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STUDY TOWARD SUPPLEMENTING PRESENT RADAR INSTRUMENTATION IN FIELD TESTING ACTIVITIES

R. I. Peterson, 5221
J. G. Lareau, 5221

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW

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ABSTRACT

This memorandum is designed to serve as the basis for supplementing present radar instrumentation as needed in the Field Testing Organization.

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STUDY TOWARD SUPPLEMENTING PRESENT RADAR
INSTRUMENTATION IN FIELD TESTING ACTIVITIES

Purpose

The purpose of this study is to survey the present radar instrumentation facilities of Field Test, the present and future needs, and the available systems that will satisfy these needs.

Applications of Radar Instrumentation

Radar and plotting board equipment is now used by the Field Testing organization for several applications:

1. With a plotting board, radar systems are used for ground controlled bombing. By controlling the flight course and plotting trajectory information release information can be given to the plane.

2. For range safety purposes, a radar and plotting board system monitors all drops and thereby determines the safeness of an airplane course and of the release point when not ground controlled. With a search system, monitoring of all aircraft in the area is possible, thereby protecting against collisions.

3. For meteorological information, a radar with a plotting board gives immediate information as to wind strength and direction, and with digitizing equipment gives punched card information on winds for use in data reduction.

4. The radar alone gives target position data for use with optical tracking turrets, giving acquisition data and range information for focusing of the long focal length telescopes.

Present Equipment

At Salton Sea Test Base, two SCR-584 radars are now used. The R-1 station, used with data digitizing equipment, is primarily for weather information. In addition, the R-1 station is used for operational evaluation of development modifications to the SCR-584 sets. At R-2 station, the radar is equipped with an Electronic Associates plotting board. The station is used for all ground controlled bombing and, as much as is possible without a search system, for range safety purposes. It also furnishes the necessary target position data for a tracking turret and by plotting weather balloon tracks, gives immediate wind information.

In use at the Nevada Proving Ground Land Target is the AN/MPQ-2A radar and plotting board system, on loan from the U. S. Air Force. It, as yet, is not sufficiently accurate for ground controlled bombing work but is quite satisfactory as a monitor for range safety. Also, in combination with a parallax computer, a remote turret is pointed at the target being tracked. Additionally, the AN/MPQ-2A serves as a

back-up on wind velocity and direction measurements, as now supplied by a GMD-1A radiosonde tracker, on loan from the Air Force.

A fourth radar set, an SCR-584 in its portable trailer, is in use at Sandia in development work. It serves as the test instrument for any radar modifications planned for the Salton Sea stations, for tracking tests involving development of radar beacons and the electronic trajectory measurement system, and for development of the tracking turrets and associated equipment.

Future Requirements

To meet existing needs and to adequately prepare for future needs, several additions to Field Test radar instrumentation facilities are necessary. For the Salton Sea range, a plotting board is needed at the R-1 station so that it may operate on balloon runs totally independent of R-2, this station often being tied up on aircraft control when needed for wind plots. The second plotting board would also serve as a safety check on the other station during operations. The use of a third radar tracker, plotting board, and a search system would satisfy all range safety requirements insofar as continuous search to avoid collisions and control of release point is concerned. This system would be comparable to the R-2 installation for ground controlled operations, and could serve as a back-up or as the primary control with R-2 as back-up. INST. Lab facilities

For Project "Outcast", another of these systems involving a radar tracker, plotting board, and search system is needed. It would provide all the basic needs for radar instrumentation. The system would be completely portable, available for use at any test site. The use of another portable radar and plotting board, not necessarily as accurate as the primary set, would be valuable as part of the weather equipment at temporary range sites. It would serve for wind plots, giving information immediately, and would also serve as a secondary control radar for operations.

As an addition to the portable radar weather station, an invaluable aid would be the permanent possession of a GMD-1A radiosonde tracker. This gives accurate information of balloon ground tracks and its tracking features add greatly to the consistency of received radiosonde signals.

Presently Available Systems

In an endeavor to obtain instrumentation radar facilities to meet these needs of the Field Testing Organization, a study of the presently available radar systems has been made. Results of the study are tabulated on the accompanying chart.

The system that most completely and economically satisfies the immediate requirements for additional radar instrumentation in one package unit is the T-33 Antiaircraft Fire Control System. The T-33 search and tracking systems are quite compatible with our needs. For instrumentation purposes, however, the plotting equipment would require extensive modification to obtain variable scale factors, target and pen parallax, and time recording. This could be easily done at Sandia. Indications are that these systems may be available on a no cost basis because the T-33 is now considered obsolete. The U. S. Army Ordnance Department plans to modify a majority of the existing T-33 systems and so may be able to supply a kit enabling the modification

of the systems at Sandia. Modified, the system would be the equivalent of the M-33 Fire Control System, the primary difference presently being in the search system and the magnetron. The T-33 search system uses a lens antenna and a scan arrangement that results in more ground clutter seen on a PPI scope than is desirable. The M-33 uses a parabolic antenna and produces an improved search pattern. The resulting system has a slower scan rate, but the ground clutter is greatly reduced. Magnetron arcing in the T-33 has been solved in the M-33. Neither of these troubles makes the T-33 unusable in its original form, however. On the basis of these considerations, each T-33 system would cost approximately $125,000 when fully modified to our needs.

A secondary consideration is the direct purchase of the M-33 systems. This would result in the same radar system as the modified T-33, but at a cost of $325,000 per system. Modifications to the plotting equipment would still be an additional factor.

A third method would be the use of the U. S. Air Force AN/MSQ-1 radar system. The plotting equipment is very satisfactory for instrumentation needs, but the radar tracking equipment is based on the SCR-584, which is not highly accurate. In addition, there is no search facility as an integral part of the system. This would involve the use of a separate search radar such as the SG-6, and therefore, except for a building installation, the need for a third operator. Cost of such a complete system would be about $410,000.

As another alternative may be grouped the Sandia modified SCR-584, the White Sands AN/MPQ-12, and the USAF AN/MPQ-2A. All are based on an SCR-584 radar. The Sandia radar and the AN/MPQ-12 do not have plotting equipment and the AN/MPQ-2A does not have plotting equipment of sufficient accuracy and reliability for our primary needs. The plotting requirements could be met with Reeves or Electronic Associates equipment for a cost of $34,000. As before, with the AN/MSQ-1, the search system would be an added requirement. Complete systems based on these radars would cost approximately $275,000.

Future Systems

For precision instrumentation work, two radar systems are now being developed and should be available in the next two to three years. These are the AN/FPS-16, being developed by RCA and expected to cost about $630,000 when incorporated with a search system and plotting equipment, and the AN/MPS-19. Only limited information is yet available on the AN/MPS-19 being developed by Reeves Instrument Corporation for use in an improved version of the AN/MSQ-1 system.

Proposed Procedure

To meet the need for a plotting board at Salton Sea R-1 station, it is proposed that an Electronic Associates vertical plotting board be bought and used with the computing equipment of the Omnigrab system. This equipment would be readied at Sandia and could be in operation by August, 1955.

An attempt should be made to obtain two T-33 radar systems, one for Salton Sea and one for Project "Outcast." Modifications to the plotting equipment would be done at

Sandia before putting the systems into operation. The Ordnance Department modifications could be accomplished as deemed necessary after complete test of the systems.

For use as a secondary system for Project "Outcast" and for use with the portable weather station, the possibility of an indefinite loan of the AN/MPQ-2A should be examined. It is usable in its present condition. Additionally, the loan, on a permanent basis of a GMD-1A radiosonde tracker should be investigated.

On a long range program, the eventual replacement of the SCR-584 radar fixed installations at Salton Sea must be considered. The previously mentioned precision tracking radars, the AN/FPS-16 and the AN/MPS-19, are considered extremely good possibilities as replacements. On this basis, the SCR-584 radars would be available for fixed installations at other future sites.

Summary

To satisfy all present needs of the Field Testing Organization in the field of radar instrumentation, the acquisition of two T-33 radar systems, one AN/MPQ-2A radar system, a plotting board for Salton Sea, and a GMD-1A radiosonde tracker is required Steps are now being taken to accomplish this.

R. I. PETERSON - 5221
J. G. LAREAU - 5221

Case No. 612.43
February 25, 1955

RADAR

SPECS	M-33 (T-33) *		AN/MSQ-1	AN/MPQ-2A
	ACQUISITION	TRACK		
OPERATING FREQUENCY	S-BAND	X-BAND	S-BAND (TUNEABLE)	S-BAND
PEAK POWER	1000 Kw.	200-500 Kw.	190 Kw.	285 Kw.
MAXIMUM RANGE	120,000 Yd.	99,500 Yd.	400,000 Yd. (BEACON TRACKING)	192,000 Yd. (BEACON TRACKING)
RESOLUTION	200 Yd. RANGE 35 ϕ Az.	65 Yd. RANGE 20 ϕ Az.	80 Yd. RANGE 110 ϕ Az. & El.	80 Yd. RANGE 110 ϕ Az. & El.
ACCURACY	±200 Yd. ± 35 ϕ	±10 Yd. ± 1 ϕ	20 Yd. RANGE ±1 ϕ	25 Yd. RANGE ±3 ϕ
BEAM WIDTH	El. - CSC^2 Az. - 80 ϕ	El. - 40 ϕ Az. - 40 ϕ	83 ϕ ELEVATION 83 ϕ AZIMUTH	El. 83 ϕ Az. 83 ϕ
RANGE TRACKING RATE	Ø	500 Yd./SEC.	GREATER THAN 3500 Yds/SEC	1700 Yd/SEC
AZIMUTH SCAN RATE	10 - 20 - 40 RPM	Ø	5 RPM	5 RPM
AZIMUTH TRACK RATE	Ø	700 ϕ/SEC	GREATER THAN 540ϕ/SEC	534 ϕ/SEC
ELEVATION ANGLE LIMITS	0-1250 ϕ	-180 TO 1500 ϕ	-70 ϕ TO 1525 ϕ	-70 ϕ TO 1585 ϕ
ELEVATION TRACK RATE	Ø	500 ϕ/SEC	GREATER THAN 540 ϕ/SEC	534 ϕ/SEC
ANTENNA TYPE	ELONGATED PARABOLA	METAL PLATE LENS	8 Ft. PARABOLA	8 Ft. PARABOLA
PLOTTING BOARDS	XY PLOTTING BOARD 28.8" x 28.8" PRES. ALT.- RANGE BOARD 14.4" x 7.58" PRED. ALT.- RANGE BOARD 14.4" x 14.4"		VERTICAL BOARD -36" Sq. REEVES TYPE OA-132 1 ARM 1 PEN GROUND TRACK ONLY	WESTERN ELECTRIC XY PLOTTING BOARD
PLOTTING BOARDS SCALE FACTORS	XY - 80,000 Yd. ACROSS BOARD. R_oH_o - 40,000 Yd. RANGE -500 TO 20,000 Yd. ALT. R_pH_p - 20,000 Yd. RANGE -500 TO 20,000 Yd. ALT.		MAP RATIOS-200000:1 400000:1 AND 1000000:1 EXPANDED SCALE - 400, 800, 1600 Yds/INCH	MAP RATIOS - 250000:1 500000:1 EXPANDED SCALE - 500 TO 2500 Yds./INCH
COMPUTERS	WESTERN ELECTRIC COMPUTER 4 SERVOS 22 DC AMPLIFIERS		28 CHANNEL REEVES AC COMPUTING CHAIN WITH SERVO AMPLIFIERS (NO DC DATA)	WESTERN ELECTRIC COMPUTER (12 CHANNELS) TO OPERATE PLOTTING BOARD
TYPE OF INDICATORS	5" A SCAN RANGE SCOPE 5" B SCAN PRECISION SCOPE 5" A SCAN Az. SCOPE 5" A SCAN El. SCOPE 12" PPI SCOPE 100 Yd. RESOLUTION RANGE DIAL 10 Yd. RESOLUTION RANGE DIAL 100 ϕ RESOLUTION Az. & El. DIALS 5 ϕ RESOLUTION Az. & El. DIALS		7" PPI 3 "J" SCOPES } Az. & El. DIALS 2000 Yds. 40000 Yds. 400000 Yds. } RANGE DIALS OPERATED FROM SERVO SYSTEM	32,000 Yd. J SCAN RANGE SCOPE 2000 Yd. J SCAN RANGE SCOPE 25 ϕ RESOLUTION Az. & El. DIALS 7" PPI SCOPE
PRIMARY POWER REQUIREMENTS	35 Kva -208v. -400~ -3 PHASE - 4 WIRE		22 Kva -115v. -60~ -3 PHASE -3 WIRE	12 Kva -115v. -60~ -3 PHASE -3 WIRE
MINIMUM NUMBER OF OPERATORS REQUIRED	TWO		TWO	TWO
ROAD WEIGHT	23,200 Lb. PLUS PRIME MOVER & GEN.		20,000 Lb. PLUS PRIME MOVER & GEN.	20,000 Lbs. PLUS PRIME MOVER & GEN.
EMPLACED WEIGHT	20,400 Lb. PLUS GEN.		20,000 Lb. PLUS GEN.	20,000 Lb. PLUS GEN.
MAXIMUM ROAD SIZE	28' x 11' x 8'		40' x 10' x 8'	40' x 10' x 8'
MAX. EMPLACED SIZE	29' x 19' x 8'		40' x 20' x 8'	40' x 20' x 8'
COST-AVAILABILITY	$525,000 IN CURRENT PRODUCTION		$311,000 LIMITED AVAILABILITY (89 SETS IN EXISTENCE)	$135,000 OBSOLETE IN USAF-CURRENTLY AVA
CONTROLLING AGENCY	USA ORD. DEPT. USA FIELD FORCES		U. S. A. F.	U. S. A. F.

* 131 T-33 SETS NOW OUT OF SERVICE AND AWAITING MODIFICATIONS TO MAKE THEM EQUIVALENT OF M-33

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RADAR TYPES

	AN/MPQ-2A	SCR-584 (SANDIA MOD.)	AN/MPQ-12 (WSPG MOD.)	
	S-BAND	S-BAND	S-BAND	X-BAND
	285 Kw.	750 Kw.	300 Kw.	500 Kw.
	192,000 Yd. (BEACON TRACKING)	140,000 Yd.	384,000 Yd (BEACON TRACKING)	
	80 Yd. RANGE 110 ϕ Az. & El.	80 Yd. RANGE 110 ϕ Az. & El.	50 Yd. RANGE 90 ϕ Az. & El.	
	25 Yd. RANGE ± 3 ±	25 Yd. RANGE ±3 ±	20 Yd. ± 3 ± Y	
	El. 83 ϕ Az. 83 ϕ	El. 83 ϕ Az. 83 ϕ	El. - 45 ϕ Az. - 45 ϕ	
	1700 Yd/SEC	1700 Yd/SEC	3000 Yd/SEC	
	5 RPM	5 RPM	5 RPM	
	534 ϕ/SEC	534 ϕ/SEC	534 ϕ/SEC	
	-70 ϕ TO 1585 ϕ	-70 ϕ TO 1585 ϕ	-20 TO 1585 ϕ	
	534 ϕ/SEC	534 ϕ/SEC	534 ϕ/SEC	
	8 Ft. PARABOLA	8 Ft. PARABOLA	10 Ft. PARABOLA	6' LENS
	WESTERN ELECTRIC XY PLOTTING BOARD	ELECTRONIC ASSOCIATES - VARIPLOTTER 205 F PLOTTING SURFACE 30" SQ.		
1	MAP RATIOS - 250000:1 500000:1 EXPANDED SCALE - 500 TO 2500 Yds./INCH	18,000 Yd. ACROSS BOARD EXPANDED SCALE - 600 TO 3000 YDS/INCH		
	WESTERN ELECTRIC COMPUTER (12 CHANNELS) TO OPERATE PLOTTING BOARD	ELECTRONIC ASSOCIATES MODEL 320 - 14 CHANNELS PROVIDE FOR PLOTTING BOARD OPERATION FROM RADAR DATA.	ELECTRONIC ASSOCIATES TYPE 1631-R REAC MODEL C202 MOD. 0 } 20 CHANNELS PROV PLOTTING BOARD RE	
	32,000 Yd. J SCAN RANGE SCOPE 2000 Yd. J SCAN RANGE SCOPE 25 ϕ RESOLUTION Az. & El. DIALS 7" PPI SCOPE	32,000 Yd. J-SCAN RANGE SCOPE 2,000 Yd. J-SCAN RANGE SCOPE 25 ϕ RESOLUTION Az. & El. DIALS 7" PPI SCOPE	32,000 Yd. J-SCAN RANGE SCOPE 2,000 Yd. J-SCAN LANGE SCOPE 25 ϕ RESOLUTION Az. & El. DIALS 7" PPI SCOPE	16,000 Yd 2,000 Yd. 12" PPI
	12 Kva -115v. -60∿-3 PHASE -3 WIRE	19 Kva -115v. -60∿-3 PHASE -3 WIRE	19 Kva -115v. -60∿-3 PHASE -3 WIRE	115 v. 60
	TWO	TWO	TWO	TWO
	20,000 Lbs. PLUS PRIME MOVER & GEN.	17,000 Lb. PLUS PRIME MOVER & GEN.	17,000 Lb. PLUS PRIME MOVER & GEN.	X
	20,000 Lb. PLUS GEN.	17,000 Lb. PLUS GEN.	17,000 Lb. PLUS GEN.	X
	40' x 10' x 8'	40' x 10' x 8'	40' x 10' x 8'	X
	40' x 20' x 8'	40' x 20' x 8'	40' x 20' x 8'	X
E)	$135,000 OBSOLETE IN USAF-CURRENTLY AVAILABLE	$164,000 COMMERCIALLY AVAILABLE OR ON HAND	$164,000 COMMERCIALLY AVAILABLE OR ON HAND	EST. $500
	U. S. A. F.	SANDIA CORP.	WHITE SANDS SIGNAL CORPS AGENCY	Bu. Aer.

X = INFORMATION NOT AVAILABLE
Y = ESTIMATED SPECIFICATIONS
Z = NOT APPLICABLE

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AN/MPQ-12 (WSPG MOD.)	(USN Bu Aer) AN/FPS-16 (XN-1) RCA	(USN Bu Ships) SG-6 (ACQUISITION ONLY)
S-BAND	X-BAND OR C-BAND	C-BAND
300 Kw.	500 Kw. 1,000 Kw.	125 Kw.
384,000 Yd (BEACON TRACKING)	300,000 Yd.	20,000 Yds.
50 Yd. RANGE 90 ϕ Az. & El.	30 Yds.	± 40 Yds. RANGE 35 ϕ Az.
20 Yd. ± 3 ϕ Y	0 Yds. ±0.1 ϕ	± 40 Yds. RANGE 35 ϕ Az.
El. - 45 ϕ Az. - 45 ϕ	22 ϕ	El. CSC 2 OR 285 ϕ Az. 43 ϕ
3000 Yd/SEC	8,000 Yd./SEC	Z
5 RPM	5 RPM Y	5 OR 15 RPM
534 ϕ/SEC	600 ϕ/SEC	Z
-20 TO 1585 ϕ	-100 ϕ — +1600 ϕ	0-1600 ϕ
534 ϕ/SEC	400 ϕ/SEC	Z
10 Ft. PARABOLA	6' LENS 12' PARABOLA	MODIFIED PARABOLA
ELECTRONIC ASSOCIATES - VARIPLOTTER 205 F PLOTTING SURFACE 30" SQ.		Z
18,000 Yd. ACROSS BOARD EXPANDED SCALE - 600 TO 3000 YDS/INCH		Z
ELECTRONIC ASSOCIATES TYPE 1631-R REAC MODEL C202 MOD. 0	20 CHANNELS PROVIDE COMPUTING FACILITIES BEYOND PLOTTING BOARD REQUIREMENTS AND GREATER FLEXIBILITY.	Z
32,000 Yd. J-SCAN RANGE SCOPE 2,000 Yd. J-SCAN RANGE SCOPE 25 ϕ RESOLUTION Az. & El. DIALS 7" PPI SCOPE	16,000 Yd. J-SCAN RANGE 2,000 Yd. A SCAN RANGE 12" PPI	10" PPI WITH CURSOR SCALES FOR TRANSFERRING TARGET LOCATIONS TO RADAR TRACKING SYSTEMS.
19 Kva -110v. -60∿-3 PHASE -3 WIRE	115 v. 60∿-3 PHASE -3 WIRE (POWER X)	230 VOLT 60 CYCLE 3 ph (POWER X)
TWO	TWO	ONE
17,000 Lb. PLUS PRIME MOVER & GEN.	X	Z
17,000 Lb. PLUS GEN.	X	X
40' x 10' x 8'	X	Z
40' x 20' x 8'	X	X
$164,000 COMMERCIALLY AVAILABLE OR ON HAND	EST. $500,000 EST. PRODUCTION BY LATE 1956	$100,000(Y) SET IS NOT IN CURRENT PRODUCTION
WHITE SANDS SIGNAL CORPS AGENCY	Bu. Aer.	U. S. NAVY. Bu Ships

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