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IN REPLY REFER TO

TL. 104-58/04

DRM/W 0300-3



CANADIAN JOINT STAFF

2450 MASSACHUSETTS AVE., N.W.

WASHINGTON 8, D.C.

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10 April 1958

10 pages

Chairman,
Defence Research Board,
OTTAWA.

AVRO VTOL Vehicles

Dear *Antley*, :

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|---------------------------|-----------------|
| Referred to... | <i>EDP</i> |
| APR 17 1958 | |
| File <i>ARB 0.3.0-1-3</i> | |
| Chgd to... | <i>10.19.13</i> |

1. Our DRCS 949 of 27 December 1957, telecon Green/Keyston of 2 January 1958, and DRCS 246 of 1 April 1958 refer.
 2. Because of the DRB interest and previous support given to the AVRO vertical take-off and landing project, Colonel D.H. Heaton of Aeronautics Division, Deputy Chief of Staff/Development, USAF, offered to brief DRM/W on the current developments in the AVRO project. Since the Canadian Army and the RCAF have an interest in the operational application of these vehicles, an invitation was extended by DRM/W to Major E.B. Robertson of CAS(W) and S/Ldr W.A. Halpin of RCAF(W) to attend. Major J.B. Downhill of Col. Heaton's office and Lt.Col. H.B. McWhirter, USAF Interchange Officer, RCAF HQ, were also present.
 3. The USAF presentation reviewed the history of the program. At the inception of the program, then called Project "Y", Canadian Government support was provided. When this Government support was withdrawn, the work was carried forward under a program jointly funded by the USAF and AVRO. After what amounted to a feasibility stage, AVRO undertook their PV (Private Venture) 704 supported by the USAF. The support took the form, principally of work on the power source (i.e. Viper engines) and wind tunnel work. The USAF portion of this phase was called Project 1794 later becoming Project 606A.
- The other two facets of the briefing included the USAF evaluation of the "Avrocar" concept suggested for US Army use and the recommended USAF/US Army integrated program.
4. The US Army and the USAF have sufficient confidence in the promise of the AVRO concept for both high and low performance vehicles to commit funds for a joint flying research vehicle. The Office of the Secretary of Defense had requested that the USAF recommend a suitably integrated USAF/Army program. AVRO had indicated they will stop PV 704 since the low capacity Army vehicle with its different engine arrangement may well be adaptable to the high performance demanded by the USAF. AVRO had originally planned to fabricate one high performance vehicle together with an engine test stand. The USAF had planned to augment the Company effort by underwriting wind tunnel tests, by conducting a system analysis

and by furnishing certain Government equipment. In addition, the USAF were assisting in the propulsion system development. To date, the funding history is as follows:

| | | |
|---------------------------|-----------|--|
| Canadian Govt - (1952-53) | 300,000 | |
| AVRO (thru 1 MCH 58) | 2,500,000 | |
| USAF (FY-54) | 785,000 | |
| USAF (FY-57) | 1,815,000 | |

| | | |
|-------|-----------|--|
| TOTAL | 5,500,000 | |
|-------|-----------|--|

— (?) ! Suggested

5. (A sketch of the high speed interceptor vehicle is attached as Appendix "A".) The test rig for the six Viper engine development is already in existence and represents a large investment to the Company. The test rig was manufactured by Orenda Engines for the Company. AVRO had asked for further USAF support. The USAF had recommended that the test operations should be supported but that the tests should be re-oriented to provide generalized data.

6. Evaluation of Avrocar

The AVRO proposal to the US Army for the Avrocar family of Army vehicles suggested that the contract should state:

- a. a fixed price "off-the-shelf" program
- b. the design should meet the AVRO specification on the standard military specs and HIAD (Handbook Information for Aircraft Designers) requirements at AVRO's option.
- c. the US Government would not have royalty free license rights.

(All these points are, of course, subject to negotiation.)

7. Subsequently, AVRO have informally indicated their willingness to guarantee that the test vehicle will have ten minutes endurance in the hover and transition stage and a minimum of 50 knots forward speed. Design performance is 250 knots and 31 to 44 minutes endurance at sea level. The basic contract will include the option for a ground and flight test program.

19 mi
meaningless

8. Appendix "B" and Appendix "C" show general views of the Avrocar configuration. It will be noted that the basic difference from the original briefing attended by DRM/W in November 1957 is that the engines are now in a volute configuration instead of being radially mounted.

9. The USAF commented that the propulsion system used a tip turbine powered fan which was new and unproven. The principle is sound but problems may be encountered because of partial entry

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turbine losses and duct losses. In addition, pressure distribution may be critical for the turbine fan and the J 69 compressor. The stability and control characteristics require a reliable automatic system. The AVRO approach is reasonable. Problems of unknown magnitude will be encountered in the development of "coanda" effect control and its mechanical operation. Computer studies and simulator work is essential. The US are doubtful of the value of the proposed "limited freedom" model and consider that testing in the Ames full scale wind tunnel is desirable.

10. General comments on the Avrocar proposal by the USAF are as follows:

- a. The weight estimates are optimistic ✓
- b. The ground effect on forward flight is unknown
- c. The crew are in the plane of the turbo rotor ✓
- d. The noise level may be high ✓
- e. The downwash in hover may be high ✓
- f. Ejection seats and fire extinguishing systems are desirable.

See
earlier
DLR
comments

11. AVRO submitted an initial cost estimate (i.e. What the US Army would get for their money.) which was not acceptable to the USAF. Subsequently a supplementary estimate was prepared which was adequate. Details of the two proposals are as follows:

a. Initial Proposal (18 Jan 58)

| | |
|---------------------------------|-----------|
| Design & Fabricate Two Vehicles | 2,028,670 |
| 50 Hr Turbo Rotor Development | |
| Full Scale Wing Tip Section | |
| Simplified W/T Model | |
| Engr Mock-up | |

| | |
|---|---------|
| LESS (Saving if the supp. program is bought) | 206,973 |
|---|---------|

1,821,697

b. Supplementary Proposal (18 Feb 58) 2,610,800

| | |
|----------------------------------|--|
| 500 Hr Turbo Rotor Devel. | |
| 500 Hr W.T. Program | |
| Control Syst. Simulation & Tests | |
| Free Flight Model | |
| Tie Down Test | |
| Ground & Hover Test | |
| Flight Demonstration | |

| | |
|---------------------|-------------|
| TOTAL CONTRACT COST | \$4,432,497 |
|---------------------|-------------|

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12. Summary of Evaluation

The USAF summarized the evaluation by stating:

- a. The basic principle is sound but many problem areas would not be solved by the AVRO proposals for tests.
- b. The Avrocar should be considered as a flying research vehicle.
- c. The initially proposed test program by AVRO is inadequate but the supplementary program is adequate. However, to be effective the supplementary program should commence concurrently with the vehicle design.
- d. The AVRO costs and time estimates are optimistic. /
- e. The success of the Avrocar, although simpler than the 704/606A, is still contingent on the solution of the following problem areas:
 - (i) stability and control (coanda effects)
 - (ii) propulsion system efficiency // + how !
 - (iii) weight
 - (iv) ground effect
 - (v) conjoint effect of these problems
- f. Continuous evaluation of these problem areas should be made as design progresses.

13. Recommendations

The USAF have recommended, and the US Army and Office Secretary of Defense have agreed, that an integrated USAF/Army program should be set up with joint funding but under the management of the USAF. Such a program would meet all the Army requirements and would be a first step for the USAF high performance interceptor. In addition, such a proposal would be economically acceptable to the Department of Defense. If the two developments were carried on separately but concomitantly, the cost would be higher with a resultant dilution of the contractors' effort. The USAF therefore will:

- a. re-orient their Project 606A immediately to
 - (i) study the simplified vehicle
 - (ii) conduct one-sixth scale Avrocar wind tunnel tests
 - (iii) conduct a control systems computer study
 - (iv) continue general sub-system and weapon system studies.

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- b. program their future funds to continue the testing of sub-systems developments, to operate the test rig, and if progress warrants, to implement the development of a suitable vehicle to meet the USAF requirements.

14. The US Army will procure the remainder of the minimum program with the present allotment of funds. The Army will program their future funds to procure two Avrocar vehicles and complete the test programs.

15. A time scale for the integrated USAF/Army program is appended as Appendix "D".

16. The cost to the USAF and the US Army is as follows:

FUNDING BY FISCAL YEAR
(in \$ Thousands)

| | Prior to 1958 | 1958 | 1959 | 1960 | 1961 | 1962 |
|------------------------|------------------|------|------|------|-------|-------|
| <u>USAF</u> | | | | | | |
| Prog to date | 2000 | | | | | |
| Prelim. Desn. Avrocar | 600 | | | | | |
| Govt Furnished Equip. | | | 500 | | | |
| Test Rig & W/S Studies | | | 600 | | | |
| Test Vehicle | | | 800 | 500 | | |
| Weapon System | | | | 1000 | 10000 | 15000 |
| TOTAL | 2600 | 7 | 1900 | 1500 | 10000 | 15000 |
| <u>US Army</u> | | | | | | |
| Dev. Avrocar | | 2028 | 900 | | | |
| Grd & Flt Test | | | 800 | | | |
| | | 2028 | 1700 | | | |

17. The USAF representatives expressed an interest in Canadian Government participation in the integrated project. It would seem this interest would be welcomed as a tangible expression of affirmation in the principles of collaboration set out by the MacMillan, Eisenhower and Diefenbaker discussions of late

why ?

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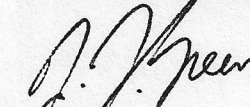
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1957. If such Canadian Government participation is forthcoming, we could be faced with two possibilities. The Government could contribute some arbitrary amount and leave the management of the project to the USAF, who have a well demonstrated competency in this regard. The USAF have ordered a study of where, and in what amounts, Canadian Government financial contribution can best help the project along. There is some indication that present financial support may leave certain aspects of the project thinly supported, e.g. spares support would fall into this category. Alternatively, since the USAF foresee a number of related research investigations on sub-systems, the Canadian Government could assume responsibility, both fiscal and managerial, for such an investigation. We opine that the "luke-warm" attitude of the Company may stem from their fear that the re-entry of Canadian Government money into the projects may also constitute some right to interfere in the direction of the project.

Possible
- but not
confined to
"Sub-systems"

18. We would be pleased to hear your comments and to supply any further information, if this is required.

Yours sincerely,



Dr. J.J. Green
Defence Research Member

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