

YCX
RCAF
AMTS
Rept.
CAE-2)

UNCLASSIFIED

DISTRIBUTION: UNLIMITED

FILE IN VAULT

ANALYZED

SECRET

ROYAL CANADIAN AIR FORCE

AIR MEMBER FOR TECHNICAL SERVICES

CHIEF OF AERONAUTICAL ENGINEERING

REPORT NO. 21

GENERAL POLICY FOR THE DEVELOPMENT

DEMONSTRATION AND EVALUATION OF THE ARROW

WEAPON SYSTEM



55684

~~SECRET~~ UNCLASSIFIED

S1038-180 (AMTS/CAE)

DATED: 15 July 58

(1)

ANALYZED

ROYAL CANADIAN AIR FORCE

DIVISION OF

AIR MEMBER FOR TECHNICAL SERVICES

CHIEF OF AERONAUTICAL ENGINEERING

REPORT NO. 21

GENERAL POLICY FOR THE

DEVELOPMENT, DEMONSTRATION AND EVALUATION

OF THE ARROW WEAPON SYSTEM

Prepared by: AWS 3 Section

Recommended by: G/C H.R. Foottit

Approved by: A/C G.G. Truscott.

9765491

~~UNCLASSIFIED~~
~~SECRET~~

(ii)

PREFACE

This information is furnished subject to the following conditions:

1. This information is to be used only by the recipient and is not to be released to another without prior written authority of the Chief of the Air Staff, Air Force Headquarters, Ottawa, Ontario.
2. This information is to be protected to prevent disclosure to unauthorized persons.

IMPROPER OR UNAUTHORIZED DISCLOSURE OF THIS INFORMATION
IS AN OFFENCE UNDER THE OFFICIAL SECRETS ACT.

~~UNCLASSIFIED~~

(iii)

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Objective	2
Weapon System Development - Associate Contractor Concept.	3
Weapon System Development - Equipment and Facilities	3
Weapon System Development, Demonstration and Evaluation Programme	3
Weapon System Development - IFTP (Contractor	5
Weapon System Capability - Method of Attainment	6
Weapon System Capability - Proof of Compliance.	7
Appendix A - RCAF AFHQ Test and Development Instruction 58/83 Issue 1 "Arrow Weapon System Flight Testing - Phase 2 Evaluation".	
Appendix B - RCAF AFHQ Test and Development Instruction 57/75 Issue 2 "Arrow Weapon System Flight Testing".	
Appendix C - RCAF Representative Missions and Attacks for the Development, Proving, Evaluation, and Demonstration Programmes.	
Appendix D - General Policy for the Demonstration of the Arrow Weapon System.	

UNCLASSIFIED
~~SECRET~~

S1038CN-180 (AMTS/CAE)

Page 1

GENERAL POLICY

FOR

THE DEVELOPMENT, DEMONSTRATION AND EVALUATION OF THE

ARROW WEAPON SYSTEM

15 July 1958

INTRODUCTION

1. The purpose of this paper is to describe the objectives of the Arrow Weapon System Development, Demonstration and Evaluation Programme, and the methods by which it is proposed to meet the requirements of DAEng 33 and the determination of the Arrow Weapon System capability.
2. Since RCAF Report DAEng 33 was written in March 1955, evolutionary changes in the development state-of-the-art and certain programme characteristics peculiar to the Arrow, have made it necessary to revise the method of meeting the requirements stated in DAEng 33. Among the more important factors are:
 - (a) Consideration of the Arrow as a weapon system rather than as an aircraft. (Ref. RCAF Specification WSC 1).
 - (b) The late start made on the design of the electronic system.
 - (c) The contractors must establish the effectiveness of the Arrow Weapon System prior to entry into squadrons.
 - (d) The formation of the AAWS group of AFHQ and the establishment of a co-ordinating contractor (Ref. Statement of Responsibilities - IOWS - Report No. 1, April 1, 1958.)
 - (e) The contractors must demonstrate a combat effectiveness of the Arrow in 1961 prior to the entry into squadrons. (Ref. Appendix "C").

.../2

UNCLASSIFIED

Page 2

3. The Arrow development, demonstration and evaluation programme will be conducted in various stages by the contractors and/or the RCAF. The objectives of the 8 phases described in DAEng 33 will be achieved not independently as implied in the report, but on an integrated basis. This means, for example, that the objectives of the Phase 2 programme (ref. Appendix "A") will be carried out concurrently and continuously with the contractors' programmes and not as a separate discrete programme. The major difference will be in the achievement of the objectives of the 8 phases. It is now realized that it is impractical and almost impossible to evaluate a system as complex as the Arrow Weapon System by flight test alone. Therefore, evaluation of the system must include extensive ground test, mathematical analysis and simulation. One of the objectives of all phases will be to gather data to improve the validity of the mathematical model already validated to a degree by the results of ground tests. Thus it can be readily appreciated that all phases are providing the data required to make the mathematical model approach the actual system and are, therefore, related.
4. It is anticipated that Phases 1, 4, 5 and 6 will be of finite length and that Phases 2, 3, 7 and 8 will be of a continuous nature of varying magnitude beyond 1961 for an indefinite period. In and beyond 1961 there will be a gradual shift of emphasis on participation in the evaluation programme from the contractors to the RCAF.

OBJECTIVE

5. The primary objective of the Arrow development, demonstration, and evaluation programme is to effect entry of the Arrow into squadron service at the earliest possible date contingent upon providing a useful capability as a weapon system. The operational date has been specified as January 1961.
6. By January 1961, it will not be possible to develop the Arrow Weapon System to the point where it has the full capability described in the applicable specifications. It has, therefore, been necessary to define an interim capability to be achieved prior to first entry of the Arrow into squadron service. (Ref. IOWS - Report No.1 - Apr 58).

.... /3

UNCLASSIFIED

Page 3

7. The fundamental philosophy of the Arrow Weapon System development and proving programme will, therefore, be that the achievement of the interim capability has first priority. Any development of a mode or component to a higher level than that necessary to achieve the interim capability is of secondary importance. Whenever necessary, time, effort or facilities being used for second priority development, will be re-allocated to first priority development work.
8. Within the framework of the policy that the interim capability must be achieved by January 1961, every effort must be made towards further development of the weapon system and its components to achieve the higher level of capability as soon as possible after January 1961.

WEAPON SYSTEM DEVELOPMENT - ASSOCIATE CONTRACTOR CONCEPT

9. The airborne portion of the Arrow Weapon System consists of four major components:
 - (a) The airframe and its systems
 - (b) The engine
 - (c) The electronics system
 - (d) The missile.
10. Since the "Associate Contractor" method of procurement is being employed, there are actually four separate programs for the development of these major components. Each of these components is currently in an early stage of development and all must be developed to a considerably higher level before they are ready to perform their functions in an operational weapon system.
11. Management control must be exercised to ensure that integration of the four individual components development programs will constitute a weapon system program. It is necessary that comparable levels of development are achieved in each program and that the components have mutual compatibility.

...../4

~~SECRET~~
UNCLASSIFIED

Page 4

12. Within the framework of their Statements of Work and the facilities provided, each associate contractor is responsible for development of his own component and for ensuring compatibility of his product with those of the others. A/AWS as weapon system manager, with the assistance of the Co-ordinating Contractor, is responsible for major component integration into a weapon system and to ensure that the program objectives are achieved.

WEAPON SYSTEM DEVELOPMENT - EQUIPMENT AND FACILITIES

13. The first thirty-seven Arrow aircraft are allocated to the development, demonstration, and evaluation programme. The first of these aircraft are allocated to the Integrated Flight Test Programme - the remainder are allocated to RCAF programmes (Phases 4,5,6, 7 and 8).
14. All thirty-seven Arrow aircraft will be operated from one or all of three bases - Malton, Cold Lake and Uplands. It is anticipated that ADC will perform the Phase 6 and 8 operations.
15. The RCAF will ensure that the firing range at Cold Lake will be available on time and will have trained personnel and facilities capable of supporting the Arrow operations planned.
16. The weapon system evaluation facilities of the RCAF, CARDE, and the Associate Contractors, will be utilized by the co-ordinating contractor in creating the mathematical model and determination of the parameters to be measured during the flight test programme.
17. The selection and installation of test equipment for the contractor and RCAF programmes will be standardized as far as possible to ensure economy of effort and to provide as much flexibility and inter-facility compatibility as possible.

WEAPON SYSTEM DEVELOPMENT, DEMONSTRATION AND EVALUATING PROGRAMME

18. AAWS will control the development, demonstration, and evaluation programmes involving the aircraft allocated to the contractors' and RCAF programmes exclusive of Phases 6 and 8. Phases 6 and 8 aircraft are under the jurisdiction of ADC. However, a very close liaison will be maintained between AAWS and Phases 6 and 8 to ensure that the proper processing and compatibility of data with other phases of the programme is maintained.

...../5

19. A/AWS will delegate to the Co-ordinating Contractor, responsibility for allocating the contractor development aircraft to achieve the weapon system objectives outlined herein. Each associate contractor is responsible for development of his own product to the level compatible with initial weapon system requirements in January 1961 and as stated in his model specification at the earliest date consistent with policies expressed herein. The Co-ordinating Contractor will re-allocate aircraft as may be necessary to achieve the primary objective.
20. AAWS will delegate to CEPE the following responsibilities by means of T&DI's. (Ref. Appendix "A" and "B").
- (a) Monitor the contractors' programmes.
 - (b) Achieve objectives of Phase 2 by means of (a) plus continual physical assessment by CEPE team at Malton i.e. aircrew and engineering integration within the contractors' programmes.
 - (c) Achieve as many of the objectives of Phase 4 as possible, during the contractors' programme as per (b) above plus any additional flying not previously covered in the programme to validate the data contained in P.O.I. and the mathematical model.
 - (d) Achieve the objectives of Phase 7 as per (b) and (c) above and by gathering extra data required to validate the mathematical model from which the weapon system capability will be deducted.

WEAPON SYSTEM DEVELOPMENT- INTEGRATED FLIGHT TEST PROGRAMME (CONTRACTOR)

21. The co-ordinating contractor, together with the associate contractors, and the RCAF will plan an integrated flight test program designed to ensure development of the interim weapon system capability by January 1961.
22. The Co-ordinating Contractor will monitor the conduct of these programs to ensure that each program is progressing in an orderly fashion towards its objective and that all programs are progressing at appropriate rates.

.... /6

23. The Co-ordinating Contractor will monitor associate contractor programs to detect incompatibilities between weapon system components and will recommend to A/AWS the action to be taken to rectify incompatibilities.
24. The Co-ordinating Contractor, with the assistance of the associate contractors, will plan and conduct the program to demonstrate the weapon system.
25. CEPE will fulfill its responsibilities and achieve its objectives as described in para 20, above.
26. AVRO Aircraft Limited will have the contractor aircraft on loan to them and will be charged with the maintenance of all Arrow Aircraft allocated to the associate contractors by the co-ordinating contractor.

WEAPON SYSTEM CAPABILITY - METHOD OF ATTAINMENT

27. To assess the usefulness of the Arrow Weapon System to the RCAF, the sole criterion must be: "How well it will perform its function of deterring enemy attack or, alternatively, of destroying enemy bombers". The decisions which must be made from time to time by the RCAF require a constant awareness of the current assessment of weapon system capability.
28. The effectiveness of a weapon system against a specified target can be described by a number of mathematical equations which can be solved in a computer or simulator. These equations describe weapon system effectiveness including such factors as serviceability, radar range, aircraft performance, missile performance, etc. Some of these factors lend themselves to exact measurement, others must be estimated.
29. An assessment of the effectiveness of a weapon system can be made at any stage in the development of that system with some degree of accuracy. Before any hardware is built, for instance, the parameters in the equations can be estimated and the effectiveness of the system calculated. At a later stage, some of the parameters can be determined experimentally and a further assessment of system effectiveness can be made. The difference the two assessments would be that the later assessment would have a higher degree of accuracy.

30. The long lead times associated with procurement to the Cook-Craigie concept of production mean that decisions, such as ordering the initial quantity of squadron aircraft, must be made long before the aircraft has experienced a thorough assessment. This situation is due in part to the fact that the amount of development to be carried out in a limited time with limited facilities makes it mandatory that all early aircraft are devoted strictly to development programmes.
31. Before its evaluation aircraft are available, the RCAF will obtain current assessments of system effectiveness by:
- (a) Close monitoring of contractors' development programmes.
 - (b) Delegating to contractors some responsibility for establishing system effectiveness.
32. Many of the parameters in the mathematical equations which determine weapon system effectiveness can be established experimentally during contractor development programs without detracting from the prime objective of these programs. Contractors will be asked to determine these parameters experimentally and to use them in assessing system effectiveness.

WEAPON SYSTEM CAPABILITY - PROOF OF COMPLIANCE

33. Prior to entry of the Arrow into squadron service, the contractors are required to demonstrate to the RCAF that the Arrow is a weapon system which is useable by them and has a known effectiveness against the anticipated target. (Ref. Appendix "D")
34. The target performance, missions, and representative attacks against which the effectiveness of the Arrow Weapon system will be assessed in 1961 is contained in RCAF Specification WSC 1 and Appendix "C".
35. The contractors will be expected to demonstrate the component Model Specification performance below which production components will be rejected. This minimum acceptable performance standard will be under constant consideration during the development program.
36. The Co-ordinating Contractor will determine which of the parameters used in the mathematical models require to be established experimentally. He will ensure that these parameters are measured during associate contractors programmes, or by the RCAF during its programme. These parameters will be measured sufficiently in advance of January 1961, to enable an assessment of effectiveness to be available to the RCAF by December 1960.

~~UNCLASSIFIED~~

Page 8

37. The mathematical model will be derived by a working team under the direction of AAWS so as to calculate the effectiveness of the weapon system. The first step will be to establish the effectiveness of the weapon system as defined for 1961. The co-ordinating contractor will develop a satisfactory programme in conjunction with the RCAF to verify that the results of demonstration missions are in accordance with the predictions of the mathematical model.
38. An example of the effectiveness could be the calculation of a series of probability of missile placements (Pmp) for the 1961 weapon system, where the Pmp figure is arbitrarily defined as the ratio of missiles which "explode" within the "Circle of lethality" for a given attack configuration to the number of missiles fired. For the 1961 weapon system, the contractors would be expected to demonstrate such Pmp figures for the attacks listed in Appendix "C" within the terminal phase of the attack - viz. from radar detection to missile "explosion". The RCAF would provide the "circle of lethality" figures for the target (ref. WSC 1) in the attack configurations given in Appendix "C". The number of missiles to be fired and the tolerances on the resulting Pmp would be worked out in conjunction with the mathematical model.
39. Weapon system missions and support operations (ref. App. "C") will be demonstrated either during the development programme or as part of the final weapon system development and proving programme.
40. Should additional automatic features be added to the aircraft subsequent to 1961, the contractors will be expected to demonstrate the automatic capability of the weapon system.

UNCLASSIFIED

SECRET
S1038CN-80 (AMTS/AAWS)

APPENDIX "A"

ROYAL CANADIAN AIR FORCE

AIR FORCE HEADQUARTERS TEST AND DEVELOPMENT INSTRUCTION 58/33

ISSUE 1

ARROW WEAPON SYSTEM FLIGHT TESTING

PHASE 2 EVALUATION

21 May 58

INFORMATION

1 This T and DI should be read in conjunction with T and DI 57/75 Issue 2 dated 21 May 58.

2 The Co-ordinating Contractor has been instructed to work out an Integrated Flight Test Programme (IFTP) with the Associate Contractors covering the Arrow aircraft allotted to them for development test purposes. The contractor will be further instructed to ensure in consultation with the RCAF that the objectives of the RCAF Phase 2 programme will be included to ensure that duplication of effort is eliminated.

INTENTION

3 It is intended that CEPE be responsible for preliminary assessment of the Associate contractors' products. The objectives of these preliminary assessments designated Phase 2 evaluations, are to include such tests as are within the limitations of the products as established by the contractors to that time.

METHOD

4 CEPE is to conduct the Phase 2 programmes to meet the objectives outlined on page 2 of Appendix "C" to CEPE Report 1304 Issue 1 as amended to cover the weapon system in a manner to ensure that the total number of flying hours required by Phase 2 is kept to a minimum.

5 Phase 2 planning will depend on the contractors' programme planning, CEPE is to review details of the contractors' programme and discuss with the contractors and AAWS ways and means of accomplishing the Phase 2 programmes in accordance with para 4 above.

SUPPLY

6 The contractors will maintain the aircraft while the IFTP,

.../2

UNCLASSIFIED

Page 2

includes the Phase 2 programme, is being carried out. Data reduction facilities and personnel will also be provided by the contractors at the contractors' plant. Data reduction facilities and personnel at Cold Lake will be provided by the RCAF.

PRIORITY

- 7 Allotted "A" priority.

SECURITY

- 8 All reports will show a "Secret" classification.

CO-ORDINATION

- 9 Co-ordination will be supplied by AMTS/AAWS.

REPORTS

- 10 Reporting is to be as follows:

- (a) A report is to be submitted as soon as possible to show in detail, CEPE's proposed approach to meeting the objectives of Phase 2 after discussions with the Co-ordinating Contractor, the associate contractors, and AAWS.
- (b) A brief qualitative report on the progress towards fulfilment of Phase 2 objectives is to be submitted monthly to AAWS.
- (c) A final report is to be issued at the completion of the Phase 2 assessments.
- (d) Reporting on the contractors' development programmes as achieved by the associated CEPE monitoring functions for the IFTP will be as outlined in T&DI 57/75.

A C K N O W L E D G E

(G.G. Truscott) A/C
for CAS

DISTRIBUTION

AMCHQ/SOAE/XP	2	CAE/AEM	3
AMTS Circulation	1	Originator	1
CR File	1		

UNCLASSIFIED

APPENDIX "B"

SECRET

SI038CN-80 (AMTS/AAWS)

ROYAL CANADIAN AIR FORCE

AIR FORCE HEADQUARTERS TEST AND DEVELOPMENT INSTRUCTION 57/75

ISSUE 2

ARROW WEAPON SYSTEM FLIGHT TESTING

21 May 58

INFORMATION

- 1 This instruction supersedes and replaces AMTS 57/75 Issue 1 dated 3 Feb 58, "Arrow Weapons System Evaluation planning".
- 2 Flight Testing of the Arrow Weapons System will fulfill the objectives as outlined in the eight phase programme of DAEng Report No. 33. Since considerable flight testing must be completed by the contractor, AAWS must ensure maximum utilization of the data obtained by the contractor, and ensure that the RCAF programmes are conducted in such a manner as to avoid duplication and explore as expeditiously as possible areas which are necessary to the safe and successful operation of the Arrow Weapon System. This includes compliance with the specification, airworthiness, performance and handling, and the capability of the weapon system to counter an enemy threat defined by AAWS in terms of speed, altitude, radar reflecting surface and manoeuvrability.
- 3 To ensure fully tested operational aircraft are delivered to squadrons by Jan 1961, flight test programmes are to be planned and executed covering development tests, contractor demonstrations and evaluation tests. Eighteen aircraft are allotted to the contractors for development tests and demonstrations. The evaluation tests except the Phase 2 evaluations will be conducted on the remaining aircraft by the RCAF.
- 4 The Co-ordinating Contractor has been instructed by AAWS to plan an Integrated Flight test Programme (IFTP) with the Associate Contractors to cover all development tests and required demonstrations. The Co-ordinating Contractor will be further instructed to ensure in consultation with the RCAF that the objectives of the Phase 2 program will be met.

.../2

S E C R E T

APPENDIX "B"

Page 2

5 The RCAF must be in a position at any time during the period of the IFTP to assess the following:

- (a) progress of the Arrow Weapons System,
- (b) capability of the contractors' flight test departments, and
- (c) adequacy of the IFTP.

INTENTION

6 It is intended that:

- (a) The RCAF will monitor the contractors' development and demonstration programme.
- (b) The RCAF plan and execute Phases 2,4,6,7,8; Phases 6 and 8 to be planned and executed by Air Defence Command or OPU with assistance from CEPE as required. Phases 2, 4,5 and 7 to be planned and executed by CEPE.

NOTE: For the purpose of this Test and Development Instruction "monitor" is defined as follows:

- (i) Provide as required details of the contractors' integrated Flight Test Programme.
- (ii) Review all reports issued by the Coordinating and Associated Contractors on the Arrow Weapon System Flight Test Programme and pass to AFHQ with comments on the reliability and adequacy of the test results.

METHOD

7 The following responsibilities are assigned to CEPE:

- (a) To plan and execute Flight Test programmes covering Phases 2,4,5 and 7 in conjunction with the co-ordinating contractor and AAWS.

../3

- (b) To assist in monitoring the IFTP by means of a team of qualified aircrew and technical officers transferred on detached duty at the contractors' plants and-or at Cold Lake, Alta. These officers will assist the AAWS through the OC TSDs in monitoring the contractors' development tests of the aircraft and achieve the objectives of Phase 2 by active participation in the contractors Flight Test Programme.
- (c) To assist as detailed by AFHQ in the planning and execution of Phases 6 and 8 at an Air Defence Base such as Station Uplands.
- (d) In preparation for the RCAF evaluations to study:
 - (i) The Data Acquisition System proposed by the contractors and to make recommendations to AFHQ regarding additional installations which may be required, keeping in mind contents of para 2.
 - (ii) and specify the requirements for facilities support equipment and data acquisition systems which will be required for Phases 4, 5 and 7.
 - (iii) and specify the requirements for:
 - (A) specially qualified personnel,
 - (B) additional personnel,
 - (C) training.
- (e) To keep abreast of development in the art of weapon system evaluations.

9 AAWS will ensure that the contractors' programmes are made available to CEPE as far as possible in advance of the target date for the completion of the associated Phase 2 programme so that the adequacy of the programme can be assured and all possible duplication eliminated. AAWS will further ensure that the total IFTP is negotiated with the contractor to provide deviations from specifications, contractual check points or "milestones", and schedules for the completion of tests, demonstrations and the clearance of deficiencies.

10 On receipt of the detailed plans for the phases for which CEPE is responsible, AFHQ will issue instructions for the implementation of each phase.

SUPPLY

11 The aircraft and complete support to the contractors' programme will be supplied by the RCAF on loan to the contractor. Office space and associated facilities required by CEPE will be arranged by AAWS with the contractors.

PRIORITY

12 Allotted "A" priority.

SECURITY

13 All reports will show a "SECRET" classification.

CO-ORDINATION

14 Co-ordination will be supplied by AMTS/AAWS.

REPORTS

15 Reports will be supplied as follows:

- (a) Re-issues of CEPE Report 1304, Arrow Weapon System Evaluation Planning are to be forwarded as required but not more than six months apart;
- (b) Reports covering monitoring of the IFTP are to be forwarded by the most expeditious channel - this will be accomplished by supplying the information to the OC TSD, while the flight tests are being conducted at the contractor facility;
- (c) Reporting on the Phase 2 programme will be accomplished as indicated in T and DI 58/33.

A C K N O W L E D G E

(G.G. Truscott) A/C
for CAS

SECRET

APPENDIX "B"

Page 5

DISTRIBUTION

AMCHQ/SOAE/XP	2
AMTS Circulation	1
CR File	1
CAE/AEM 3	3
Originator	1

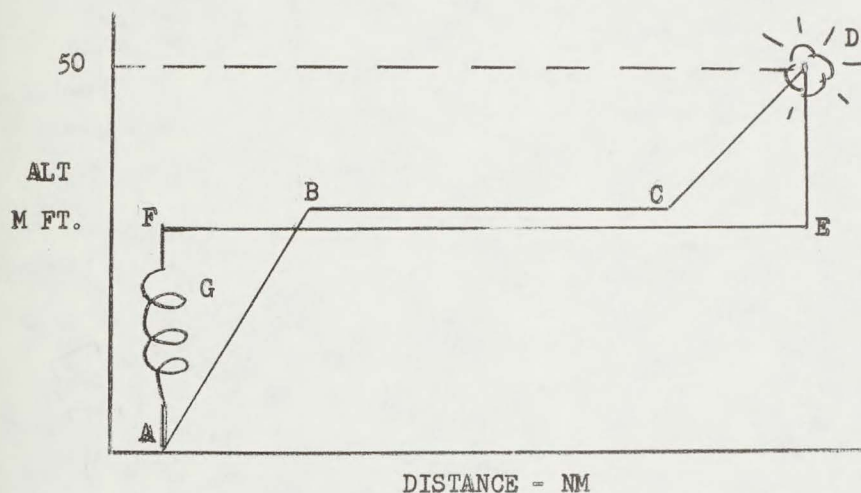
S E C R E T

APPENDIX "C" TO
S1038CN-180 (AMTS/CAE)
DATED: 15 July 58

1. Representative Mission Profiles for Contractor Demonstration of the Arrow Weapon System

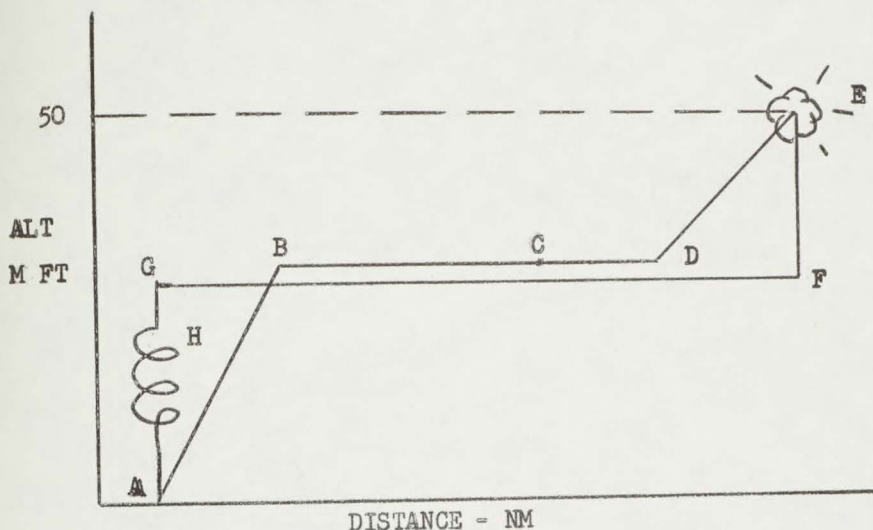
The following mission profiles are considered representative of the tactical employment of the Arrow Weapon System in a close control environment. The details of the Arrow performance in the mission profiles will be quoted in the Arrow 2 Model Specification on the basis of full internal fuel and all armament fired during 5 minutes combat.

(a) Subsonic, High Altitude Mission - Subsonic Combat



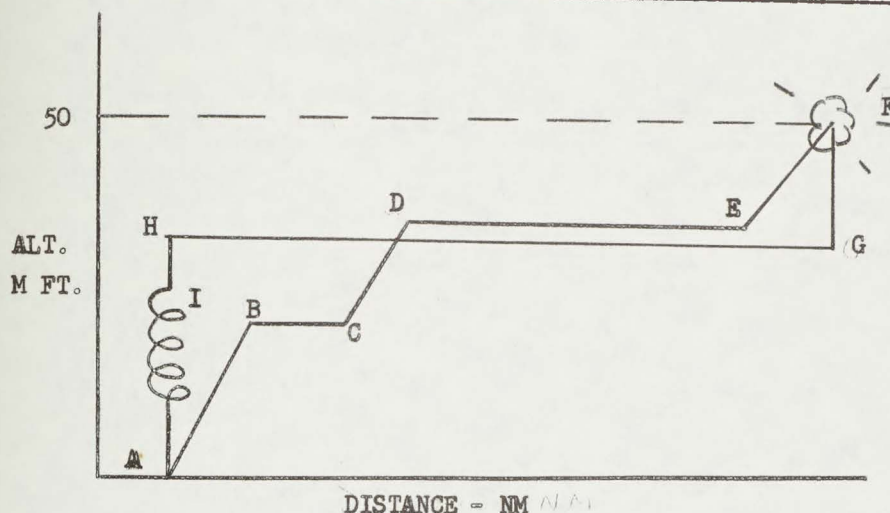
- A Engine Start - full internal fuel
Take-off to Unstick - Mil Rating
Accelerate to Subsonic Climb - Mil Rating
- A-B Subsonic Climb - Mil Rating - to Cruise Altitude
- B-C Subsonic Cruise - Maximum Range Conditions
- C-D Subsonic Climb - Mil Rating - to 50,000 ft.
- D Combat Subsonic for 5 Minutes
- D-E Descend to Cruise Altitude - Idling RPM
- E-F Subsonic Cruise - Maximum Range Conditions
- F-G "Descend" to holding Altitude - 40,000 ft.
- G Hold at 40,000 - Maximum Endurance - 15 Minutes
- G-A Descend to Sea Level - Idling RPM
- A Land with 5 Min. Fuel - Maximum Endurance

(b) Subsonic, High Altitude Mission - Supersonic Combat



- A Engine Start - Full Internal Fuel
- Take-off to Unstick - Mil Rating
- Accelerate to Subsonic Climb - Mil Rating
- A-B Subsonic Climb - Mil Rating - to Cruise Altitude
- B-C Subsonic Cruise - Maximum Range Conditions
- C-D Accelerate to 1.5MN - A/B Lit
- D-E Climb at 1.5 MN to 50,000 ft. - A/B Lit
- E Combat at 1.5 MN 50,000 ft., A/B Lit, including a 1.5 g
180° Constant Altitude Turn at Max. Thrust - 5 Minutes
- E-F Descend to Cruise Altitude - Idling RPM
- F-G Subsonic to Cruise - Maximum Range Conditions
- G-H "Descend" to Holding Altitude - 40,000 ft. - Idling RPM
- H Hold at 40,000 ft. - Maximum Endurance - 15 mins.
- H-A Descend to Sea Level - Idling RPM
- A Land with 5 Minutes Fuel - Maximum Endurance

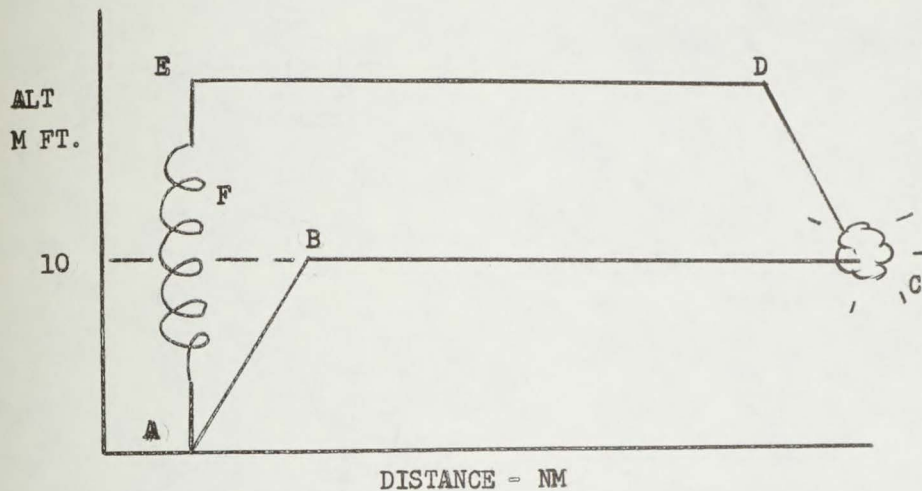
(c) Supersonic, High Altitude Mission - Supersonic Combat



- A Engine Start - Full Internal Fuel
 Take-off to Unstick - Maximum Thrust - A/B Lit
 Accelerate to Subsonic Climb - Maximum Thrust - A/B Lit
- A-B Subsonic Climb to Best Acceleration Altitude - Maximum Thrust - A/B Lit
- B-C Accelerate to 1.5 MN Maximum Thrust - A/B Lit
- C-D Climb to Cruise Altitude at 1.5 MN Maximum Thrust - A/B Lit
- D-E Supersonic Cruise at 1.5 MN - Partial A/B
- E-F "Climb" to 50,000 ft. at 1.5 MN - Maximum Thrust - A/B Lit
- F Combat at 1.5 MN at 50,000 ft. including a 1.5 g 180° Constant Altitude Turn - Maximum Thrust - A/B Lit - 5 Minutes
- F-G Descend to Cruise Altitude - Idling RPM
- G-H Subsonic Cruise - Maximum Range Conditions
- H-I "Descend" to Holding Altitude - 40,000 ft. - Idling RPM
- I Hold at 40,000 ft. - Maximum Endurance - 15 Minutes
- I-A Descend to Sea Level - Idling RPM
- A Land with 5 Minutes Fuel - Maximum Endurance

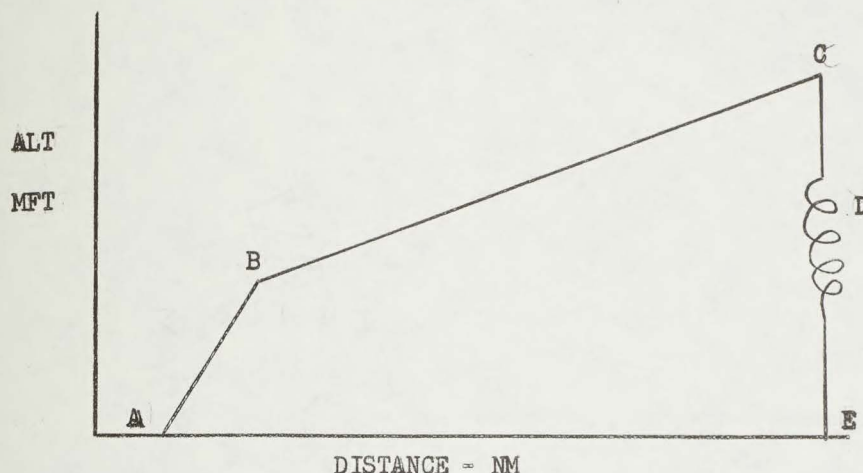
- A Engine Start - Full Internal Fuel and External Belly Tank
Take-off to Unstick - Maximum Thrust - A/B Unlit
Accelerate to Subsonic Climb - Maximum Thrust - A/B Unlit
A-B Subsonic Climb to Cruise Altitude - Maximum Thrust - A/B Unlit
B-D Subsonic Cruise - Maximum Range Conditions
C External Belly Tank Jettisoned when Fuel Gone
D 90° Turn - Maximum Thrust A/B Lit
D-E Accelerate to 1.5 MN - Maximum Thrust A/B Lit
E-F Climb to 50,000 ft. at 1.5 MN Maximum Thrust A/B Lit
F Combat at 1.5 MN at 50,000 ft. including a 1.5 g 180° Constant
Altitude Turn - Maximum Thrust - A/B Lit - 5 Minutes
F-G Descend to Cruise Altitude - Idling RPM
G-H Subsonic Cruise - Maximum Range Conditions
H-I "Descend" to Holding Altitude - 40,000 ft. - Idling RPM
I Hold at 40,000 ft. - Maximum Endurance - 15 Minutes
I-A Descend to Sea Level - Idling RPM
A Land with 5 Minutes Fuel - Maximum Endurance

(e) Subsonic, Low Level Mission (10,000 ft) - Subsonic Combat



- A Engine Start - Full Internal Fuel
- Take-off to Unstick - Maximum Thrust - A/B Lit
- Accelerate to Subsonic Climb - Maximum Thrust - A/B Lit
- A-B Subsonic Climb to 10,000 ft. - Maximum Thrust - A/B Lit
- B-C Subsonic Cruise - Maximum Range Conditions
- C Subsonic Combat at 2 g at 10,000 ft. - 5 Minutes
- C-D Subsonic Climb to Cruise Altitude - A/B Unlit
- D-E Subsonic Cruise - Maximum Range Conditions
- E-F "Descend" to holding Altitude - 40,000 ft.
- F Hold at 40,000 ft. - Maximum Endurance - 15 Minutes
- F-A Descend to Sea Level - Idling RPM
- A Land with 5 Minutes Fuel - Maximum Endurance

(f) Ferry Mission - No Armament



- A Engine Start - Full Internal Fuel and Armament Pack Tank or Normal Pack (no Missiles) and External Belly Tank Take-off to Unstick - Maximum Thrust - A/B Unlit
 Accelerate to Subsonic Climb - Maximum Thrust - A/B Unlit
- A-B Subsonic Climb to Altitude for Start of Cruise Climb - Maximum Thrust - A/B Unlit
- B-C Subsonic Cruise Climb to Maximum Cruise Altitude - Maximum Range Conditions
- C-D "Descend" to Holding Altitude - 40,000 ft. - Idling RPM
- D Hold at 40,000 ft. - Maximum Endurance - 15 Minutes
- D-E Descend to Sea Level - Idling RPM
- E Land with 5 Minutes Fuel - Maximum Endurance

2. Representative Interceptions for Contractor Demonstration of Arrow Weapon System

The following interceptions are considered representative for the tactical employment of the Arrow Weapon System in a close control environment. In flying these interceptions, the following general details are pointed out:

- (i) The mission profile to be flown for these interceptions should be as shown in para 1(c), i.e., the high speed, high altitude mission. However, it is considered that several interceptions could be done on each sortie.
- (ii) The purpose served in flying at differential altitudes of 2 and 3,000' during the interceptions specified is to demonstrate the ability of FCS to determine and display accurately steering requirements in the two angular dimensions.
- (iii) To keep the required sorties to a minimum, demonstrations of the optical and visual identification modes could be done coincidentally.
- (a) Lead Collision. To demonstrate the ICC mode 4 set-ups are submitted:
 - (i) 10° aspect angle relative to the nose of the target
 - (ii) 45° aspect angle relative to the nose of the target
 - (iii) 90° aspect angle relative to the nose of the target
 - (iv) 135° aspect angle relative to the nose of the target

All 4 set-ups should be basically co-altitude, however, an altitude differential of 3,000 ft. above or below the target are to be used on 2 of the attacks.
- (b) Lead Pursuit. Two set-ups are submitted as necessary to demonstrate the lead pursuit mode:
 - (i) 90° aspect angle relative to the nose of the target

S E C R E T

APPENDIX "C"

PAGE 8

(ii) 135° aspect angle relative to the nose of the target

An altitude differential of 3,000 feet is to be used on the two runs, one above, and the other below the interceptor.

(c) Lead Collision with Automatic Snap-Up. Four set-ups, as detailed are considered the minimum to demonstrate the snap-up capability.

(i) The set-up is to be 90° aspect angle off the nose of the target with the interceptor at an altitude above 50,000 feet and the target 5-10,000 feet above the interceptor.

(ii) The set-up is to be 90° aspect angle off the nose of the target with the interceptor at an altitude of 35,000 feet and the target at least 20,000 feet above the interceptor.

(iii) The set-up is to be 45° aspect angle relative to the nose of the target with the interceptor at an altitude of 45,000 feet and the target 17-18,000 feet above the interceptor. This set-up should obtain a comparison of a borderline snap-up situation.

(iv) The set-up is to be 10° aspect angle relative to the nose of the target with the interceptor at an altitude of 35,000 feet and the target 17-18,000 feet above the interceptor. This set-up should obtain a comparison of a borderline snap-up situation together with a head-on attack.

(d) Optical. An attack using the Optical Mode is required to confirm that the sighting accuracies are sufficient to allow missile lock-on.

(e) Visual Identification. The Visual Identification mode will be demonstrated via 3 attacks starting at aspect angles relative to the nose of the target of 45°, 90° and 135°. At set-up, the altitude differentials respectively should be, co-altitude, 3,000 feet below the target and 2,000 feet above the target.

S E C R E T

APPENDIX "D" TO
S1038CN-180 (AMTS/CAE)
DATED: 15 July 58

GENERAL POLICY FOR THE DEMONSTRATION OF THE ARROW WEAPON SYSTEM

1. Introduction

Prior to entry of the Arrow into squadron service, the contractors are required to demonstrate to the RCAF that the engineering requirements of their contracts have been fulfilled and that the Arrow Weapon System is useable by the RCAF and has a known effectiveness against the anticipated target.

2. Objectives

The objectives of the demonstration program shall be therefore:

- (a) To provide evidence of compliance with applicable model specifications.
- (b) To provide evidence that the Arrow Weapon System is useable by the RCAF.
- (c) To establish the effectiveness of the Arrow Weapon System against a specified target.

3. Method

The objectives will be attained by means of:

- (a) Associate contractor demonstrations.
- (b) A weapon system demonstration at an RCAF base.
- (c) A mathematical model.

4. Associate Contractor Demonstrations

- (a) Associate contractors will demonstrate that their products meet the applicable model specifications by submitting technical data, obtained during their development programs to the co-ordinating contractor and the RCAF and by conducting component tests approved and monitored by the RCAF.

S E C R E T

APPENDIX "D"

PAGE 2

- (b) In certain cases, where it is more convenient to do so, proof of compliance may be demonstrated during the period of weapon system demonstration at an RCAF base.
- (c) In the case of specification clauses implying statistical concepts e.g. probabilities, the results from the mathematical model will be submitted as evidence of compliance.

5. Weapon System Demonstration

The co-ordinating contractor, in conjunction with the associate contractors, will demonstrate the performance of the weapon system. This demonstration will take place at an RCAF base in an environment resembling, as closely as possible, that defined in the relevant specifications. Supporting equipment and facilities used will be representative of those available at an Arrow base. The demonstration will cover the following aspects:

- (a) States of readiness and take-off
- (b) Performance of missions and attacks (ref. Appendix "C")
- (c) Navigation capability
- (d) Interception capability (ref. Appendix "C")
- (e) Weapons installation and Fire Control System
- (f) Missile capability
- (g) Landing and turn-around.

Significant parameters will be recorded during the demonstration in order that mission performance, and interception and attack capability can be evaluated.

6. Weapon System Effectiveness

The effectiveness of the Arrow Weapon System in performance of its military mission will be assessed by the results of the mathematical model. Data obtained during the weapon system demonstration will be shown to be statistically in accordance with the predictions of the mathematical model.

SECRET

APPENDIX "D"

PAGE 3

7. Requirements

- (a) The demonstrations must be completed no later than the date upon which the first production aircraft enters squadron service.
- (b) Associate Contractors shall submit to the co-ordinating contractor proposals for demonstrating proof of compliance with the provisions of their specifications. These proposals shall indicate the methods by which this proof is to be obtained, the manner and timing in which it will be submitted and which aspects will be more conveniently demonstrated as part of the weapon system demonstration.
- (c) The co-ordinating contractor, with the assistance of the associate contractors, shall submit to the RCAF a combined proposal for the component(s) and weapon system demonstrations, defining the program to be carried out, facilities and manpower requirements, etc.
- (d) Following RCAF approval of the proposals for the demonstrations, the relevant statements of work will be amended as necessary to maintain contractual compatibility
- (e) The RCAF will provide specialist officers to the contractors to monitor and interpret demonstration data. In this manner AAWS will be kept continuously informed of the progress of the demonstrations.
- (f) It is intended that RCAF maintenance personnel will be available at the RCAF base to alleviate the requirement for contractor personnel and to ease the transition of the weapon system into RCAF service.

