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Modern MANPRINT Instrumentation

Manned Systems Group  
Systems Research Laboratory

November 1987



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U. S. Army Research Institute for the Behavioral and Social Sciences

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# U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON  
Technical Director

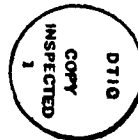
WM. DARRYL HENDERSON  
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Research accomplished under contract for  
the Department of the Army

Cubic Defense Systems, Inc.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Soldier performance is now recognized as a vital component of weapon system effectiveness, and Army Regulation 602-2 requires measurement of soldier performance of critical operations and maintenance tasks. However, the presence of much of the instrumentation traditionally used to record such performance tends to be obvious and may in fact intrude on the simulated tactical play of most operational tests.  <p style="text-align: right;">(continued)</p>		

ARI Research Product 87-32

20. Abstract (continued)

This document presents the results of a recent survey of electronic instrumentation which is suitable for detecting and measuring soldier performance, but which is also either not noticeable by test participants or which is at least unobtrusive enough not to distract soldiers from full participation in the tactical situation of the test.

Some of this instrumentation has already been used successfully on military systems, and that listed here has been selected from vendors' responses based on the criteria of unobtrusiveness, low cost, and reliability. The four appendixes to the report contain instrumentation listings with summary technical specifications, American vendor sources, and authors' comments.

Research Product 87-32

## Modern MANPRINT Instrumentation

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Department of the Army

November 1987

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Army Project Number  
2Q283731A792

Manpower and Personnel

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## FOREWORD

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The inclusion of data on soldier performance in models of weapon system effectiveness and availability is expected to open new avenues for manpower considerations to directly influence the design of hardware and software in new systems. Methodologies for evaluating soldier performance data are already under development by the Army Research Institute (ARI).

This research grew out of a larger effort performed for the U.S. Army Operational Test Evaluation Agency (OTEA). That effort, in support of the Manpower and Personnel Integration (MANPRINT) portion of the OTEA program entitled Continuous and Comprehensive Evaluation (C2E) was conducted under a Memorandum of Agreement between OTEA and the ARI signed 1 October 1984 and 19 October 1984.

During the conduct of the larger program, it became apparent that an important question concerning the use of the MANPRINT analysis methodology would be whether there were available any essentially nonintrusive instruments for the collection of data for soldier performance. It was strongly felt by sponsors at OTEA that no methodology that required instrumentation that compromised the "tactical realism" of an operational test would be acceptable. This small research task was created to identify instrumentation that was available from American sources and could be used to collect soldier performance data.

This report, which is essentially a catalog of available instruments believed to be suitable for use during operational tests, should be read with the report of the major project, in which the concepts of soldier performance measurement are explained. Use of the instrumentation identified in this report should provide a cost-effective means for obtaining and analyzing data during manned systems tests.



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# MODERN MANPRINT INSTRUMENTATION

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NOTE

Use of trade names and brand names in this report is for purposes of identification only and does not constitute endorsement or approval of the products, manufacturers, or sales organizations.

## MODERN MANPRINT INSTRUMENTATION

### 1.0 INTRODUCTION

#### 1.1 Background

A program entitled "Continuous Comprehensive Evaluation (C2E)" has recently been initiated by the United States Army Operational Test and Evaluation Agency, under the direction of the Vice Chief of Staff of the Army (VCSA). C2E is a concept which approaches data acquisition in a manner somewhat different from traditional operational testing. System tests and evaluations conducted under C2E are expected to be of longer duration and more comprehensive in nature and, consequently, should embrace a wider range of data sources. One data source as dictated by the newly emerging requirements of the MANPRINT (Manpower and Personnel Integration) effort, will involve measurement of critical soldier performance and reporting of that performance in calculations of system effectiveness and availability (para 2-12, AR 602-2). Models and measures for MANPRINT during C2E have been developed which explain how to process and interpret soldier performance data once it has been collected (Lowry and Seaver, 1986).

Although MANPRINT improvements to traditional test procedures promise to increase the accuracy and realism of resulting evaluations, some seasoned testers have expressed concern that the new requirement for collection of soldier performance data may somehow compromise the tactical nature of operational testing. If MANPRINT in C2E is to succeed, the instrumentation utilized for capturing critical soldier performance must be as unobtrusive as possible, while remaining fully compatible with the range of data collection techniques currently employed by the systems analysis community.

A new generation of electronic instrumentation (i.e., recording and microprocessing devices) now on the market makes it possible simultaneously to sense, record, and analyze many aspects of soldier performance which in the past were handled either by observers with clipboards and stopwatches (inappropriate to most operational testing situations) or by more specialized, single-purpose data recording and processing devices.

#### 1.2 Objective

The purpose of the research effort reported here was to -

- a. Acquire technical information on state-of-the-art electronic data collection instrumentation available for recording time and accuracy dimensions of critical soldier performance in ways that do not compromise the realism requirements of operational testing, and
- b. Develop preliminary concepts and strategies for utilizing electronic data collection instrumentation for recording soldier performance of critical tasks.

### 1.3 Use

This report is intended to aid government and contractor personnel responsible for planning and conducting MANPRINT test and evaluation. This report specifically addresses the identification and availability of unobtrusive instrumentation appropriate for obtaining measures of performance of critical operations and maintenance tasks in new weapon systems.

## 2.0 INSTRUMENTATION SPECIFICATION

All of the instrumentation devices described in this report are off-the-shelf items, and most are built to commercial specifications. However, with appropriate mounting, all should function reliably in the system environments where measurement of soldier performance is required. The standard operating environment of weapon systems maintained and operated by soldiers is identified in paragraph 5.8 of MIL-STD-1472. In addition to those requirements, some of the instruments have also been developed for more specialized military applications and, therefore, also adhere to other military specifications. Such instruments have special notations in the appendices to this report.

### 2.1 Instrumentation Technical Data

The technical data contained in those appendices were obtained from manufacturers and suppliers in responses to an industry survey. Neither the corporate author nor the Army sponsor of this project has verified these data. No recommendations are made as to the selection of any particular brand of instrument, and no endorsement of any instrument or manufacturer should be inferred from an entry in this report. Potential users of MANPRINT instrumentation should make their selections from the appendices to this report based on the ability of the instrument to fulfill specific measurement needs in terms of technical capability, availability, cost and supporting services.

### 2.2 Instrumentation Appendices

This report includes four separate appendices, each for a different type of instrumentation. Appendices are provided for miniaturized video cameras, video recorders, remote control and mounting devices, and databus recorders. When this report was written, each instrument listed in the appendices was available and represented current state-of-the-art in terms of size, capability, and competitive cost of the technology represented. Unusual aspects of the listed instruments are specifically noted in the appendices.

## 2.3 Technical Assistance

Many of the manufacturers and suppliers provide technical assistance in the use of these instruments. Therefore, each appendix includes the name a vendor, address, point of contact, and telephone number for each listed instrument. Test planners may wish to use these complimentary services.

## 2.4 Scope of Instrumentation

The instruments listed in this report are relatively low cost/high tech items selected to meet specific performance monitoring needs. Requirements for more sophisticated instrumentation, such as the Army's MILES systems and test ranges used at the National Training Center, are not addressed in this report.

The instruments listed in appendices 1 through 4 were also selected for their compliance with the criterion of "unobtrusiveness." However, the user needs to exercise independent judgment in matching instrumentation to the specifics of the soldier-machine system to be tested: an 18-inch long video camera might be unobtrusive when mounted on a pole in a darkened corner of a command post tent; the same camera, mounted inside an armored personnel carrier, is not unobtrusive.

## 3.0 TEST SITUATIONS

The instrumentation listed in this report is structured around four hypothetical test "situations," each representing a progressively more difficult challenge to the instrumentation planner. The four are:

Situation 1 - Stationary vehicle or tactical operations center (TOC) with one operator being monitored.

Situation 2 - Stationary vehicle or TOC with three or four operators being monitored simultaneously.

Situation 3 - Moving vehicle or mobile TOC with one operator being monitored.

Situation 4 - Moving vehicle or mobile TOC with three to four operators being monitored simultaneously.

## 4.0 SELECTION OF INSTRUMENTATION

This section of the report explains how to make selections from the four instrumentation appendices given (1) the general situation (paragraph 3.0 above) and (2) the specific requirements of the soldier-materiel system to be tested. The guidance below

is intended to lead to the selection of the lowest-priced instrumentation appropriate to test data requirements.\* The user should also consider the size of the instrumentation package when making a selection.

#### 4.1 Situation 1.

The following basic guidelines are provided when using Appendices 1 through 4 to meet the requirements of Situation 1 (monitoring a single individual in a stationary structure or sedentary position).

A. For tests in daylight, where the test subject does not require cues from color perception in order to perform his critical tasks correctly -

1. Select a black-and-white video camera from Appendix 1. Make the selection based on appropriate power, size, weight, and anticipated ambient light.

2. Select a video recorder from Appendix 2 based on appropriate power, size, weight, recording time, tape format and compatibility with camera selected.

3. Where the tasks to be monitored may be performed in an area larger than a single console, selection of a wide-angle lens is recommended. An alternative is a multiple camera setup with a remote control unit (from Appendix 3) to activate different cameras on a set schedule, or a movement detection device to activate each camera when a test participant moves into its range.

B. For tests in daylight where the test soldier requires cues from color perception in order to perform critical tasks correctly -

1. Select color video camera from Appendix 1.

2. Follow steps 2 and 3 as stated above.

Where available space is particularly scant (as in the cockpit of an aircraft) a miniaturized camera of the sort shown in Figure 1 is recommended.

C. For tests in very low light levels -

1. Select a "night vision" observation device from Appendix 1. Make the selection based on appropriate power, size,

-----

\*The user is reminded that there is often an additional trade-off between cost and reliability. That issue is not addressed in this report.



**Figure 1 Example Of Subminiature Video Color Camera  
To Monitor A Soldier In Close Quarters**

weight, and anticipated fluctuations in ambient light of .0075 fc or less.

2. Select a compatible video recorder.

3. Where circumstances make video recording impractical, consider using a databus (Appendix 4). The latest developments in databus recording make it possible, for relatively low cost, to read selective data from the 1553 databus for accurate measurement of task performance in both time and error parameters.

#### 4.2 Situation 2

The following guidelines are provided for using Appendices 1 through 4 to meet the requirements of Situation 2 (three or four individuals in a stationary location). The guidelines for Situation 2 are the same as for Situation 1 with these exceptions:

A. For tests in daylight, select a video recorder that will record synchronized multi-channels. Visible action of three or four individuals can be recorded and displayed with synchronized split screen for post performance evaluation.

B. For tests in low light level situations, primary consideration should be given to use of a databus: the ease and accuracy of its use in multiple-player situations generally outweighs its cost.

Figure 2 shows how MANPRINT testers can simultaneously monitor the performance of multiple soldiers performing critical tasks on and around stationary platforms.

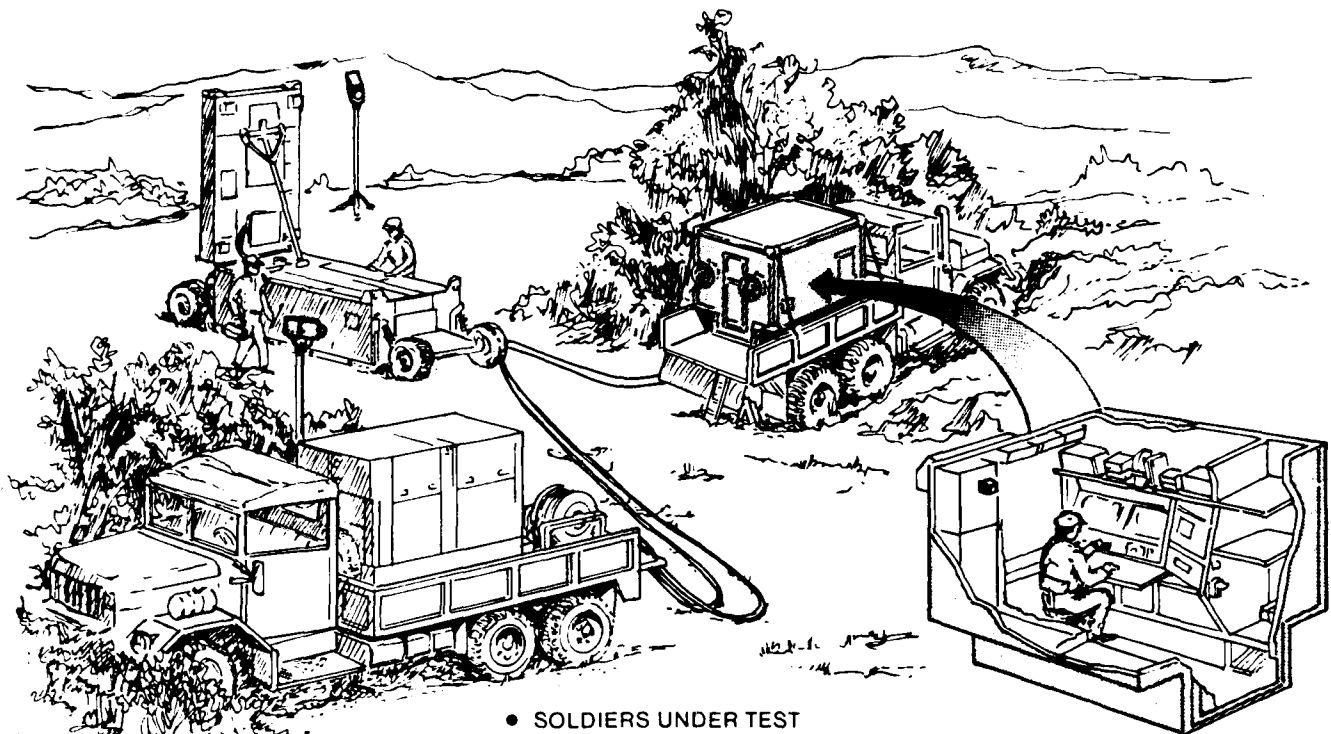
#### 4.3 Situation 3

This situation is analogous to Situation 1, except that the platform on which the soldier performance of interest is taking place is moving. Such movement introduces four instrumentation concerns:

A. Mounting of instruments. When testing in a moving environment, instruments should be mounted in the same plane as the moving platform to limit the effects of vibration on the quality of video recording. This is not a problem with databus recording. Use Appendix 3 to select appropriate mounting.

B. Remote Control. Hard-wired remote control cannot be used on a moving platform. Care must be taken in selecting radio remote control so that signals do not interfere with tactical data transmission or data collection.

C. Data Recording Location. Where the soldier performance of interest is on a moving platform, the test planner must decide



• SOLDIERS UNDER TEST



• TEST AND EVALUATION PERSONNEL

**Figure 2 Illustration of Monitoring Three Or More Soldiers In A Stationary Location**

whether to add to the platform (on which space is normally at a premium) a data recording device or to transmit the data from sensors on the platform to a fixed recording station. Advances in electronics now make both alternatives feasible, although tactical maneuvers (as occur in many operational tests) are normally accompanied by a high volume of radio signals any of which could conflict with data telemetry. Moreover, DoD and Army T&E leaders have often expressed the desire to conduct at least some tests under electronic warfare (EW) conditions. These circumstances often tend to bias the choice toward on-platform data recording using devices such as the one shown in Figure 3. Appendix 2 lists several small video recorders suitable for on-platform mounting, although some ruggedization (such as viscous damping) may be necessary if the platform is going to experience severe shocks and high moments of force.

D. Power Supply. A free-moving platform requires that instrumentation aboard have its own power source or be wired into the power organic to the platform. Appendix 1 shows both AC and DC voltages for video cameras, and Appendix 2 presents the same information for recorders.

#### 4.4 Situation 4

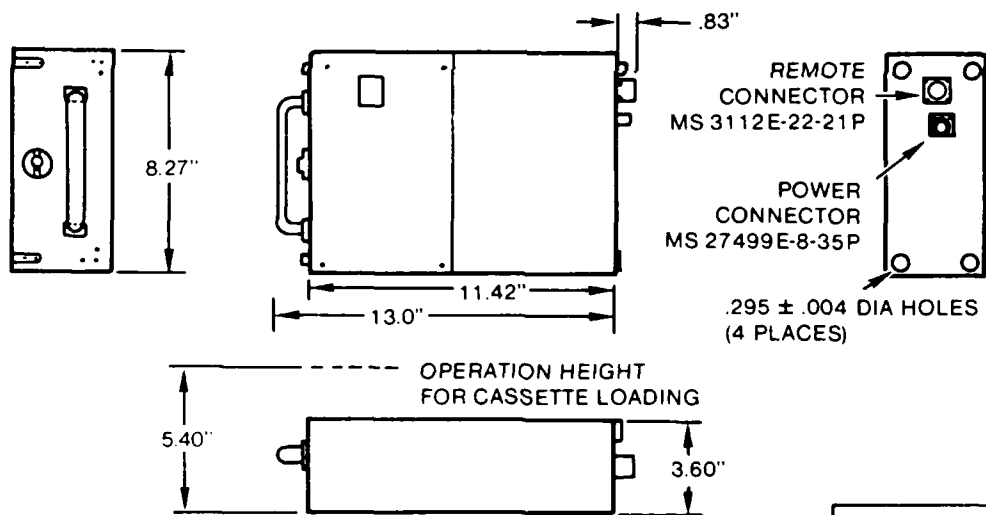
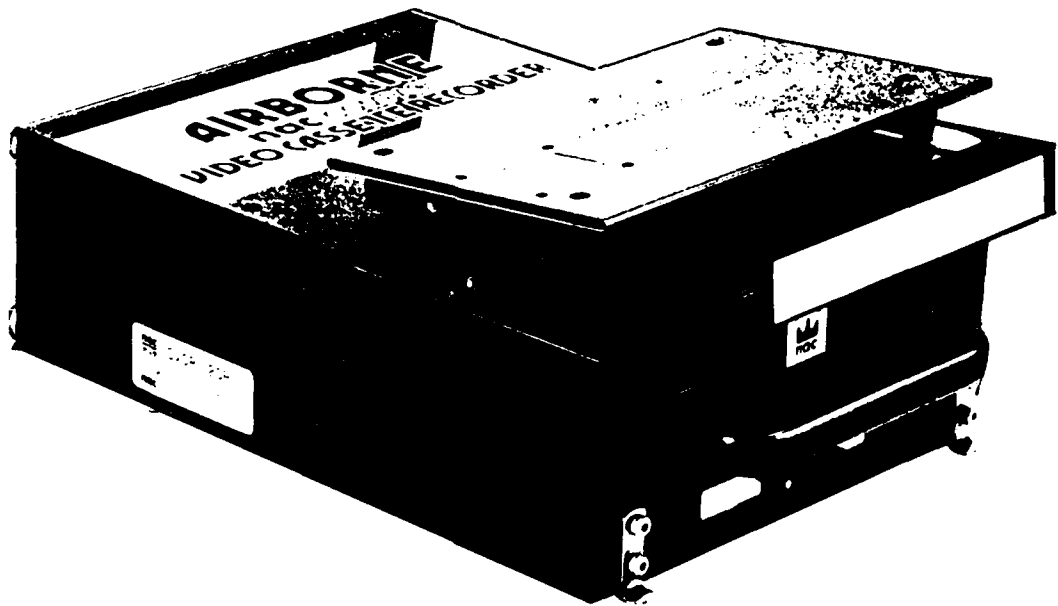
This situation is analogous to Situation 2, except that there are multiple operators and, often, multiple moving platforms on which the soldier performance of interest is occurring. The same instrumentation concerns discussed in para 4.3 (above) apply here as well; but in this situation there is the additional complication of the need for multiple simultaneous performance records. Especially when the performance analysis of the system (or force) depends upon knowing the sequence in which events happened, it is necessary to link together many (or all) of the data sensors on a common time-line. A databus normally includes a "real-time" record, and many multi-channel recorders have it as an option.

Figure 4 illustrates the use of multiple sensors over a single piece of terrain on which soldiers in multiple vehicles are maneuvering, where all sensors are controlled from a single point on the terrain.

#### 5.0 REFERENCES

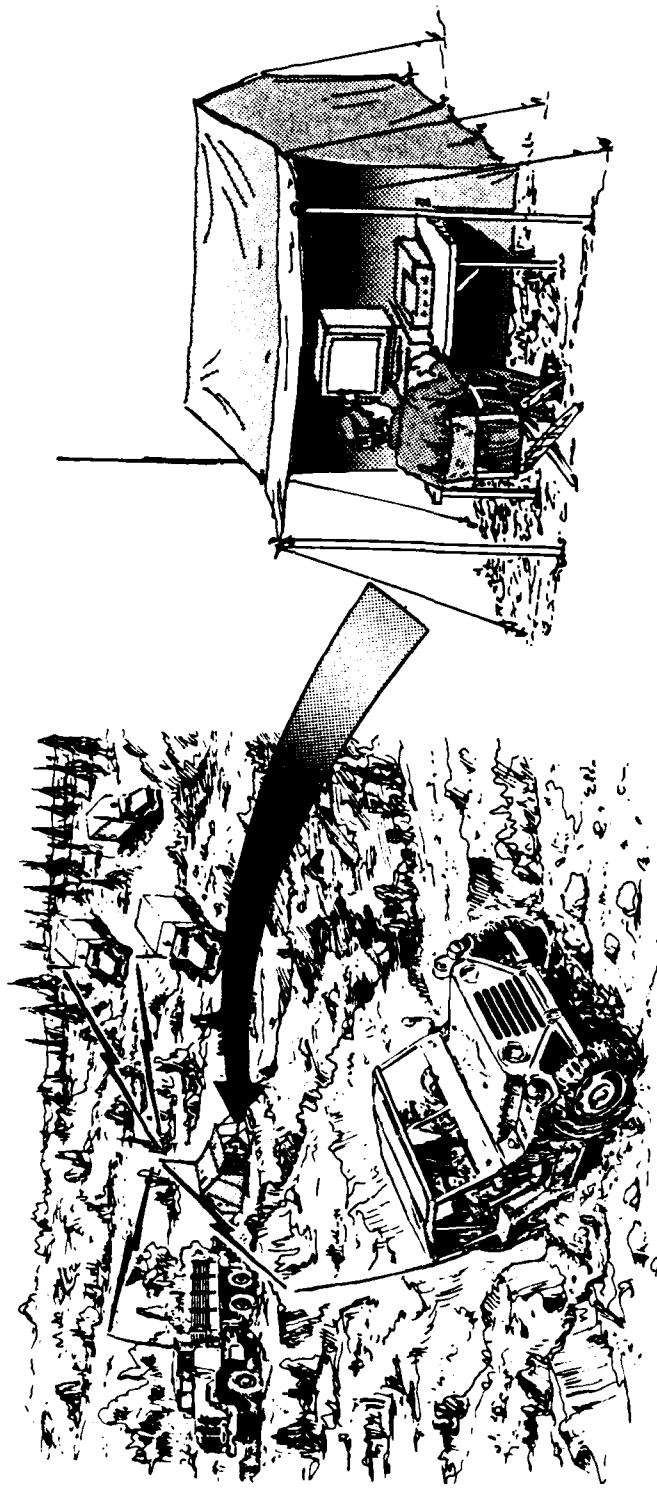
Army Regulation 602-2, MANPRINT. Washington, D.C. 1987

Lowry, John and Seaver, David, "Handbook for Quantitative Analysis of MANPRINT Considerations in Army Systems." Alexandria, VA: Allen Corporation of American Technical Report, June 13, 1986.



THE SVCR-120R-A CAN  
OPERATE PROPERLY WHEN  
MOUNTED AND USED IN ANY  
OF THE SIX POSSIBLE AXES.

Figure 3 Example Of Video Cassette Recorder Used For Monitoring  
Soldier Performance In A Moving Vehicle



- TEST AND EVALUATION PERSONNEL

- SOLDIERS UNDER TEST

Figure 4 Illustration of Monitoring Multiple Moving Platforms

APPENDIX 1

MANPRINT SURVEY OF MINIATURIZED

VIDEO CAMERAS

APPENDIX 1

MANPRINT SURVEY OF MINIATURIZED VIDEO CAMERAS

Part One

#	COMPANY	MODEL NUMBER	COLOR ?	SEP HEAD ?	SENSOR TYPE	LENS MOUNT	LINES* OF RESOL	POWER REQUIREMENTS (VDC/VAC)	SIZE (W" x H" x D")	WT (lbs)
1	TELEDYNE CAMERA SYSTEMS	MCTS	N	N	MOS	'C' MOUNT	500	28/	4.9 x 1.7 x 5.4	2
2	SANYO ELECTRIC	VDC3900	Y	N	CCD	'C' MOUNT	300	12/120	3.1 x 2.2 x 5.2	17.9
3	SANYO ELECTRIC	VDC3824	N	N	CCD	'C' MOUNT	420	--/24,120	3.1 x 2.2 x 5.0	21.3
4	GENERAL ELECTRIC	TN2700	N	N	CID	'C' MOUNT	377	10.5 - 18/----	3.4 x 3 x 5	1.5
5	GENERAL ELECTRIC	TN2710	N	N	CID	'C' MOUNT	754	10.5 - 18/----	3.4 x 3 x 5	1.5
6	GENERAL ELECTRIC	TN2250	N	N	CID	'C' MOUNT	514	10.5 - 18/----	3.4 x 3 x 7	2.25
7	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	TC1036/H	N	N	SIT	12.5 - 180 mm/F1.9	550	24/120, 220	5.6 DIAM x 22	29
8	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	TC1030/H	N	N	SIT	12.5 - 180 mm/F1.9	600	24/120, 220	5.6 DIAM x 22	29
9	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	TC7000	N	N	ULTRICON	'C' MOUNT	600	12.24/120	2.75 x 4.75 x 6.6	2
10	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	TC200	Y	N	CCD	'C' MOUNT	330	12/120	4.1 x 3.4 x 6.2	2
11	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	TC1040/H	N	N	SIT	'C' MOUNT	550	24/120	6.7 DIAM X 22.9	22.3
12	FARGO COMPANY	HVM-302	N	N	SATICON	11mm/F1.8	525	6/----	2.1 x 1.3 x 4	0.4

APPENDIX 1

MANPRINT SURVEY OF MINATURIZED VIDEO CAMERAS

Part One (continued)

#	COMPANY	MODEL NUMBER	COLOR ?	SEP HEAD ?	SENSOR TYPE	LENS MOUNT	LINES* OF RESOL	POWER REQUIREMENTS (VDC/VAC)	SIZE (W" x H" x D")	WT (lbs)
13	VIDEO LOGIC CORPORATION	CDR-460	N	N	CCD	'C' MOUNT	280	12/---	5.5 x 2.5 x 3.0	0.125
14	VIDEO LOGIC CORPORATION	CDR-460RM	N	Y	CCD	'C' MOUNT	280	12/---	1.75 x 1.5 x 1.5	0.125
15	MP VIDEO	MC-6	Y	Y	CCD	'V' MOUNT W/'C' MOUNT ADAPTOR	330	12/115	1.5 x 1.7 x 1.75	0.156
16	TELEDYNE CAMERA	CCTS	Y	N	MOS	CUSTOM F2.8	350	24/---	3.9 x 4.9 x 1.75	2
17	JAVELIN ELECTRONICS INC.	JE3210M	Y	Y	MOS	'C' MOUNT	350	12,24/115	1.6 x 1.5 x 3.0	0.219
18	JAVELIN ELECTRONICS INC.	LL777SRE	N	N	SIT	'C' MOUNT	550	12,24/115	3.5 x 3.5 x 5	30
19	WESTINGHOUSE ELECTRIC CORPORATION	ETV-1250	N	Y	VIDICON	16 mm f2.8	550	--/115	1.25 DIAM x 12	1
20	WESTINGHOUSE ELECTRIC CORPORATION	ETV-1253	N	Y	NEWVICON	16 mm f2.8	550	--/115	1.25 DIAM x 11.4	2
21	CARDION ELECTRONICS INC.	CVS-102	N	Y	VIDICON	'C' MOUNT	520	28/---	3.6 x 2.25 x 4.6	2

\*Although video camera technology is rapidly changing, the industry accepted range of horizontal lines of resolution is low; below 400, medium, 400-600, high; above 600.

APPENDIX 1

MANPRINT SURVEY OF MINIATURIZED VIDEO CAMERAS

Part Two

#	MODEL NUMBER	LIGHT RQMT (fc)	MILITARY SPECIFICATION MIL-SPEC-XXXX	TEMP RANGE (Deg C)	SHOCK (g)	HUMIDITY (%)	COMMENTS
1	MCTS		810C	-30 to 50	59	95 N/C	CURRENTLY USED ON AV-8B.
2	VDC3900	1.39		-10 to 40			NO INTERFERENCE FROM MAGNETIC OR ELECTROSTATIC FIELD.
3	VDC3824	1.39		-10 to 50			
4	TN2700	0.3		-30 to 50	50	95 N/C	
5	TN2710	0.3		-30 to 50	50	95 N/C	
6	TN2250	0.3		-20 to 50			
7	TC1036/H	0.093	810C	-40 to 60	30	100	PREPACKAGED FOR ADVERSE ENVIRONMENTS FULL SUNLIGHT TO QUARTER MOONLIGHT
8	TC1030/H	0.001		-18 to 60	30	95	LONG DISTANCE CONTROL CAPABILITY
9	TC7000	0.016		-18 to 60	50	95	
10	TC200	1.8		-20 to 50		95 N/C	REQUIRES A 1.3 LB POWER SUPPLY
11	TC1040/H	0.000054		-18 to 60	50	95	RCA LOW BLOOM INTENSIFIED SILICON INTENSIFIER TARGET (SIT) CAMERA. RANGES FROM STARLIGHT TO FULL SUNLIGHT. CAN BE CONTROLLED UP TO ONE MILE.
12	HVM-302	5					INCLUDES MONITOR (SONY WATCHMAN) AND POWER SUPPLY. DESIGNED FOR NARCOTICS 'STING' OPERATIONS.

APPENDIX 1

MANPRINT SURVEY OF MINIATURIZED VIDEO CAMERAS

Part Two (continued)

#	MODEL NUMBER	LIGHT RQMT (fc)	MILITARY SPECIFICATION MIL-SPEC-XXXX	TEMP RANGE (Deg C)	SHOCK (g)	HUMIDITY (%)	COMMENTS
13	DR-460	3					DESIGNED FOR INDUSTRIAL AUTOMATION
14	CDR-460RM	3					DESIGNED FOR INDUSTRIAL AUTOMATION. COMES WITH 10' CORD FOR SENSOR HEAD.
15	MC-6	3		0 to 40		100	COMES WITH CONTROL UNIT AND 12' CABLE. OPTIONAL 12VDC AVAILABLE.
16	CCTS		810C	30 to 50	50	95 N/C	THE B & W VERSION IS SIMILAR IN SIZE & WEIGHT BUT HAS 500 LINES RESOLUTION.
17	JE3210M	0.5		-10 to 50		95	COMES WITH 10' CORD CONNECTING TO CAMERA CONTROL UNIT. WORKING ON THE F-14. WILLING TO DEMO PRODUCT. SEEMS LIKE VERY GOOD CANDIDATE.
18	LL777SRE	0.000075					ULTRA LOW LEVEL SIT CAMERA WITH REMOTELY CONTROLLED 15-150 mm LENS WITH TC-143 OR REMOTE CONTROL UNIT.
19	ETV-1250	0.125		-25 to 60		95	AUTOMATIC LIGHT LEVEL COMPENSATION.
20	ETV-1253	0.125		-25 to 60		95	MINIATURE UNDERWATER TV CAMERA USED PRIMARILY FOR NUCLEAR REACTOR INSPECTION. WEIGHT 30 LBS WITH 125 FEET OF CABLE.
21	CVS-102	0.1	5400	-54 to 55		100	AUTOMATIC LIGHT CONTROL AND MOTORIZED ZOOM LENS.

APPENDIX 1

MANPRINT SURVEY OF MINIATURIZED VIDEO CAMERAS

NAME AND ADDRESS

Part Three

<u>NUMBER</u>	<u>COMPANY</u>	<u>NAME OF CONTACT</u>	<u>CONTACT'S TITLE</u>	<u>COMPANY ADDRESS</u>	<u>TELEPHONE</u>
1,16	TELEDYNE CAMERA SYSTEMS	DERMOT MATHEWS	V.P. MARKETING	131 N. FIFTH AVE. ARCADIA CA 3740	91006-818-359-6691
2,3	SANYO ELECTRIC AUDIO VIDEO SUPPLY	PETER MASCARO	SALES REP	4274 CARDIN SAN DIEGO CA 92111	619-565-1101
4,5,6	GENERAL ELECTRIC		ELECTRONIC CAMERA OPERATION	890 SEVENTH NO. ST. LIVERPOOL NY 13088	315-456-2832
7,8,9,10,11	RCA CLOSED CIRCUIT VIDEO EQUIPMENT	KERBY D. LONG	PACVID REP FOR RCA	8404 FRANKLIN AVE LOS ANGELES CA 90069	213-650-7373
12	FARGO COMPANY			577 TENTH ST SAN FRANCISCO CA 94103	415-621-4471
13,14	VIDEO LOGIC	YASMIN HITCHBORN	SALES SUPPORT	597 N. MATHILDA AVE. SUNNYVALE CA 94086	408-245-8622
15	MP VIDEO	STEVEN J. MINES	IND SALES/MKTG MGR	65 SOUTH STREET HOPKINTON MA 01748	617-435-2131
17,18	JAVELIN ELECTRONICS INC.	MARTIN SANCHEZ	SALES REP	P.O. BOX 2033 TORRANCE CA 90510	800-528-9200
19,20	WESTINGHOUSE ELECTRIC CORPORATION	BOB ZOLLER	REGIONAL ACCTS MGR	473 SAPENA CT., SUITE #1 SANTA CLARA CA 95054	408-735-2217
21	CARDION ELECTRONICS INC.	GEORGE GAUGHAN	MARKETING MANAGER	LONG ISLAND EXPRESSWAY WOODBURY NY 11797	516-921-7300

APPENDIX 1

TABLE OF VIDEO CAMERA IMAGE SENSOR TYPES

ACRONYM	TECHNICAL NAME	CHARACTERISTICS
CCD	CHARGED COUPLED DEVICE	<ul style="list-style-type: none"> <li>◦ SMALL, RUGGED, AND LOW POWER CONSUMPTION</li> <li>◦ ANTI-BLOOMING</li> <li>◦ REQUIRES MINIMUM 2 FC OF LIGHT</li> </ul>
CID	GENERAL ELECTRIC POLYSILICON-ALUMINUM CONSTRUCTION	<ul style="list-style-type: none"> <li>◦ ANTI-BLOOMING</li> <li>◦ HIGH EFFICIENCY</li> </ul>
MOS	METAL OXIDE SEMICONDUCTOR	<ul style="list-style-type: none"> <li>◦ EVERY PIXEL SENCED WITHOUT DISTORTION</li> <li>◦ INHIBITS BLOOMING, NO SENSOR BURN</li> <li>◦ REQUIRES MINIMUM 2 FC OF LIGHT</li> </ul>
SATICON	HITACHI TRADEMARK VIDEO TUBE	<ul style="list-style-type: none"> <li>◦ LOW LAG CURRENT</li> <li>◦ 50 °C MAXIMUM TEMPERATURE</li> </ul>
SIT	SILICON INTENSIFIED TARGET	<ul style="list-style-type: none"> <li>◦ OPERATES IN LOW LIGHT (MOONLIGHT TO STARLITE)</li> <li>◦ LOW BLOOM</li> </ul>
ULTRICON	RCA TRADE MARK VIDEO TUBE	<ul style="list-style-type: none"> <li>◦ OPERATES OVER VERY WIDE LIGHT RANGE</li> <li>◦ IMMUNE TO BURN AND IMAGE RETENTION</li> </ul>
VIDICON	INDUSTRY STANDARD VIDEO TUBE PHOTO RESISTOR	<ul style="list-style-type: none"> <li>◦ MODERATE TARGET BURN</li> <li>◦ MODERATE INFRA-RED SENSITIVITY</li> <li>◦ SENSITIVE TO LOW LEVEL VIBRATION</li> </ul>
NEWVICON	DEVELOPED BY MATSUSHITA	<ul style="list-style-type: none"> <li>◦ GOOD RESISTANCE TO TARGET BURN AND INFRA-RED</li> <li>◦ SENSITIVE TO LOW LEVEL VIBRATION</li> </ul>

APPENDIX 2

MANPRINT SURVEY OF VIDEO AND AUDIO RECORDERS

APPENDIX 2

MANPRINT SURVEY OF VIDEO AND AUDIO RECORDERS

Part One

#	COMPANY	MODEL NUMBER	POWER RQ/MNT (VDC/VAC)	SIZE (W" x H" x D")	WEIGHT (lbs)	MAX REC (HRS)	TAPE TYPE	TAPE FORMAT
1	Sekai Electronics of America Inc.	V-1000ABN	28/---	12.25 x 6.6 x 13	30	0.5	3/4" Cassette	U-Matic
2	Sekai Electronics of America Inc.	V250G-F	--/115	19 x 5.25 x 10.6	26.5	1	1/4" Cassette	S Format
3	Sekai Electronics of America Inc.	V-250AB-F	28/---	7.5 x 4.25 x 6.1	8.8	1	1/4" Cassette	S Format
4	Photosonics Inc.	SVCR-120R	28/115	8.3 x 13 x 3.6	13.2	2	1/2" Cassette	VHS
5	RCA Closed Circuit Video Equipment	TC-3900	--/120	17.5 x 12.8 x 3.8	17.5	6	1/2" Cassette	VHS
6	RCA Closed Circuit Video Equipment	TC-3920	--/120 --/230	17.1 x 13.4 x 4.9	18	6	1/2" Cassette	VHS
7	Precision Echo	WR-221	28/115	18 x 2 x 7	47	1	1" x 10.5" Real	Special
8	Precision Echo	WRR-421	28/115	31 x 19 x 17.5	165	1	1" x 10.5" Real	Special
9	Precision Echo	AN/AQH-4(V)2	28/115	19 x 17 x 8.5	76	1	1" x 10.5" Real	Special
10	Kodak	MVS-5000	--/115	2.6 x 5.3 x 6.5	2.1	2	1/2" Cassette	8 MM

MANPRINT SURVEY OF AUDIO RECORDERS

1	Datatape Inc.	CMS-1000	115	5 x 8.4 x 13	11.5	1.5	C60,C90 Audio Cassette
2	Fargo Company	L-200	Battery	.5 x 2 x 4	0.25		Micro Cassette
3	Int'l Tapetronics Corp./3M	99B-PM	--/115				3M Cartridges

APPENDIX 2

MANPRINT SURVEY OF VIDEO AND AUDIO RECORDERS

Part Two

#	MODEL NUMBER	MILITARY SPECIFICATION (MIL-SPEC-XXXX)	OPERATING TEMP RNG (DEG C)	SHOCK (g)	HUMIDITY (%)	COMMENTS
1	V-1000ABN	810C	-10 to 55	10	80	HIGHLY RUGGEDIZED FOR USE IN HOSTILE AIRBORNE ENVIRONMENTS. THIS IS A RECORD AND PLAYBACK PRODUCT. RECORDS 72 MIN ON A 30 MIN TAPE IN B & W OR COLOR.
2	V250G-F		5 to 40			USED FOR POST MISSION ANALYSIS OF RECORDINGS MADE WITH THE AIRBORNE RECORDERS.
3	V-250AB-F	810C	-15 to 55	15	80	HIGHLY RUGGEDIZED FOR USE IN HOSTILE AIRBORNE ENVIRONMENTS.
4	SVCR-120R	810C	-40 to 50	15		STANDARD EQUIPMENT ON THE USMC OV-10. CAN BE USED FOR 1553 BUS RECORDING WITH SPECIAL INTERFACE FM DIAGNOSTIC RETRIEVAL OF NEW YORK.
5	TC-3900		5 to 40			CAN BE TURNED ON AT SPECIFIC CUES. USES A SPECIAL TAPE FOR 12 HOUR AUDIO RECORDING.
6	TC-3920		5 to 40			CAN BE TURNED ON AT SPECIFIC CUES. USES A SPECIAL TAPE FOR 12 HOUR AUDIO RECORDING. SELECTABLE SPEEDS.
7	WR-221					"SMALLEST AND LIGHTEST PORTABLE AIRBORNE RECORDER WITH 6 MH BANDWIDTH...RECORDS VIRTUALLY ANY TYPE OF SIGNAL INCLUDING RADAR, T.V. AND AUDIO".
8	WWR-421					UNIVERSAL INSTRUMENTATION WIDE-BAND RECORDER/REPRODUCER. USED TO ANALYZE TAPES RECORDED ON WR-221.

APPENDIX 2

MANPRINT SURVEY OF VIDEO AND AUDIO RECORDERS

Part Two (continued)

#	MODEL NUMBER	MILITARY SPECIFICATION (MIL-SPEC-XXXX)	OPERATING TEMP RNG (DEG C)	SHOCK (g)	HUMIDITY (%)	COMMENTS
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9	AN/AQH-4(V)2	5400	-54 to 55	15	100	CURRENTLY IN USE ON USN P-3C FOR ASW INFORMATION GATHERING.
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10	MVS-5000					RECORDS UP TO 12 HOURS OF DIGITAL AUDIO SOUND USING ONE 8MM VIDEO CASSETTE.
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MANPRINT SURVEY OF AUDIO RECORDERS

1	CMS-1000	N/A	0 to 50		90 N/C	USES STANDARD COMPACT CASSETTES WITH FRONT LOADING COMPUTER CONTROL CAPABILITY VIA IEEE 488 BUS. TRANSCRIBER/REMOTE CONTROL CAPABILITY WITH BIDI-RECTIONAL SEARCH FUNCTION.
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2	L-200					HAS AN AUTOMATIC VOICE OPERATION CIRCUIT ACTUATED BY AN RF SIGNAL.
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3	99B-PM					MONOPHONIC BROADCAST QUALITY RECORDER WITH HIGH SPEED RECUE.
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APPENDIX 2

MANPRINT SURVEY OF VIDEO AND AUDIO RECORDERS

NAME AND ADDRESS

Part Three

<u>NUMBER</u>	<u>COMPANY</u>	<u>NAME OF CONTACT</u>	<u>CONTACT'S TITLE</u>	<u>COMPANY ADDRESS</u>	<u>TELEPHONE</u>
1,2,3	SEKAI ELECTRONICS OF AMERICA INC	RON BURNETT	WESTERN REGIONAL MGR	14700 E. FIRESTONE BLVD #122 LA MIRADA CA 90638	(714) 670-1854
4	PHOTOSONICS INC.	DON STAFFORD	W. COAST APP. MGR.	820 S. MARIPOSA ST. BURBANK CA 91506-3196	(805) 273-2118
5,6	RCA CLOSED CIRCUIT VIDEO EQUIPMENT			NEW HOLLAND AVE. LANCASTER PA 17604-3140	
7,8,9	PRECISION ECHO	DAVID NELSON	W. REGIONAL SALES MG	3105 PATRICK HENRY DR. SANTA CLARA CA 95054	(408) 988-0516
10	MVS-5000	KODAK			(800) 242-2424
MANPRINT SURVEY OF AUDIO RECORDERS					
1	DATATAPE INC.			P.O. BIN 7014 PASADENA CA 91109-7014	(818) 796-9381
2	FARGO COMPANY			577 TENTH ST. SAN FRANCISCO CA 94103	(415) 621-4471
3	INT'L TAPETRONICS CORP/3M	MARK HILL	SALES REP.	2425 S. MAIN ST. BLOOMINGTON IL 61702-0241	(309) 828-1381

APPENDIX 3

MANPRINT SURVEY OF PAN AND TILT  
CONTROL UNITS

APPENDIX 3

MANPRINT SURVEY OF PAN AND TILT CONTROL UNITS

Part One

#	COMPANY	MODEL NUMBER	MOUNT	MAX LOAD (lbs)	PAN ANGLE (deg)	TILT ANGLE (deg)	POWER ROMNT (VDC/VAC)	SIZE (W" x H" x D")	WEIGHT (lbs)
1	ARVIN/DIAMOND	PT-100	CM-107, 108, 109, 112	15	360	+/- 90	--/115	7.75 x 8.25 x 4.5	20
2	ARVIN/DIAMOND	PT-102	CM-108, 109	40	360	+/- 90	--/115	11.25 x 9.75 x 5.9	22
3	ARVIN/DIAMOND	PT-103	CM-110, 111	100	360	90	--/115	15.4 x 14 x 7.25	65
4	COHU INC. ELECTRONICS DIV	V330APT		35	350	90	24/---	14 x 11 x 7	38
5	COHU INC. ELECTRONICS DIV	V330-115APT		35	350	+/- 90	--/115	14 x 11 x 7	38
6	COHU INC. ELECTRONICS DIV	V390APT		80	350		--/115	14 x 11 x 7	40
7	COHU INC. ELECTRONICS DIV	V3800PT		200	350		--/115	17 x 22 x 14	140
8	GRC CLOSED CIRCUIT TV CORP	AS-7	WM-9	12	360		--/24		
9	GRC CLOSED CIRCUIT TV CORP	AS-5	WM-9	12	360		--/117		
10	GRC CLOSED CIRCUIT TV CORP	YU-305	WM-5A	12	360		--/24		

APPENDIX 3

MANPRINT SURVEY OF PAN AND TILT CONTROL UNITS

Part One (continued)

#	COMPANY	MODEL NUMBER	MOUNT	MAX LOAD (lbs)	PAN ANGLE (deg)	TILT ANGLE (deg)	POWER ROMNT (VDC/VAC)	SIZE (W" x H" x D")	WEIGHT (lbs)
1	GBC CLOSED CIRCUIT TV CORP	YU-303	WM-6		360		--/24		
12	MOTOROLA COMMUNICATIONS AND ELEC. INC.	VDN6713	SDN6184/7	100	355	90	--/115		65

APPENDIX 3

MANPRINT SURVEY OF PAN AND TILT CONTROL UNITS

Part Two

#	MODEL NUMBER	OPERATING TEMP RNG (DEG C)	COMMENTS
1	PT-100		INDOOR MODEL FOR LIGHT DUTY USE. REQUIRES PTC-100 CONTROLLER.
2	PT-102		OUTDOOR MODEL FOR MEDIUM DUTY USE. REQUIRES PTC-100 CONTROLLER.
3	PT-103		OUTDOOR MODEL FOR HEAVY DUTY USE. REQUIRES PTC-100 CONTROLLER.
4	V330APT	-51 to 74	A MEDIUM DUTY ALL WEATHER PAN AND TILT DRIVE UNIT. A PRESET POSITION CONTROL IS AVAILABLE FOR USE WHEN NOT OPERATING IN AN AUTOMATIC PAN MODE.
5	V330-115APT	-51 to 74	A MEDIUM DUTY ALL WEATHER PAN AND TILT DRIVE UNIT. A PRESET POSITION CONTROL IS AVAILABLE FOR USE WHEN NOT OPERATING IN AN AUTOMATIC PAN MODE.
6	V390APT	-54 to 74	A HEAVY DUTY ALL WEATHER PAN AND TILT DRIVE UNIT. UP TO EIGHT PRESET POSITIONS ARE AVAILABLE FOR USE WHEN NOT OPERATING IN AN AUTOMATIC PAN MODE.
7	V3800PT	-29 to 74	AN EXTRA-HEAVY DUTY ALL WEATHER PAN AND TILT DRIVE UNIT. UP TO EIGHT PRESET POSITIONS ARE AVAILABLE FOR USE WHEN NOT OPERATING IN AN AUTOMATIC PAN MODE. USES HEAVY WORM GEAR AND OVERSIZED MOTORS.
8	AS-7		COMES WITH CONTROL BOX THAT PROVIDES EITHER AUTOMATIC OR MANUAL SCANNING WITH PROVISION FOR INSTANT STOP AND START VIEWING.
9	AS-5		COMES WITH CONTROL BOX THAT PROVIDES EITHER AUTOMATIC OR MANUAL SCANNING WITH PROVISION FOR INSTANT STOP AND START VIEWING.
10	YU-305		INDOOR PAN AND TILT WITH REMOTE CONTROL BOX THAT PROVIDES EITHER AUTOMATIC MANUAL SCANNING WITH PROVISION FOR INSTANT STOP AND START VIEWING.
11	YU-303		HEAVY DUTY INDOOR AND OUTDOOR PAN AND TILT WITH REMOTE CONTROL BOX.
12	VDN6713	-23 to 60	HEAVY DUTY PAN/TILT UNIT WHICH CAN BE PRESET TO VARIOUS POSITIONS AUTOMATICALLY USING THE MICROPROCESSOR BASED DIGITAL CONTROL SYSTEM.

APPENDIX 3

MANPRINT SURVEY OF PAN AND TILT CONTROL UNITS

NAME AND ADDRESS

Part Three

<u>NUMBER</u>	<u>COMPANY</u>	<u>NAME OF CONTACT</u>	<u>CONTACT'S TITLE</u>	<u>COMPANY ADDRESS</u>	<u>TELEPHONE</u>
1,2,3	ARVIN/DIAMOND			4465 COONPATH ROAD CARROLL OH 43130	(614) 756-9222
4,5,6,7	COHU INC. ELECTRONICS DIVISION			P.O. BOX 85623 SAN DIEGO CA 92138-5623	(619) 277-6700
8,9,10,11	GBC CLOSED CIRCUIT TV CORP			315 HUDSON ST. NEW YORK NY 10013	(212) 989-4433
12	MOTOROLA COMMUNICATIONS AND ELEC. INC.			1301 E. ALGONQUIN RD. SCHAMBURG IL 60196	(312) 397-1000

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

Part One

#	COMPANY	MODEL NUMBER	MAX RFC (Hrs)	POWER RQMTS VDC/VAC	SIZE W" x H" x D"	LBS	MIL SPEC NUMBER	TEMP RANGE (Deg C)	SHOCK (g)	HUMIDITY (%)	COMMENTS	COST
1	SUNSTRAL DATA CONTROL INC.	AN/ASK -7									CURRENTLY IN USE ON B-1B AND B-52 FOR BOMB SCORING.	0.00
2	LOCKHEED AIRCRAFT SERVICES CO.			--/115 ?		175	ARINC 591				USED ON C-5 AND C-130 BUT NOT CAPABLE OF BROADBAND 1553 RECORDING.	0.00
3	PRECISION ECHO	WR-221	1	28/115	18 x 2 x 7	47					RECORDS 10 MHZ-6 MHz BANDWIDTH. CURRENTLY USED ON A MK-48 TORPEDO PRACTICE HEAD.	
4	PRECISION ECHO	WRR-421	1	28/115	31 x 19 x 17.5	165					UNIVERSAL INSTRUMENTATION WIDE-BAND. RECORDER/REPRODUCER. USED TO ANALYZE TAPES RECORDED ON WR-221.	0.00
5	PRECISION ECHO	AN/AQH -4(V)2	1	28/115	19 x 17 x 8.5	76	5400				CURRENTLY IN USE ON USN P-3C FOR ASW INFORMATION GATHERING.	0.00
6	ELECTRODYNAMICS INC	ADC	115	28/230							TOTALLY SOLID STATE AIRBORNE DATA RECORDER (ADC). CURRENTLY FLYING ON THE B-1B, T-46 and the T-38.	

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

Part One (continued)

#	COMPANY	MODEL NUMBER	MAX REC (Hrs)	POWER RQMTS (VDC/VAC)	SIZE (W" x H" x D")	LBS	MIL SPEC NUMBER	TEMP RANGE (Deg C)	SHOCK (g)	HUMIDITY (%)	COMMENTS	COST
7	SCI SYSTEMS, INC	RD461A	--/115	14.3 x 11.5 x 18.5	45	5400	-20 to 50				USES 1/4" TAPE CARTRIDGES. ALSO INCLUDES AN AUTO BIT AND CRC READ - WHILE - WRITE DATA INTEGRITY CHECKS.	0.00
8	LEIGH INSTRUMENTS INC	UNK									TOTALLY SOLID STATE NON-VOLATILE MEMORY. HAS AN IBM PC INTERFACE CAPABILITY FOR POST MISSION ANALYSIS. CUSTOMERS ARE U.S. NAVY, RAF HAWK & TORNADO.	0.00
9	SUNSTRAND DATA CONTROL INC	SETS -II	28/---	5.6 x 3.7 x 3.7	3.5	5400 /810C	-55 to 70	15	95	N/C	192 KB/SEC DATA TRANSFER RATE.	0.00
10	SUNSTRAND DATA CONTROL INC	DATA LOGGER	28/---	4 x 7 x 7.5	9	5400 /810C	-55 to 70	60	95	N/C	230 KB/SEC DATA TRANSFER RATE.	0.00
11	LEAR SIEGLER INC	SFDR -6213	28/---	6.2 x 7 x 7.3	14.5	5400	-54 to 71	25			COMPRISED OF 3 UNITS: SIGNAL ACQUISITION UNIT, MEMORY UNIT, GROUND READOUT EQUIPMENT. EQUIPMENT IS OPERATED BY A MIL-STD-1750A CPU.	0.00
12	ASTRONAUTICS CORP OF AMERICA	SDR									THEIR SHIPBOARD DATA RECORDER. IT INTERFACES NON AVIONICS EQUIPMENT WITH THE 1553 AVIONICS MUX BUS.	0.00

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

Part One (continued)

#	COMPANY	MODEL NUMBER	MAX REC (Hrs)	POWER RQMTS VDC/VAC	SIZE W" x H" x D"	LBS	MIL SPEC NUMBER	TEMP RANGE (Deg C)	SHOCK (g)	HUMI-DITY (%)	COMMENTS	COST
13	PHOTONICS INC	SVCB -120R	2	28/115	8.3 x 13x 3.6	13.2	810C	-40 to 50	15		STANDARD EQUIPMENT ON THE USMC OV-10. CAN BE USED FOR 1553 BUS RECORDING WITH SPECIAL INTERFACE fm DIAGNOSTIC RETRIEVAL OF NEW YORK.	0.00
14	AMPEX CORP DATA SYSTEMS DIVISION	AHBR -17001	3.8	28/115	20.7 x 8.7 x 12.5	17	5400 /810C	-29 to 55	15	95 N/C	RECORDS ENTIRE BROADBAND 1553 MUX BUS AND INCLUDES BIT EQUIPMENT.	0.00
15	INSTRUMENT TECH-NOLOGY SYSTEMS	9930 VTR	?	28/---	20.7 x 8.7 x 12.5		5400	0 to 55				0.00
16	INSTRUMENT TECH-NOLOGY SYSTEMS	9931 VTR	?	28/---	20.7 x 8.7 x 12.5		5400	0 to 55				0.00
17	DATATAPE INC	M-14E	16		20.3 x 16 x 10.5	74	5400 /704a	-18 to 54	15	95 N/C		0.00
18	DATATAPE INC	AN/USH -24	16	--/115	26 x 19 x 16	170	810C	0 to 50	15	95 N/C	1000 HOUR HEAD LIFE	0.00
19	AMPEX CORP DATA	HBR -30001	3.8	--/115	77 x 30 x 46	170					RECORDS ENTIRE BROADBAND 1553 MUX BUS AND INCLUDES BIT EQUIPMENT. USES 1" TAPE ON A 14" REEL. USED FOR DETAILED ANALYSIS OF AHBR17001 RECORDINGS.	0.00

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDINGS

Part One (continued)

#	COMPANY	MODEL NUMBER	MAX REC (Hrs)	POWER RQMTS VDC/VAC	SIZE W" x H" x D"	LBS	MIL SPEC NUMBER	TEMP RANGE (Deg C)	SHOCK (g)	HUMIDITY (%)	COMMENTS	COST
20	LORAL INSTRUMENTATION	SSA-10	N/A	--/115	25.5 x 16.7 x 8.7	60		10 to 43		95 N/C	THIS DEVICE IS USED FOR POST-MISSION ANALYSIS OF THE 1553 MUX BUS. IT RECONSTRUCTS THE DATABUS AND ALLOWS CORRELATION OF THE MANY TIME CRITICAL EVENTS ON ALL DATA CHANNELS. TOTALLY MENU DRIVEN.	0.00

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

NAME AND ADDRESS

Part Two

<u>NUMBER</u>	<u>COMPANY</u>	<u>NAME OF CONTACT</u>	<u>CONTACT'S TITLE</u>	<u>COMPANY ADDRESS</u>	<u>TELEPHONE</u>
1	SUNSTRAND DATA CONTROL INC	WES CARROLL	MARKETING MANAGER	OVERLAKE INDUSTRIAL PARK REDMOND WA 98052	(206) 885-3711
2	LOCKHEED AIRCRAFT SERVICES CO	DICK SCROB	MARKETING MANAGER	P.O. BOX 33 ONTARIO CA 91761	(714) 988-0516
3,4,5	PRECISION ECHO	DAVID NELSON	W. REGIONAL SALES MANAGER	3105 PATRICK HENRY DR. SANTA CLARA CA 95054	(408) 988-0156
6	ELECTRODYNAMICS INC			1200 HICKS RD. ROLLING MEADOWS IL 60008	(312) 259-0740
7	SCI SYSTEMS INC	BOB KEARNEY	MARKETING MANAGER	P.O. BOX 4000 HUNTSVILLE AL 35802	(205) 882-4800
8	LEIGH INSTRUMENTS INC	JIM WELLS		2680 QUEENSVIEW WAY OTTOWA, OT K2B 8J9 CANADA	(613) 820-9720
9,10	SUNSTRAND DATA CONTROL INC	WES CARROLL	MARKETING MANAGER	OVERLAKE INDUSTRIAL PARK REDMOND WA 98052	(206) 885-3711
	LEAR SIEGLER INC	MIKE GRADY	SENIOR MARKETING MGR.	4141 EASTERN AVE. S.E. GRAND RAPIDS MI 49508	(616) 241-8853
12	ASTRONAUTICS CORP OF AMERICA	STEFANIE HOFFMAN		P.O. BOX 523 MILWAUKEE WI 53201	(414) 671-5500
13	PHOTONICS INC	DON STAFFORD	W. COAST APP MGR	820 S. MARIPOSA ST. BURBANK CA 91506-3196	(805) 273-2118

APPENDIX 4

MANPRINT SURVEY OF DATABUS RECORDERS

NAME AND ADDRESS

Part Two (continued)

<u>NUMBER</u>	<u>COMPANY</u>	<u>NAME OF CONTACT</u>	<u>CONTACT'S TITLE</u>	<u>COMPANY ADDRESS</u>	<u>TELEPHONE</u>
14	AMPEX CORP DATA SYSTEMS DIVISION	RENE CHIKHANI	MARKETING MANAGER	401 BROADWAY M/S 10-15 REDWOOD CITY CA 94063	(415) 367-3722
15,16	INSTRUMENT TECHNOLOGY SYSTEMS	LINDA WILLIS		19360 BUSINESS CENER DR. NORTHBRIDGE CA 91324-3547	(818) 886-2034
17,18	DATATAPE INC			P.O. BIN 7014 PASADENA CA 91109-7014	(818) 796-9381
19	AMPEX CORP DATA SYSTEMS DIVISION	RENE CHIKHANI	MARKETING MANAGER	401 BROADWAY M/S 10-15 REDWOOD CITY CA 94063	(415) 367-3722
20	LORAL INSTRUMENTATION	JANET SHELTON	SALES ENGINEER	8401 AERO DRIVE SAN DIEGO CA 92123	(619) 560-5888