the K&E UniRanger did not meet the requirements for long-range accuracy and phase error.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SUMMARY

This MACI evaluation program was conducted by testing first for critical issues and providing a report on those tests completed. The critical issues tested were: short-baseline accuracy, long-base line accuracy, phase error, and others as outlined in this report.

Reliability and environmental test data were obtained from the contractors. To protect its confidentiality, the contractor proprietary information has not been included in this report. The US Army Environmental Hygiene Agency has conducted electromagnetic radiation tests (Dec 80) to determine conformance to safety requirements.

The report concludes that the Hewlett-Packard HP3808A met the requirements of MIL-S-52848A for Surveying Instrument, Distance-Measuring, Medium-Range, Infrared. The Keuffel & Esser UniRanger did not meet the requirements of MIL-S-5284A for long-range accuracy and phase error.

APPENDIX C, 82nd Airborne Division Artillery
User Evaluation

DEPARTMENT OF THE ARMY
HEADQUARTERS, 82D AIRBORNE DIVISION ARTILLERY
FORT BRAGG, NORTH CAROLINA 28307

25 May 1983

SUBJECT: User Evaluation for Survey Electronic Distance Measuring Equipment - Medium Range (SEDME-MR)

Mr. Roy E. Renepacker
Directorate of Combat Developments
Fort Sill OK, 73503

1. References:

a. Fonecon, COL Hallada, Cdr 82d Abn Div Arty, and LTC Matchette USAFAS, 8 March 1983, Subject: 82d Airborne Division Artillery Evaluation of the Wild Heerbrugg DI4L Distomat.

b. Letter, ATSF-CMS, USAFAS, 24 March 1983 SAB.

2. Written evaluations of the DI4L Distomat were completed by two DS Battalion survey sections of the 82d Abn DivArty. The results of those evaluations are included as inclosures 1 and 2. The format that is inclosed with reference "b" was used to complete the evaluation. Each battalion had at least 2 weeks to complete the evaluation.

3. The DI4L is currently being tested by the 1st Battalion (ABN), 320th FA. As soon as their evaluation is completed, the results will be forwarded to your office.

4. POC, this headquarters is CPT Weeks, AVN 236-1705/9252.

FOR THE COMMANDER:

2 Incl
as

SYLVESTER A. RYAN JR.
MAJ, FA
Adjutant

EVALUATION REPORT (1-319 FA)

1. Time period of evaluation is 11-22 April 1983.

2. Components evaluated were:

1 ea DI4L Distomat
1 ea Counterweight
1 ea Theodolite adapter kit
2 ea NiCad battery, 12V AH
4 ea Circular prisms
1 ea One prism holder, GPH1A
1 ea Three prism holder, GPH3
1 ea Power supply cable
1 ea Keyboard
1 ea Plumbing pole, GLS11
1 ea GRT 10 reflector carrier for GPH1 and GPH3

3. One DI4L Distomat system was evaluated.

4. 1-319th FA survey section performed this evaluation of the DI4L Distomat.

5. During each survey operation, the DI4L was utilized in conjunction with the T-16, optional keyboard, and associated equipment listed in paragraph 2 above. The survey party used standard survey procedures to complete each survey. It was noted that a conventional party could be reduced to a 3 man team, with each team consisting of a Party Chief, instrument operator and computer/recorder, and still provide accurate survey data to the battalion in a timely manner.

6. Summary of survey operations: (See Annex 1 of this report for schematic of surveys).

a. A total of 3 surveys were conducted.

1) Survey 1 - 1416 meters in total length
2) Survey 2 - 3598 meters in total length
3) Survey 3 - 2278 meters in total length

b. Length of measured lines:

1) Survey 1 - 176.64m, 453.87m, 785.66m, Avg 471.72
2) Survey 2 - 1062.98m, 788.67m, 1319.04m, 301.69m, 126.11m Avg 719.6
3) Survey 3 - 602.62m, 302.55m, 585.21m 487.46m, 300.15m Avg 455.6

c. Accuracies:

1) Survey 1 - 1:2500
2) Survey 2 - 1:3000
3) Survey 3 - 1:2800

d. Average time per station was 12 minutes. (This average time includes setup and march order).

e. The lack of direct read out was no problem because no distance exceeded 2000 meters.

7. Time to train 82Cs was 30 minutes. However, the operator's manual is not adequate. It needs to be written in a simpler format.

8. Three surveys were completed with one fully charged NiCad battery and there was still a charge left. Time required to charge the the battery was 3 hours.

9. No interface problems were experienced between the DI4L and our T-16. It takes approximately 10 minutes to modify a T-16 for the DI4L and keyboard.

10. No maintenance problems were experienced during this evaluation period.

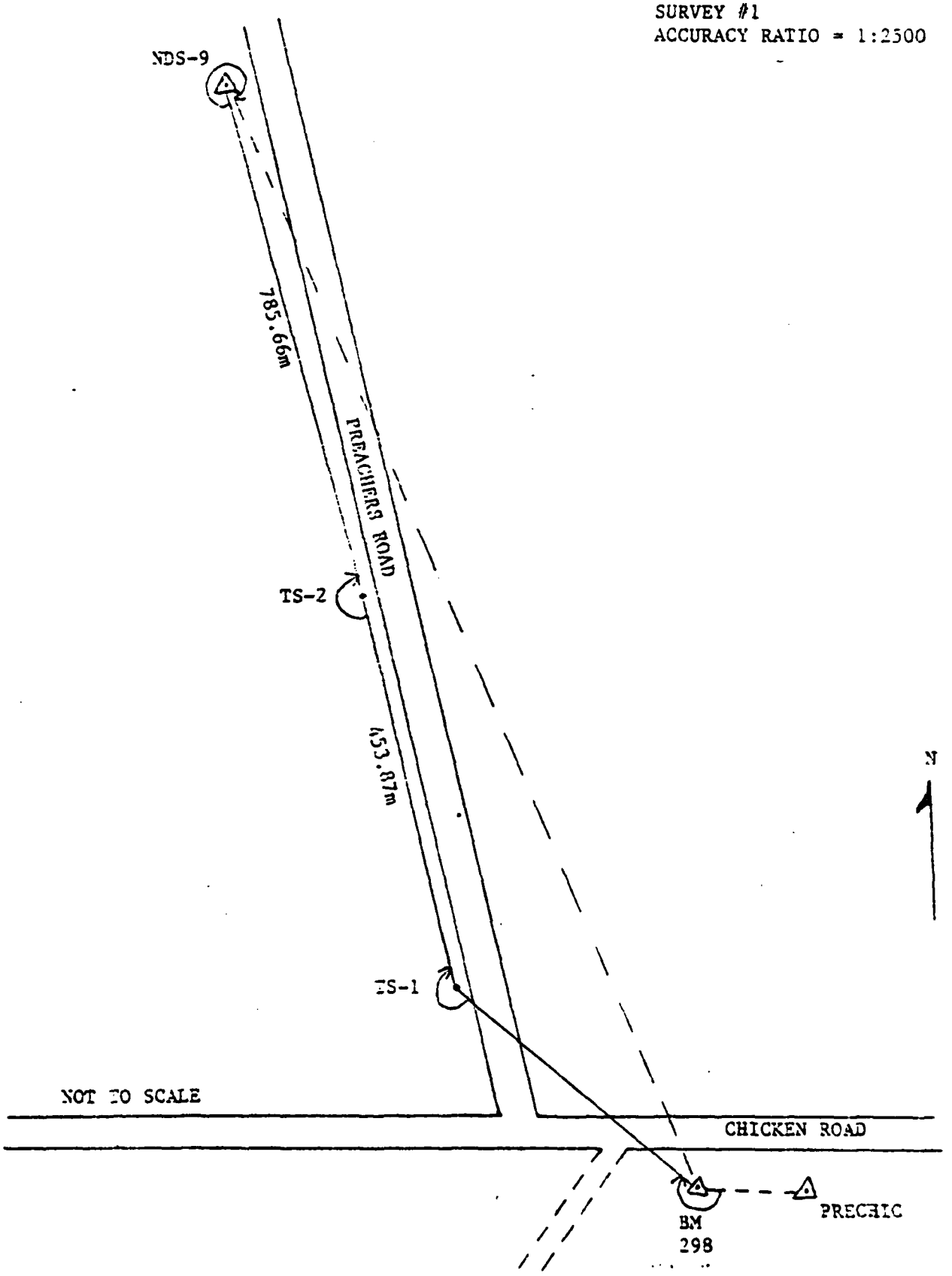
7. Time to train 82Cs was 30 minutes. However, the operator's manual is not adequate. It needs to be written in a simpler format.

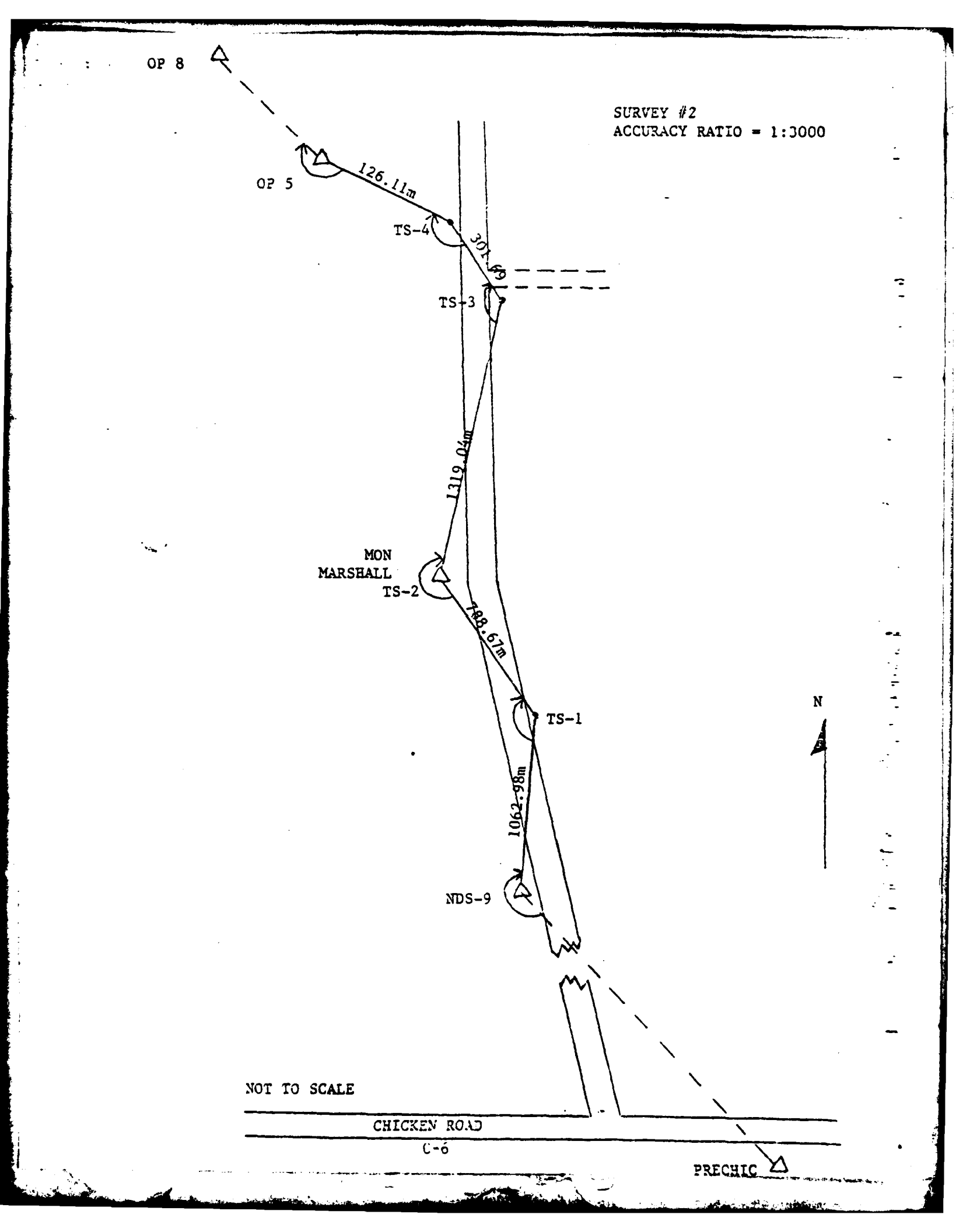
8. Three surveys were completed with one fully charged NiCad battery and there was still a charge left. Time required to charge the the battery was 3 hours.

9. No interface problems were experienced between the DI4L and our T-16. It takes approximately 10 minutes to modify a T-16 for the DI4L and keyboard.

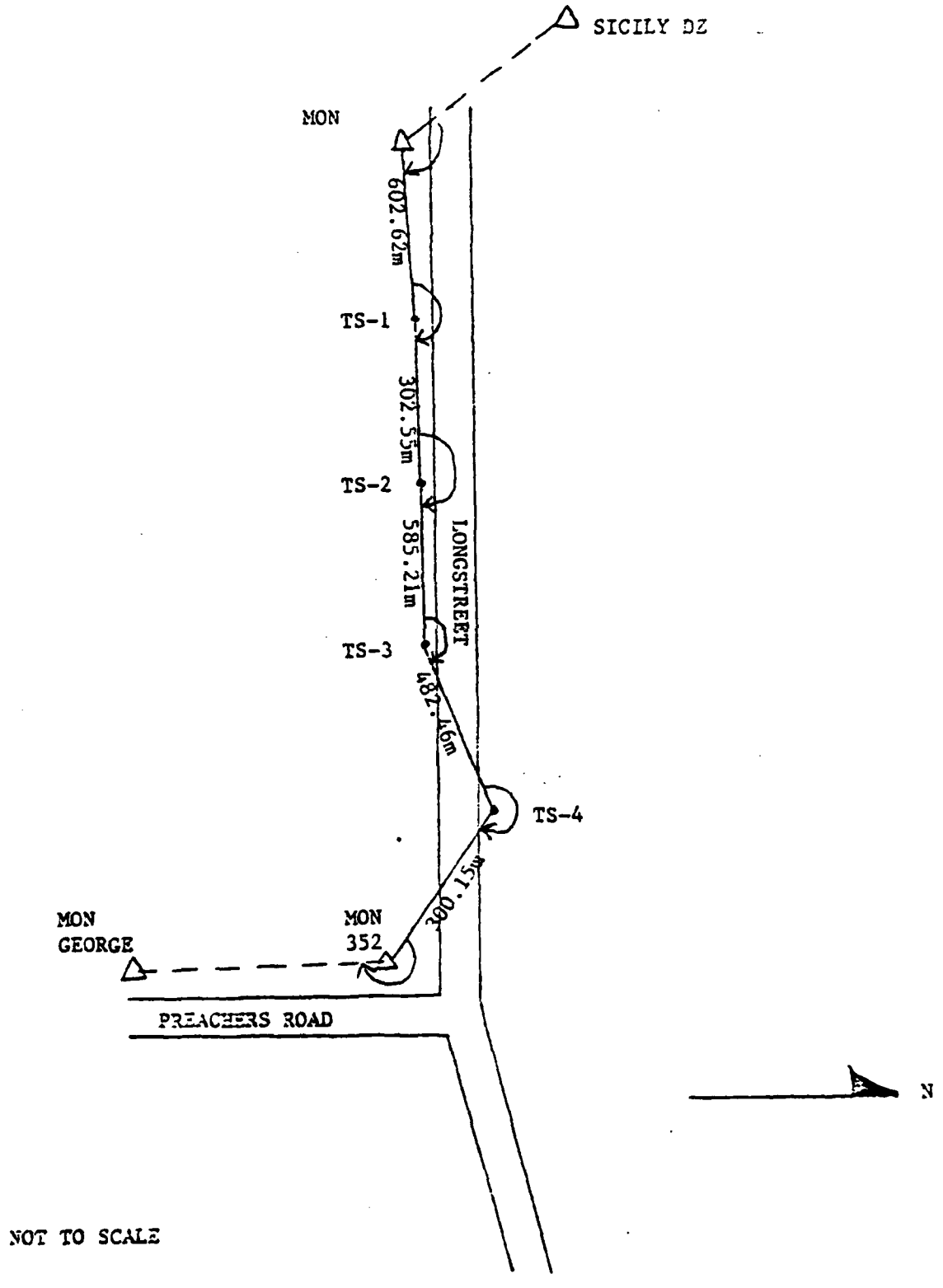
10. No maintenance problems were experienced during this evaluation period.

SURVEY #1
ACCURACY RATIO = 1:2500




OP 8
SURVEY #2
ACCURACY RATIO = 1:3000
OP 5
126.11m
TS-4
301.49
TS-3
1319.04m
MON
MARSHALL
TS-2
788.67m
TS-1
N
1062.98m
NDS-9
NOT TO SCALE
CHICKEN ROAD
C-6
PRECHIC

SURVEY #3
ACCURACY RATIO - 2800



NOT TO SCALE

EVALUATION REPORT (2-321 FA)

1. Time period of evaluation was 7 Jan-21 March 1983.

2. Components evaluated were:

1 ea Distomat (DI4L)
1 ea Counterweight
1 ea Theodolite adapter for T-16
2 12V, 7AH NiCad batteries
4 ea Circular prism
1 ea One prism holder GPH1
1 ea Three prism holder GPD3
1 ea Power supply cable
1 ea Keyboard
1 ea Plumbing pole, GL5-11
1 ea GRT-10 reflector carrier for GPH1 and GPH2

3. One DI4L distomat system was evaluated.

4. 2-321 FA survey section performed this evaluation of the DI4L distomat.

5. Operational concept used: The leap-frog technique and standard procedures for Bn survey.

6. Summary of survey operations:

a. Eight surveys were conducted with an average length of 2500 meters.

b. Average length of measured lines was 200-300 meters. Longest line measured was 853 meters.

c. Average accuracy ration for eight surveys was 1:2800.

d. Average time to measure distances were 1 1/2 to minutes. Average total time at each station was 12-15 minutes. (This average time includes set up and march order).

e. No problems were encountered with the direct readout because no measurement was in excess of 2 km.

7. An operator's manual needs to be written that has a step by step or "by the numbers" type instruction. The commercial manual goes off onto many different tangents during each step of the operating procedures; i.e., by the time the operator finishes reading all the variations of each step, he has forgotten what step he is on and exactly where he is at in the operation of that step.

8. Only the NiCad batteries were used, and they never lost their charge during a day's operation. The batteries were recharged at the end of each day of operation.

9. No interface problems were encountered with the Distomat and our T-16 Theodolite. To modify the T-16, two holes already exists on top of the telescope for the distomat mounting brace and two holes had to be drilled and tapped for the keyboard mounting bracket. Total time to modify T-16 is approximately 10 minutes. An alignment device is used to align the mounting brace for the distomat so that the distomat can be boresighted with the theodolite telescope.

10. The only maintenance problem encountered was the test button was stuck in the test mode and a measurement could not be performed. The Distomat with one NiCad battery was shipped back to the technical representative at the Wild Heerbrugg Corp in Farmingdale, LI., N.Y. and repaired. It was later determined that the plastic coating on the test button was cracked which caused an electrical short to occur. The probable cause of the plastic cracking was pressing down too hard with some type of sharp instrument. The Wild Heerbrugg Corp has informed us that they have since changed/improved the plastic material used in the test mode button. We have not had a reoccurance of the problem.

APPENDIX D

Abstract, User Evaluation Report for Survey Electronic Distance Measuring Equipment-Medium Range (SEDME-MR), July 1983, Target Acquisition Department, United States Army Field Artillery School (USAFAS).

The report provides the results of the USAFAS evaluation of four candidate commercial distance measuring equipments during the period 13 May to 2 June, 1983. The purpose of the evaluation was threefold: (1) determine the capability of the candidate systems to satisfy performance characteristics stated in the Letter Requirement (LR) for the SEDME-MR; (2) evaluate the proposed organizational and operational (O&O) plan for the Target Acquisition Battery (TAB) Conventional Survey Party (CSP); and (3) evaluate the adequacy of the proposed training package for the SEDME-MR.

The evaluation consisted of four phases as follows: (1) Training of subject matter experts and player personnel; (2) conduct of representative twenty kilometer surveys by player personnel organized as a TAB CSP; (3) distance and accuracy checks on known base lines, and (4) other evaluations to collect data on battery life, night operating capability and NBC operations.

The candidate systems and the manufacturer's stated range capability were: (1) Wild Heerbrugg DI4L, up to 7 km; (2) Wild Heerbrugg DI20, up to 14 km; (3) Keuffer and Esser Company Uniranger, up to 10 km; and (4) Keuffer and Esser Company Autoranger, up to 6.5 km.

The issues and criteria for the evaluation were extracted from the USAFAS Independent Evaluation Plan for the SEDME-MR, June 1983, approved by USACAC on 21 July 1983. A summary of the evaluation findings is at table 1. Three of four candidate systems failed to achieve the 10 km distance measuring requirement and the reading grade levels of the operator's manuals and the USAFAS supplemental instructional material was more than one reading grade level (RGL) below the RGL of the target audience. The Uniranger also failed the accuracy criteria and the DI20 and Autoranger systems did not have a night lighting capability.

Table 1. Summary of Findings

SYSTEM MET CRITERIA (Yes/No)

OBJECTIVE/ISSUE/CRITERIA:	DI4L	DI20	UNIRANGER	AUTORANGER
1. Mission Performance				
a. Slope Distance-10km	N	Y	N	N
b. Accuracy-one meter/5km	Y	Y	N	Y
c. Internal Btry-400 Measurements	Y	Y	Y	Y
d. Replace Btry-five min	Y	Y	Y	Y
e. Vehicle Power	Y	Y	Y	Y
f. NBC Operations	Y	Y	Y	Y
g. Night Operations	Y	N	Y	N
2. O&O Plan.				
a. Survey TIme-30% reduction	Y	Y	Y	Y
b. Survey Closure	Y	Y	Y	Y
3. Training.				
a. Level 1 Task	Y	Y	Y	Y
b. RGL Manufacturer's Operator's Manual	Y	Y	Y	Y
c. RGL USAFAS Instructional Material	Y	Y	Y	Y

APPENDIX E, IEP Extract, System Description and Operational Concept

* * * * *

1.3 System Description. There are two components to the SEDME-MR system: the distance meter group and the reflector group. These groups interface with the standard military surveying tripod, load bearing equipment, and the survey party vehicle to form a complete system. System use is illustrated at figure 1. The distance meter and reflector groups are discussed in subsequent paragraphs.

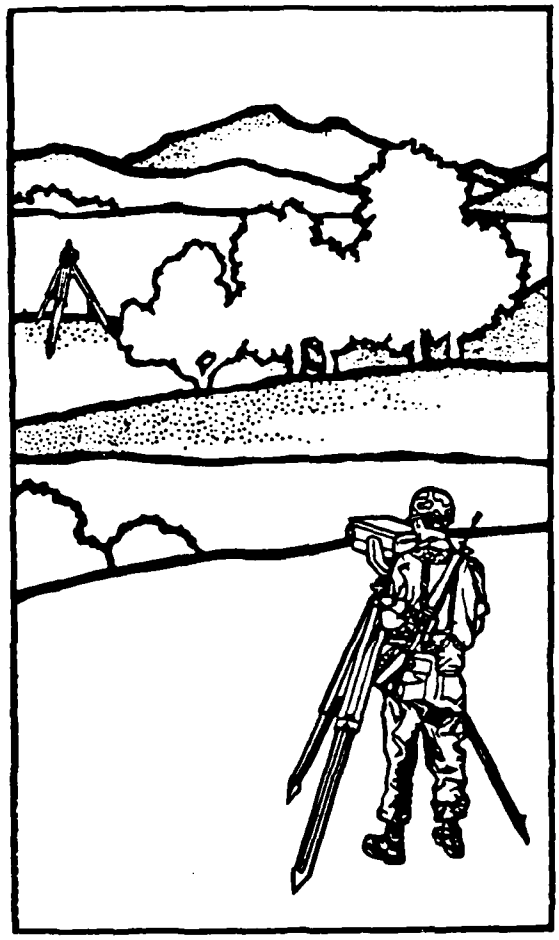


Figure 1. Overview of SEDME-MR System

1.3.1 A typical distance meter group is illustrated at figure 2. The distance meter, the primary component, and the tribrach may be combined into one unit which mounts on the standard military tripod. The meter may be powered by an internal battery pack or by an external battery cable connectable to standard 12V military batteries. A battery charger is required for recharging the nickel-cadmium batteries used for internal power. The operator's manual provides the instructions for installation, operation, and maintenance. A transport case is required for protection during transit.

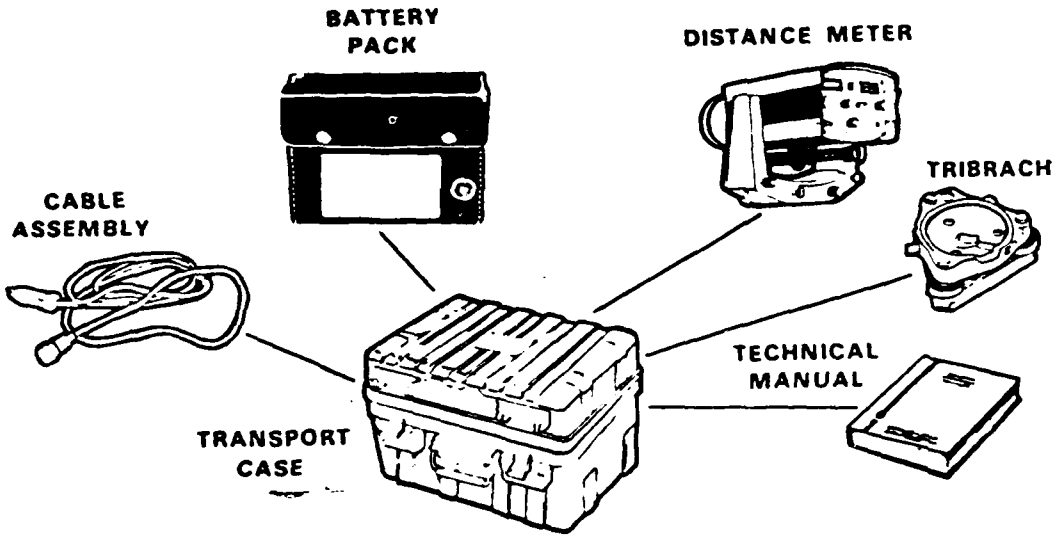


Figure 2. Distance Meter Group, SEDME-MR

1.3.2 The components of a typical reflector group are illustrated at figure 3. Manufacturers package the reflectors in a variety of sizes and shapes. A set of reflectors consists of the total number of reflectors, brackets, and cases required to achieve the range requirement. Two sets of reflectors are required for system operational concepts.

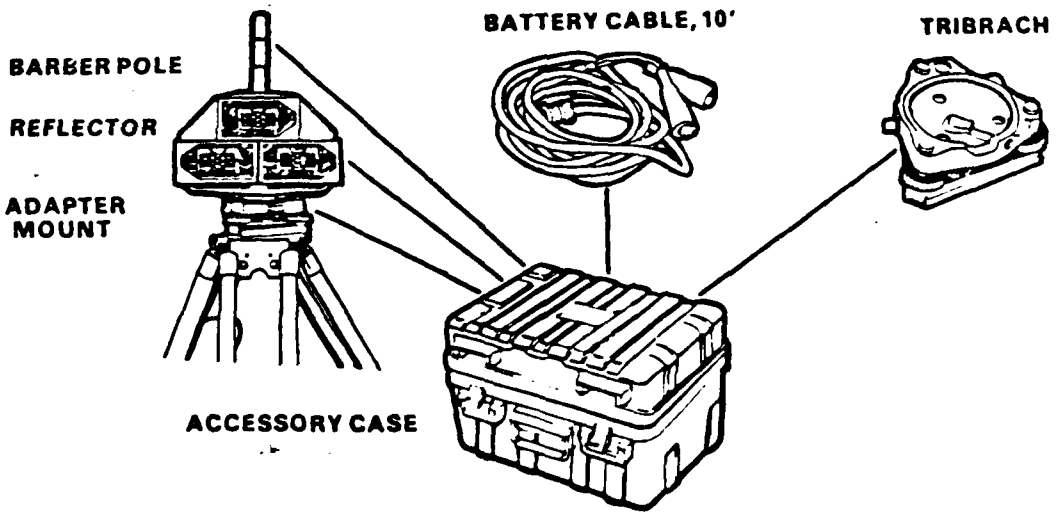


Figure 3. Typical Reflector Group, SEDME-MR

1.4 Operational Concept.

1.4.1 The operational concept for the SEDME-MR reorganizes the present fourth-order eight-man survey parties (division artillery level) into six-man parties capable of conducting all survey operations. The primary method of survey operations will be traverse. The party organization and major items of equipment are described at table 1.

Table 1. Survey Party Organization for the SEDME-MR

Type Section	Personnel	Equipment
Measuring Section-1 (MS-1)	Instrument Operator Computer/Recorder	Theodolite 1 1/4 Ton Vehicle AN/GRC-160 Radio
Measuring Section-2 (MS-2)	Computer Instrument Operator	SEDME-MR Theodolite AN/GRC-160 Radio
Reconnaissance Section	Chief of Party Rodman/Tapeman(driver)	1/4-Ton Vehicle AN/GRC-160 Radio (IRR)/Ranging Poles (RP)

1.4.2 Party deployment and measuring operations are illustrated in figure 4. Measuring Section 1 (MS-1) occupies the survey control point (SCP), measures angle A-1, and sets up a set of infrared reflectors (IRR) prior to moving to Traverse Station 2 (TS-2). Measuring Section 2 (MS-2) occupies TS-1, measures angle A-2 and distance D-1/D-2, and moves to TS-3 to repeat the cycle. The reconnaissance section plans the survey, establishes forward stations, and recovers IRRs and ranging poles as required.

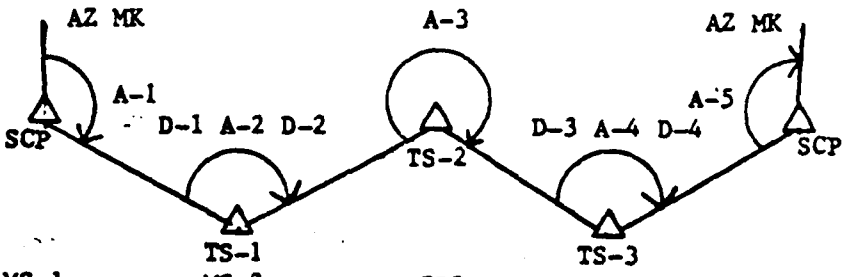


Figure 4. Operational Concept for the SEDME-MR Survey Party

COORDINATION

SOURCE	CMTS REC'D	ACCEPTED	NOT ACCEPTED	REMARKS
USATRADOC	0			
USATSC	0			
USACAC	1	1		
USALOGC	1		1	See text below
USASSC	0			
USASC&FG	4	4		
USAOTEA	0			

Rationale for non-acceptance of USALOGC comment.

Comment: The required slope distance accuracy of the SEDME-MR appears to have been changed from .005 meters/km (.025m/5km) as found in the LR to the test criteria of 1m/5km as found in the IEP and IER.
(Reference: LR, page A-3, para 5d(2)
IEP, dtd Apr 83, page 5, para 2.1.1.2.1
IER, page 3, para 2.1.3.1)

Rationale: Survey control points established to first-order accuracy are required to verify the performance standard stated in paragraph 5d(2) of the LR. Since these points are not available at Fort Sill, the IEP, paragraph 2.1.1.d, stated that a less stringent comparative accuracy requirement would be used in the user evaluation. The IEP was approved by USACAC on 21 July 1983. An explanation of this change was also included at paragraph 2.1.1.4 of the IER when staffed. The ultimate test of the accuracy of the distance measuring equipment is the ability to close surveys to the doctrinal prescribed standard. The analysis at paragraph 2.2.3.2.1 of the IER indicates that these standards were achieved with all candidate instruments.

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4. HQ Department of the Army, FM 6-2, Field Artillery Survey: 1 March 1982 as changed.

5. ASVAB scores for MOS 82C10 personnel, Fort Sill, OK and Fort Bragg, NC and methodology for determining reading grade levels, USA Soldier's Support Center, 22 June 1983.

6. DF, ATSF-DA, USAFAS, 3 September 1982, subject: Target Reading Grade Levels for Proponent MOS and Skills Levels.

7. HQ Department of the Army. FM 6-82C1/2, Soldier's Manual MOS 82C Field Artillery Surveyor Skill Level 1/2, 6 November 1979.

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9. Wild Heerbrugg Ltd. Operator's Manual, Wild DISTOMAT DI20, undated.

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11. Keuffel and Esser Company. Operating Manual, Autoranger EDM Electronic Distance Measuring Equipment, undated.