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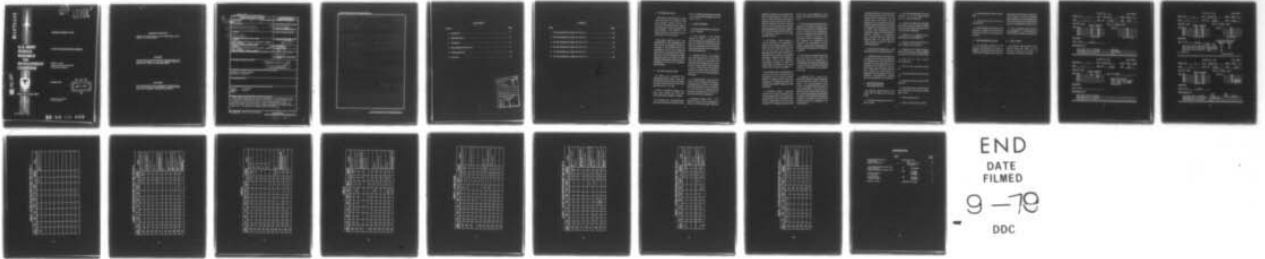
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RC/MAT EVALUATION TEST REPORT.(U)
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Redstone Arsenal, Alabama 35809

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RC/MAT EVALUATION TEST REPORT

William J. Lyons
Systems Simulation Directorate
Technology Laboratory

23 March 1979

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1. INTRODUCTION

The Radio Controlled Miniature Aerial Target (RC/MAT) was designed for small arms training, gunnery practice for VULCAN and M-42 automatic weapons, and tracking for infrared systems such as CHAPARRAL and REDEYE. RS Systems, Division of Tech Services, Inc., is the contractor for the RC/MAT.

Three major objectives were to be accomplished by the qualifications test. They were (1) to determine the degree of compliance of the delivered item to the specifications set forth in the contract and subsequently to the requirements of the test plan, (2) to provide infrared source design information, and (3) to define any design changes which might be necessary prior to production of the item and to determine field suitability.

2. FLIGHT OPERATION

All flights were conducted from unimproved pasture fields, which were harvested and hay-crop variety. The weather was clear and sunny and the wind varied, generally calm to 5 to 6 mph.

A total of 10 different airplanes were flown with engines and radio gear transferred between airplanes as needed.

The aircraft was a foam-constructed, delta-wing configuration powered by a KB,

0.61 CU engine developing approximately 1.4 hp. The optimum propeller was a Top Flite 11-7 1/2.

3. CONCLUSIONS

The following performance characteristics were evaluated:

- Vmax Duration — Four aircraft samples were flown in this mode, one aircraft from each of four flight kits. In this mode the throttle was fully advanced and flown for a minimum of 10 min with one sample flying as long as 16 min. All samples performed satisfactorily.

- Maximum Velocity — Four samples were used during this test. Test runs were made both upwind and downwind, with average air speeds ranging from 70.3 to 76.6 knots. One flight without muffler averaged 71.0 knots. All flights with the exception of the latter were initial flights on the airborne unit. None of the units met the specification of 80 knots.

- Low-Speed Flight — Four units were flown. Five runs were made with each unit, averaging 26.5 to 27.5 knots. Two exceeded the 25 knot specification and two were below at 21.7 and 24.3 knots. It appears that the low-speed requirement can be met by all units with some minor adjustments.

- Maximum Engine Time — The objective of this test was to accumulate a maximum of 30 hr on one engine. Other test

objectives and lack of time limited the total time on sample engine No. A12292 to 472 min (7 hr, 52 min). Difficulties encountered during this time necessitated the use of four different airplanes for this test. Although there is no way to determine the maximum expected engine life from the tests, it appears that the selected engine will have satisfactory life expectancy adequate for the three airframes of the kit.

- IR Tracking — Initial attempts to track the IR source were unsatisfactory. However, after changing batteries in the tracker unit, the results were much better and the IR source was tracked to approximately 800 m range. The IR source furnished by the contractor was considered satisfactory. Subsequent tests repeated at Fort Bliss, Texas, were completely unsatisfactory inasmuch as neither IR source could be tracked at any range. Results from this test are inconclusive.

The contractor had no requirements to provide an IR source. The only contract requirement was to provide an airframe capable of mounting the IR source and carrying the 2 lb additional payload. The airframe was completely satisfactory in this requirement.

- Transmitter Range — Receivers mounted 60 ft above the ground were operated satisfactorily from the transmitter at a distance of 1.6 km. This distance is less than the specification but is more than satisfactory for all flight operations of this

aircraft since visual observation of the aircraft by the operator is limited to less than 1 km.

- The RF band of interest within the RF spectrum was monitored during the tests. Interference was present at times and some control problems were experienced; however, it is generally felt that the major control problems occurred in the transmitters. After the qualification tests were complete, the transmitters were returned to the manufacturer. The RS engineers concurred that a problem did exist in the transmitters and they were working on a solution.

In the interval since completion of the test and the writing of this report, the transmitters have been returned with a design change. A bench check was made and it appears that the transmitters can be used satisfactorily. Additional tests are scheduled in this area.

- Additional Tests — One of the transmitters (Sample I-C) failed completely and the failure was traced to the mixer circuit. The electromechanical mixer consists of a plastic housing to contain the mixer potentiometers. The plastic has a tendency to flow or expand after a period of time, thereby permitting the potentiometer to separate. The manufacturer repaired the transmitters by placing a strap around the housing to prevent the separation of the potentiometers.

Repaired transmitters, transmitters which failed during acceptance tests, have been returned and are operational. The one problem which still exists in all the transmitters is an undesirable interaction between the pitch and roll functions on large control inputs. This interaction, the severity of which varies significantly among transmitters, makes the aircraft difficult to maneuver, especially for inexperienced pilots. The aircraft cannot be trimmed for hands-off flight. Any rapid flight path change causes the aircraft to assume an undesired flight path.

- Maneuverability Specification — Roll and pitch rates were within specifications.

- Engine performance was satisfactory. A broken motor mount was experienced on one landing; however, this may have saved the engine. Two glow plugs failed; one was replaced after the electrode was bent in a crash. Three props were broken, primarily due to being in the wrong position on landing. The trainer transmitter mode works satisfactory. Interchangeability, assembly time and maintainability were satisfactory.

4. RECOMMENDED REQUIREMENTS

The following recommendations were reached after 55 flights over a four-day period:

- The airframe shipping container is not sturdy enough.

- The Tool kit is inadequate. There is no screwdriver to fit the muffler-attached screws or carburetor adjustment.

- Washers are needed under the engine mount units to prevent them from recessing into wood; this tended to make the Austin four-way wrench inoperable.

- Include 1-1/2 in. length by 1/8 in. brass tube to use in fuel filler line.

- Supply fuel filter either in line or on end of pickup for fuel pump line.

- Supply epoxy in smaller containers such as 2 oz tubes. Epoxy should be supplied per airframe kit and not per GSE kit basis.

- Add one set servo control arms/airframe kit.

- Add one spare carburetor/airframe kit.

- Add one spare motor mount/airframe kit.

- Mark GSE container top with "THIS SIDE UP."

- Add reflective tape to extend from the root of the wing to the wing tip on leading edge of wing.

- Delete continuity tester.

- Delete 1 gal of epoxy from GSE.

- Add one carburetor filter/carburetor body.

- Add automatic cutoff 5-min timer on each flight box.

- The transmitters as delivered were not acceptable. A change must be made in the control stick and mixer to insure satisfactory operation.

5. RECOMMENDATIONS

- The equipment delivered by the contractor was deficient in two areas: (1) inability to meet the 80 known maximum velocity and (2) inability to meet the 2 km

range operation of the radio command link. The performance in these two areas does appear adequate. It is recommended that a review of the requirements be made with the purpose of reducing these required values.

- After the changes stated in Section 4 are accomplished, it is recommended that the RC/MAT be released for production.

6. TEST LOGS

The actual test logs are shown on the following sheets and *Tables 1-6*. The remarks columns are records of observations at the time of the flight.

RC MAT KIT I

DATA SHEET 1

VEHICLE NO. A DATE 30 Oct 78 ATMOS. PRESS —TEMP — WIND VEL. 5 mph TIME 1447

VELOCITY (mph)

UPWIND DOWNWIND

VMIN @ 25 KNOTS (mph)

VMAX RUN	UPWIND	DOWNWIND	RUN NO.	VMIN
1	75	87	1	26
2	70	88	2	39
3	74	88	3	27
4	76	88	4	24
5	75	89	5	25
Avg 81 mph			Avg 28.2 mph	

ENDURANCE

VMAX 10 MIN 13 min

MANEUVERABILITY

ROLL RATE 180 TO 270°/SEC	<u>240°/sec</u>
PITCH RATE 120 TO 180°/SEC	<u>4 sec/loop</u>
YAW RATE 180 TO 270°/SEC	<u>NA</u>

RC MAT KIT II

DATA SHEET 1

VEHICLE NO. A DATE 30 Oct 78 ATMOS. PRESS —TEMP — WIND VEL. 5 mph TIME 1450

VELOCITY (mph)

UPWIND DOWNWIND

VMIN @ 25 KNOTS _____

VMAX RUN	UPWIND	DOWNWIND
1	73	85
2	70	94
3		90
4		
5		

Vehicle Destroyed.
Radio functioned normally
after crash. One SERVO
inoperative.

ENDURANCE

VMAX 10 MIN _____

MANEUVERABILITY

ROLL RATE 180 TO 270°/SEC	_____
PITCH RATE 120 TO 180°/SEC	_____
YAW RATE 180 TO 270°/SEC	_____

RC MAT KIT III

DATA SHEET 1

VEHICLE NO. A DATE 30 Oct 78 ATMOS. PRESS —TEMP — WIND VEL. 5 mph TIME 1356

VELOCITY (mph)

UPWIND DOWNWIND

VMAX RUN	UPWIND	DOWNWIND
1	88	94
2	86	88
3	85	88
4	86	93
5	85	89

Avg 88.2 mph

VMIN @ 25 KNOTS (mph)

RUN NO.	VMIN
1	22
2	28
3	24
4	26
5	25

Avg 25 mph

ENDURANCE

VMAX 10 MIN 16 min

WITHOUT MUFFLER (mph)

DOWNWIND UPWIND

	RIGHT	LEFT	DOWNWIND	UPWIND
ROLL RATE 180 TO 270°/SEC	2 sec	1 sec*	94	78
PITCH RATE 120 TO 180°/SEC	3.9 sec/loop		83	78
YAW RATE 180 TO 270°/SEC	NA		77	88

* = 240°/sec

Avg 82.3 mph

RC MAT KIT IV

DATA SHEET 1

VEHICLE NO. A DATE 31 Oct 78 ATMOS. PRESS —TEMP — WIND VEL. 6 mph TIME 1405

VELOCITY (mph)

UPWIND DOWNWIND

VMAX RUN	UPWIND	DOWNWIND
1	82	97
2	83	83
3	81	89
4	80	91
5	82	94

Avg 86.2 mph

VMIN @ 25 KNOTS (mph)

RUN NO.	VMIN
1	40
2	35
3	30
4	25 (upwind)
5	23 (upwind)

ENDURANCE

VMAX 10 MIN 14 min

MANEUVERABILITY

	RIGHT	LEFT
ROLL RATE 180 TO 270°/SEC	2 sec	2 sec = 180°/sec
PITCH RATE 120 TO 180°/SEC	5 sec/loop	
YAW RATE 180 TO 270°/SEC	NA	

RC MAT KIT V

DATA SHEET 1

VEHICLE NO. A DATE 31 Oct 78 ATMOS. PRESS —

TEMP — WIND VEL. 6 mph TIME 1312

VELOCITY (mph)

UPWIND DOWNWIND

VMAX RUN 1	<u>82</u>	<u>89</u>
RUN 2	<u>86</u>	<u>84</u>
RUN 3	<u>84</u>	<u>88</u>
RUN 4	<u>86</u>	<u>86</u>
RUN 5	<u>86</u>	<u>90</u>

Avg 86.1 mph

VMIN @ 25 KNOTS (mph)

UPWIND DOWNWIND

RUN NO. 1	<u>38</u>	<u>34</u>
2	<u>33</u>	<u>31</u>
3	<u>29</u>	<u>31</u>
4	<u>30</u>	<u>33</u>
5	<u>27</u>	<u>31</u>

Avg 31.7 mph

ENDURANCE

VMAX 10 MIN 12 min (Flight No. 3)

MANEUVERABILITY

ROLL RATE 180 TO 270°/SEC	<u>4 sec / 2 rolls = 180°/sec</u>
PITCH RATE 120 TO 180°/SEC	<u>3.8 sec/loop</u>
YAW RATE 180 TO 270°/SEC	<u>NA</u>

TABLE 1. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. 1

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN.)	DATE	WEATHER COMMENTS	REMARKS
A 12284	1	1	1	I-F	A	1	15	30 Oct 78	Clear and Sunny	Engine rich, I/A has gap in right leading edge and bottom. Repaired with epoxy and tape
A 12284						2	11			
A 12284						3	13			YMAX flight.
A 12284				I-C		4	4 (43)	31 Oct 78	Clear, Sunny and Windy	(0911) Crashed - no apparent reason.
A 12285	3	3	3	IV-A	B	5 (1425 hrs)	13/56	1 Nov 78		Engine from I-A. Radio from III-A.
A 12285						6	18/71			
A 12285				I-B		7 (1535)	14/85			
A 12285						8	4			Mid-air collision. (Butch driver)
A 12282	5	5	5	I-D I-F	I-C	11	6/456	17 Nov 78		Repaired transmitter. 7 hr. 38 min total.

TABLE 2. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. II

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12285	2	2	2	I-E	A	1	5	30 Oct 78		Destroyed after 5 min. Struck by I-B I-A in the in the air.
						2				
						3				
						4				
						5				
						6				
						7				
						8				
						9				
						10				

TABLE 3. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. III

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12292	3	3	3	I-E	III-A	1	11	30 Oct 78	Clear and Sunny	Engine lean on first flight high-speed rows.
A 12292						2	3			Second speed run to complete downwind series. Engine died. Throttled too low.
A 12292						3	16			This is VMAX for 10 min.
A 12292						4	8			Without muffler.
A 12292						5	10	31 Oct 78		This A/F will now be used to log continuous time (30 hrs) 0636. Wind variable. 3 to 10 mph. Broke prop. on landing.
A 12292						6	11			(0955)
A 12292						7	11			Bad glow plug on start-up. (1013)
A 12292						8	12			Charged transmitter battery after fl. 1 min charge
A 12292						9	11			Wind variable. 8 to 10 mph. (1055).
A 12292						10	10			2 min dump charge on transmitter. This is buddy box test. I-E transmitter was slave.

TABLE 3.

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12292	3	3	3	I-E	III-A	11	11	31 Oct 78	Clear and Sunny	(1259) Wind calm (3-7 mph).
A 12292						12	10			(1316)
A 12292						13	14			(1348)
A 12292						14	14			(1413)
A 12292						15	9			(1436)
A 12292						16	10/68			
A 12292						17	10/78		Clear/Sunny	(1505)
A 12292						18	1:30/80			Interference shut down engine. Loosened motor mount and broken prop. Possible transmitter problem (bad pot).
A 12292						19	10/198			(1614) New transmitter seems OK.
A 12292						20	13/21.1	1 Nov 78		

TABLE 3.

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANG. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12292	3	3	3	IV-A	III-A	21	15/226	1 Nov 78	Clear and Sunny	Wind speed 3 to 4 mph.
A 12292						22 (1024 hr)	7/233			Inadvertent shutdown into trees/east
A 12292	5	5	5	I-C	III-B	1	20/253			Engine transferred to A/F III-B. Radio, etc from A/F 5-A. Replaced glow plug. Wind 5-8 mph. G - 12 mph.
-	-	-	-	-	-	2	-	-	-	RS IR source. Good track.
A 12292	5	5	5	I-C	III-B	3	18/269			
A 12292						4 (1548)	15/284			Receiver ch. 2M.
A 12292						5	12/296			Collided with I-B. No damage.
A 12292						6	20/316			(1848)
A 12292						7 (1000 hr)	16/332	2 Nov 78		Calm conditions.
A 12292						8 (1021 hr)	12/344			Broke motor mount on landing—apparently the muffler hit something.

TABLE 3. (CONCLUDED)

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12292	5	5	5	I-C	I-C	1 (1110)	9/353	2 Nov 78	Clear and Sunny	Wind picked up a little. 1/1110 hr.
A 12292						2 (1125)	10/363			
A 12292						3	13/376			Flown with either transmitter .007 or .004
						4	15/391			
A 12292	5	5	5	I-E	I-C	5	16/406			
A 12292						6 (1340)	2/408	8 Nov 78	Clear and Sunny	To check radios.
A 12292						7 (1345)	3/411			Control problems; declared unflyable.
A 12292				I-D I-F		8	10	17 Nov 78		Repaired transmitters.
A 12292						9	7			
A 12292						10	22			

TABLE 4. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. IV

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12263	4	4	4	I-D	IV	1	15	31 Oct 78	Clear and Sunny	Maneuvers and pitch, roll, open on this flight.
A 12263						2	14			VMAX this flight.
A 12263						3	10			15:57 flight with battery for IR and control SERVO without muffler. Log caused some motor mount problems.
A 12263						4	8			Flight with battery, with muffler.
A 12263				I-C		5	Approx. 10	1 Nov 78		IR flight. Very marginal. Lock at 3-400 m. in flight. Seems to get good lock. Stationary at 400 m.
A 12263						6	10/67			IR flight. (1400)
A 12274	1	1	1	SN 007 or 004	IV-C	7	4	2 Nov 78		Receiver changed. Sent to targets officer.
A 12274						8	6			Requed carburetor. Crashed into trees, chasing cattle.

TABLE 5. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. V

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12274	5	5	5	I-C	A	1	8	31 Oct 78	Clear and Sunny	(1312) Engine died at low throttle Prop Broken on landing.
						2	14			Maneuvers and speed runs taken on this flight.
						3	12			10 min VMAX flight.
						4	14/48	1 Nov 78		To check possible interference in area where III-A went down.
A 12294	4	4	4	ID	B	(1340) 1	2	2 Nov 78	Clear	Built up A/B 5 from engine I. Receiver No. IV.

TABLE 6. RC MAT QUALIFICATION FLIGHT TEST, KIT NO. VI

ENG. SERIAL NO.	REC. NO.	SERVO NO.	BATT. NO.	TRANS. NO.	AIRFRAME NO.	FLIGHT NO.	DURATION (MIN)	DATE	WEATHER COMMENTS	REMARKS
A 12295	←	← OLD RS RADIO →		←	VI	1 (1325)	9/9	8 Nov 78	Clear and Sunny	Engine Replaced from 30 Oct crash on A/C I-A flights to compare radios.
A 12295						2 (1400)	13/22			Lost throttle control.
A 12292						3 (1430)	1/412			Engine No. 12295 seized. Replaced with No. 12292. Engine died: too lean.
A 12292						4 (1434)	7/419			
A 12292						5 (1444)	2/421			
A 12292						6 (1453)	3/424			

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		TDD	Mr. Lyons Mr. Powell Mr. Wright	3 1 1
IIT Research Institute ATTN: GACIAC 10 West 35th Street Chicago, Illinois 60616	1	TDK	Mr. Batiuk Mr. Killough	1 1
		DRSMI-LP, Mr. Voigt	DRSMI-TM-X Mr. Perrett	6