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A. V. ROE CANADA LIMITED
MALTON - ONTARIO

RESEARCH & DEVELOPMENT (AIRFRAME)

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SPECIFICATION FOR ROCKET SLED TESTING OF THE ARROW ESCAPE SYSTEM

UNCLASSIFIED

CHECKED:

APPROVED:

DATE: Sept. 10/57

PREPARED BY E.J. Lynch & G. Grossmith

DATE September 10th, 1957

FORM 1368

PROJECT

ARROW ESCAPE SYSTEM

DATE September 10th, 195
PREPARED BY E.J. Lynch & G. Grossmith

LIST OF CONTENTS

LIST OF CONTENTS (Continued)

1.0 Title

Specification for Rocket Sled Testing of the Avro Arrow Escape System.

2.0 Summary

This specification is intended to form the technical basis of a contract for the design and construction of a rocket sled vehicle, and for the supply of materials and services in connection with a program of rocket sled tests, intended to prove the adequacy of the escape system of the Avro Arrow Aircraft. Its issue does not itself establish such a contract, nor a declaration of intent to enter into a contract. The security classification of this document is "Secret".

3.0 General Information

3.1 Object And Scope Of Test Program

The object of the test program referred to herein is to demonstrate the effectiveness of the complete escape system of the aircraft. This object may be regarded as sufficiently realised if the tests show that, under all conditions prescribed:-

(a) the emergency canopy opening system functions satisfactorily without causing hazard to the crew.

(b) the crew ejection system functions correctly, with safe and satisfactory separation of the dummy crew members from the aircraft and its services.

(c) the post-separation performance of the ejection seats and personal equipment of the crew members is such that the latter pass safely clear of the aircraft structure without either suffering injury or being subjected to unacceptable accelerations, and, having regard to the available knowledge of the seat characteristics, without apparent danger of subsequent mishap.

The possible need for escape system development in order to achieve this object is acknowledged. Such development would be the responsibility of Avro Aircraft Limited, and suitable modifications may be made from time to time to the test vehicle and other equipment, as well as to the test program.

3.2 The Aircraft And Applicable Specifications

The Avro Arrow Aircraft is a supersonic two-place fighter, with the navigator's cockpit aft of the pilot's cockpit. A general view of the front fuselage area of the aircraft wooden mock-up is shown in Figure (1). It is being produced under a contract between Avro Aircraft Limited, and the Canadian Government, and the technical requirements are those contained in the Model Specification, which fairly closely defines the physical nature of the escape system. The test

3.2 (Continued)

requirements for the system are those defined by U.S.A.F. A.R.D.C. Manual 80-1 (Handbook of Instructions for Aircraft Designers), of which the applicable paragraph is number 6.115. Since flight demonstrations of the escape system are impracticable, it is necessary to resort to Rocket Sled Testing.

3.3 Preliminary Investigations

In January 1957, a visit was paid by an Avro group to W.A.D.C. at Dayton, Ohio, in order to learn the current attitude and practices of the U.S.A.F. with respect to escape system development and testing. These subjects were discussed with Mr. A.B. Nutt, Chief of Special Projects Branch of the Aircraft Laboratory, and his staff. Preliminary data was also obtained concerning the "SMART" track at Hurricane Mesa. This was followed in March by visits to the tracks at Edwards Air Force Base, N.O.T.S. China Lake and Hurricane Mesa, during which the facilities were inspected and the technical feasibility of carrying out the Avro program was discussed. As a result of this tour, the conclusion was reached that there exists no basic technical requirement for the selection of any particular one, of these three tracks.

3.4 Track Selection

It is desired to engage the services of a sub-contract firm to design and build the rocket sled vehicle, and to provide other services incidental to the carrying out of the test program. In view of the apparent absence of any technical necessity for the selection of a particular track, it is felt that interested firms should be afforded the opportunity to include recommendations on this point as part of their proposals. It will obviously be necessary to ensure acceptance of the proposed program by the track authorities concerned, before any commitment can be made which would require the use of a particular track.

3.5 Responsibility For Track Provision

Responsibility for the arrangements under which the selected track, and the facilities normally provided by the track authorities, are made available to Avro Aircraft Limited, will be assumed by the Royal Canadian Air Force.

4.0 Services Desired Of The Sub-Contractor

4.1 Summary

The services desired are as follows:-

(a) Design and construction of the sled vehicle, plus locomotive, if required.

(b) Structural testing of the sled vehicle.

(c) Design, supply and assembly of all sled-borne instrumentation and devices for initiating events.

(d) Supply of all dummy aircrew and instrumentation as specified.

(e) Supply of all rocket motors and/or propellants required.

(f) Necessary assistance to track personnel in setting up and conducting test runs.

(g) Technical liaison with Avro Aircraft Limited.

(h) Necessary repair, maintenance, modification and replacement of all items, except the replacement of items supplied by Avro Aircraft Limited.

(i) All necessary assistance with data reduction, and the preparation of interim reports.

(j) Preparation and submission of a final report.

The services listed above are further discussed in the following paragraphs.

4.2 Sled Vehicle And Locomotive

The vehicle is to be based upon a front fuselage to be supplied by Avro Aircraft Limited. This will include the air intakes, the canopies and their actuating mechanisms, the canopy seal inflation system and other necessary standard details. It will not include the radar nose. The sub contractor is to design and provide a substitute radar nose of representative shape, and incorporating proper support for the cockpit front pressure bulkhead, and a fairing of aircraft profile extending backwards for at least five feet behind the navigator's bulkhead, whether or not rocket motors are to be housed in that location. He is also to provide sled-borne means for pressurising the cockpit, and for maintaining cockpit pressure constant up to the time of ejection. An access door, preferably in lieu of one front windscreen panel is to be provided to enable the internal canopy locks to be operated from outside, before commencing a test. The sled vehicle and/or locomotive must include track slippers and braking arrangements. The effective angle of attack of the fuselage on the track will be specified by Avro Aircraft Limited. The contractor is to be responsible for the design, manufacture and satisfactory performance of all items not supplied by Avro Aircraft Limited, and is also to be responsible for the design and incorporation of all strengthening modifications to aircraft structure as may be necessary to permit safe and satisfactory operation of the vehicle under track conditions, in lieu of normal flight conditions. Such modifications shall receive the approval of Avro Aircraft Limited. The completed vehicle is to be painted in a colour scheme to be approved by this company, and is to exhibit prominently on both sides the name and company insignia of Avro Aircraft Limited.

4.3 Structural Testing

Static strength tests of the rocket sled vehicle are to be conducted to prove its sufficiency to meet the maximum anticipated loads. Two cases shall be considered, and proof load tests performed for both unless one is shown to overrule the other decisively. The cases shall represent maximum longitudinal acceleration and maximum longitudinal deceleration respectively. Proof loads shall be 1.125 times the maximum actual loads expected to occur, and shall not occasion any significant permanent deformation, or any deformation under load which would interfere with the operational tests. The loads to be applied at the proper locations shall include motor thrust or brake loads, slipper vertical reactions and drag, and inertia loads on critical portions of the structure. Balancing loads may be applied in a generally appropriate manner. The proposed schedule of accelerations and decelerations for the operational tests, and the proposed loads and procedures for the static tests shall be submitted beforehand for the approval of Avro Aircraft Limited, and the static tests shall be witnessed by an Avro engineering representative. Following the completion of the tests specified above, the loads for the more critical case shall be re-applied, to maximum working values only, and the cockpit shall then be pressurised in suitable increments to a maximum differential pressure of 5.75 p.s.i., after which the pressure and the loads shall be removed.

4.4 Instrumentation And Special Devices

It is expected that the track facility will provide all land-based cameras and telemetry receiving equipment, as well as a system for indicating the passage of a magnetic device on the vehicle past a series of fixed points on the track. The measurements and observations required are specified in the section of this document entitled "Technical Data", and the sub-contractor is required to provide all sled-borne cameras, transducers etc. and transmitting or recording equipment necessary to achieve the desired objectives. The accuracy of all such measurements shall be subject to the approval of Avro Aircraft Limited, and shall at least represent good experimental practice.

4.4 (Continued)

This section covers the supply of replacement instrumentation items and the repair of damaged instrumentation items, as necessary to complete the test program.

All trackside and sled-borne devices for initiating action aboard the sled are to be supplied by the sub-contractor, and are to be of types of already proven reliability, as far as possible. No installation inside the cockpit is to be made in such a way as to interfere with or influence the operation of the escape system.

4.5 Dummy Aircrew

To cater for the test program as specified in section 6, the sub-contractor is to supply anthropomorphic dummies as required. Provision must be made to salvage ejected dummies, and to repair or replace damaged appendages when economical. The general requirements for the anthropomorphic dummies supplied shall be as nearly as possible as follows,

(a) General: Height 6' 1" Weight 200 lb.

(b) Motions Of The Appendages (In Degrees)

NECK

Forward Flexion.....60
Backward Flextion.....60
Lateral Flexion.....40
Rotation.....70

UPPER ARM

Forward Flextion At Shoulder.....180
Backward Flexion At Shoulder..... 60
Lateral (Outward Only).....135
Rotation..... 90

FOREARM

Flexion At Elbow (Forward Only)....145
Rotation of Wrist..... 90

SHOULDER

Upward Flexion.....40
Forward Flexion.....20
Backward Flexion.....20

4.5 (Continued)

(b) CHEST (Relative To Pelvis)

Forward.....40
Backward.....20
Lateral.....45
Rotation.....45

HAND

Forward Flexion At Hip.....90
Backward Flexion At Wrist.....60
Finger Flexion.....Fit Functional Hands

UPPER LEG

Forward Flexion At Hip.....145
Backward Flexion At Hip.....45
Lateral Flexion At Hip (Outward Only).....70
Rotation.....90

LOWER LEG

Backward Flexion At Knee.....135

FOOT

Forward Flexion At Ankle.....30
Backward Flexion At Ankle.....75
Lateral Flexion At Ankle.....15

(c) Principal Dimensions (In Inches)

Sitting Height (Seat To Top Of Head).....38
Shoulder Height (Standing).....60
Shoulder Height (Sitting).....25
Elbow Rest Height (Seat To Bottom Of Elbow).....11
Knee Height (Sitting).....23
Buttock-Knee Length (Sitting).....25
Shoulder-Elbow Length (Elbow Flexed).....15

(d) Weight Distribution

The weights and weight distributions of all members shall duplicate as nearly as possible the properties of a male human pilot of similar dimensions.

4.6 Rocket Motors And/Or Propellants

During inspections of the track facilities (see para. 3.3) the impression was gained that, by the time the subject test program will be commenced, at least some of the tracks would possess liquid-fueled locomotives, which, if available for use on suitable terms, would offer much lower running costs than solid-fueled motors. It is accordingly desired that potential sub-contractors take this factor into account, with a view to securing the best economic advantage with regard to the provision of the vehicle, and the running costs. Provision of motors and/or propellants should be taken to include storage arrangements and handling arrangements, in so far as these services are not provided by the track authorities. It is expected that if intervention by military authority is required to allocate or expedite motors or propellants, the necessary action can be initiated by the R.C.A.F. upon request via Avro Aircraft Limited.

4.7 Preparation And Conduct Of Tests

This item is intended to cover co-ordination of material deliveries to the test site, preparation of all sled-borne equipment for test, inspection and preparation of the track for test, collaboration with track personnel in setting up and calibrating sled-to-fixed station telemetry apparatus, assistance with the operation of land-based equipment where necessary; inspection, measurement and recording of all pertinent evidence upon completion of each test run, and recovery of all re-usable or salvagable equipment for future use.

4.8 Liaison With Avro Aircraft Limited

In the design, manufacturing and static testing phase, an Avro engineering representative will visit the sub-contractor's establishment at intervals to observe progress and to assist in the settlement of technical questions. Matters requiring special attention in this phase may be the subject of communication, or of visits by the sub-contractor's personnel to Avro Aircraft Limited. Certain matters prescribed elsewhere in this document require Avro approval before proceeding, or the attendance

4.8 (Continued)

of Avro witnesses, for which due notice is required. In the track phases, an Avro engineering representative will be constantly assigned to liaison with the sub-contractor, and, together with the sub-contractor, will carry out liaison with the track authorities and others, as may be expedient. At this stage, communication from the test site to Avro Aircraft Limited, will normally be via the Avro engineering representative. Notice will be required in advance of all test firings so as to permit time for arranging the attendance of witnesses, and acknowledgement will be necessary before proceeding.

4.9 Repairs, Maintenance, Modifications and Replacements

Equipment of every kind shall be repaired and maintained in good order as may be required, to ensure continued and satisfactory operation, whenever such action would represent proper economy. Otherwise, such equipment may be replaced. Modifications to aircraft structure or equipment specified by Avro, or repairs occasioned by test damage, are to be carried out as needed. Equipment originally provided by Avro will be replaced by Avro when necessary.

4.10 Reports and Data Reduction

All engineering materials and labour necessary to reduce data and prepare reports are required for:-

(a) The static strength and pressure tests.

(b) An advance statement in detail of all preparations and arrangements proposed for the test program proper, including full procedural and instrumentation details.

(c) Essential and especially requested, immediate results for each track test.

(d) A final report, co-ordinating all the previously issued reports, and completing the presentation of all data obtained.

4.10 (Continued)

Item (a) is to be submitted within four weeks of the successful completion of the subject tests, item (b) not later than six weeks before the first test run, and item (d) within 3 months after completion of the test program. All reports are to be submitted directly to Avro Aircraft Limited in reproducible form. Each shall be issued and signed by a responsible official of the sub-contracting company.

4.11 General Conditions

All items in the foregoing paragraphs covering the supply of material shall be understood to include arrangements for the transportation, storage and prudent insurance for such material, and in particular the delivery of the completed vehicle, and locomotive, if any, to the track is included.

All technical questions, and the disposition of all damaged material, shall at all times be the subject of Avro Aircraft Limited discretion.

No material, the cost of which has been charged to Avro Aircraft Limited, shall be disposed of except as prescribed by Avro. The sub-contractor shall undertake to use practices and materials of good commercial quality throughout all phases of the contract, suited to the purposes intended, and shall indemnify Avro Aircraft Limited, against all consequences of his neglect in such matters.

No data acquired by the sub-contractor out of this document, or as a result of the proposed contract, or as a result of tests conducted under such a contract, shall be revealed to any third party except with prior consent in writing from Avro Aircraft Limited.

The sub-contractor shall provide to Avro Aircraft Limited a complete set of drawings for the structural design, instrumentation, modification and repairs to, the test specimen, dummy aircrew and test vehicle.

All communications addressed to Avro Aircraft Limited, covering the subject test program shall be addressed to the Procurement Manager, unless they are of a purely non-contractual character, in which case they shall be addressed to the Chief Ground Test Engineer.

4.12 Amendments

The possible necessity for modifications to portions of the escape system, or of basic alterations in the type of system employed, and for consequent changes to the vehicle and/or the test program, shall be recognised. Such changes shall not affect the general intentions of the original contract, but shall be the subject of negotiation in each case.

5.0 Services To Be Provided By Avro Aircraft Limited

5.1 Engineering Materials And Services

This company will provide all engineering drawings of the front fuselage structure and systems necessary for proper execution of the sub-contractor's work, together with suchstress reports as contain information needed by the sub-contractor. Since the longitudinal accelerations and decelerations of track testing are not related to cases normally considered for the aircraft, particular analyses to cover the test conditions are not available, and this company specifically does not undertake to carry out additional analysis for this purpose. Data drawings defining the shape of the radar nose and the fuselage aft of the cockpit section will be supplied. Reports on rig tests of the canopy emergency actuating system are available and will be supplied if required.

5.2 Engineering Liaison

An engineering representative of Avro Aircraft Limited, will provide liaison with the sub-contractor and with the track authorities as already described in para. 4.8.

5.3 Technical Assistance

This company will provide, for the program, a crew to assist with the installation and servicing of the ejection seats.

5.4 Witnessing Of Tests

Avro Aircraft Limited engineering representatives will witness the performance of the structural tests on the vehicle, as well as the track tests.

5.5 Non-Engineering Materials

This company will supply the following:-

(a) Front fuselage structure, complete with windscreen, canopies and actuating systems, canopy seals, and all relevant internal details.

(b) Ejection seats, suitably coloured and marked, in quantities sufficient for the test program.

(c) Seat and canopy actuating cartridges, in quantities sufficient for the test program.

(d) Clothing, suitably coloured and marked, and personal equipment for the dummy aircrew, in quantities sufficient for the test program.

(e) Spare canopies and linkage items, as required.

(f) Spare gas system parts, as required.

(g) Spare manufactured structural parts, as required for repair purposes.

Transportation and insurance in transit will be provided for these items, to the point of delivery to the sub-contractor.

6.0 Test Program

As presently foreseen, the test program will consist of five runs, one at low speed, one at intermediate speed, and three at high speed. These speeds are defined as 150, 490 and 700 knots (E.A.S.) respectively. In each case both dummy aircrew members will be ejected in sequence, and their respective canopies will be opened by the emergency systems. It is anticipated that the cockpit will be pressurised in two of the high speed runs.

The exact program will be specified at a later date, but initial estimates of running costs should be submitted on the above basis. Prior to the dispatch of the front fuselage section to the sub-contractor, ejection tests will have been carried out at Avro Aircraft Limited, with the cockpit stationary and no repetition of this test will be required at the track

6.0 (Continued)

for Avro purposes. It is recognised that it may be desirable to conduct one run using the accelerating impulse only, without ejections, in order to establish the drag co-efficient variation with speed, over the entire range.

7.0 Technical Data

7.1 List Of Drawings Supplied Herewith

The data contained in the drawings supplied is intended as basic information. Additional drawings can be supplied if and when required.

(a) Front Fuselage (Component 52)

G.A. Structure.....Sht 2.....7-1052-1
Skin.....Sht 2.....7-1052-3907-11-12
Pilots Bulkhead-Top.....Sht 2.....7-1052-15-16
Pilots Bulkhead-Lower.....Sht 2.....7-1052-37-38
Navigators Bulkhead.....Sht 2.....7-1052-64
Bulkhead Stn. 120.....Sht 2.....7-1052-21-22
G.A. Floor.....Sht 2.....7-1052-395-396
Assembly-Top Longeron.....Sht 3,4,6...7-1052-397-398
Assembly-Lower Longeron.....Sht 2.....7-1052-401-402
Windscreen.....7-1052-4

(b) Air Intake (Component 55)

G.A. Air Intake.....Sht 2.....7-1055-1/2
Ramp Stn. 188-423.....Sht 3.....7-1055-2578/7

(c) Cockpit Area

G.A. Pilots Canopy.....Sht 4,5.....7-1053-1-2
G.A. Nav. Canopy.....Sht 4,5,8...7-1053-3-4
G.A. Pilots & Nav. Position.Sht 1,2.....7-4452-7

7.1 (Continued)

(d) Nose (Component 51)

G.A. Radar Nose.....7-1051-1
G.A. Radar Nose Structure.....7-1051-2
Lines.....7-0151-25, 26, 27, 28, 29

(e) Centre Fuselage (Component 54)

G.A. Structure.....7-1054-1
Skin.....Sht 4 7-1054-3621-22
Arm Bay Roof.....Sht 4.....7-1054-2289

(f) Miscellaneous

Ejection Seat Installation.....7-2852-2
Canopy Mechanism-Normal & Emergency..7-1052-19 Shts. 3

7.2 Extent And Construction Of The Component Supplied

This company will supply, as referenced in (5.5A) a front fuselage, with the following structural and mechanical items installed:—

(a) Front fuselage structure, including ramps, windscreen and nacelles from Stn. 120 to Stn. 255.

NOTE: The cockpit floor and tranverse bulkheads are of aluminum alloy sheet. The outer fuselage skins are of magnesium, and all stiffeners are of aluminum alloy. The nacelles are constructed of aluminum alloy throughout. All construction is by means of rivets or other fasteners, except for one or two reinforcing members on the bulkheads, which are metal-bonded.

(b) Pilot's and Navigator's canopies and seals, complete with normal and emergency actuating mechanisms and seal inflation piping.

(c) Ejection seats (operating charges supplied separately).

(d) Control mech's, such as stick, rudder and radar units, or suitable mock-up, as deemed necessary to demonstrate compliance with the ejection path clearance requirements.

7.3 Operation And Maintenance Of Canopy Locking And Opening Systems

7.3.1 Locking

The locking and actuating mechanisms are shown schematically in Figure 2. Five latches (17) are mounted on one canopy half, and are connected by link rods. Their key-hole slots engage mushroom studs on the other canopy half. Forward motion of the lever (13) engages the latches, and finally disengages the lever itself from the latching arrangements.

7.3.2 Normal Opening

The latches are first disengaged by pulling handle (13) down and aft. A micro-switch thus actuated normally operates a solenoid valve to deflate the canopy seals. The normal electric actuator (14) is then operated via a selector switch.

7.3.3 Emergency Opening Without Ejection

Either by operation of handle (12) inside the cockpit, or by pulling on cable (9) from outside the sear is withdrawn from firing unit (4), which is a cartridge-operated gas generator. Gas due to this firing passes to the latch-operating jack (5), actuating the push-rod (6) and the bell-crank (7) to disengage the latches. Motion of the push-rod (6) allows the gas pressure to be sequenced from the jack (5) to the emergency canopy-operating jack (1), and the action of this jack, through the linkage, shears a pin in the rod-end of the normal actuator (14), and opens the canopies.

The emergency opening action goes further than the normal action, and results finally in removal of the sear (11) from the seat ejection gun. The striker is restrained, however, by the presence of a safety pin connected to cable (16).

7.3.4 Emergency Escape

Either by pulling the face blind handle (8), or by operating an alternative control (not shown), mounted on the seat pan, the sear is removed from the firing unit (4) and the sequence described in para. 7.3.3 is initiated. At the same time, the safety pin attached to cable (16) is removed, so that upon completion of the canopy-opening action, the ejection seat is fired.

7.3.5 Safety

Cartridges shall not be placed in the chambers of the firing units or the ejection seat guns until the last possible moment before firing. If any work is subsequently necessary in the cockpit, all safety pins, with prominent warning notices attached, must be inserted in such a way as to prevent accidental firings, before such work is commenced, and must remain until all such work is finished. If the cockpit is to be left unattended at any time when the cartridges are in the chambers, the safety pins and warning signs must be fitted.

7.3.6 Inspections and Replacements

All cables and moving parts shall be inspected frequently for wear and proper operation, and lubricated and replaced as necessary. After each firing of the canopy mechanism, the following should be replaced:-

(a) Normal actuator shear pin.
(b) Flexible hoses from latch operating jacks to emergency operating jacks.
(c) Copper rings in latch operating jack.
(d) Any mechanism parts worn or damaged.

7.3.7 Cleaning

All parts of the gas system (i.e. firing unit, gas piping, latch jack, and emergency actuating jack) must be dismantled as promptly as possible after each firing, and cleaned of all corrosive deposits by boiling in water. The parts must then be thoroughly dried.

7.4 Operation And Maintenance Of Ejection Seats

The ejection seat presently specified for these tests will be the Martin Baker Mk. C.5. It is anticipated that at a later date a detailed brochure will be available on the operation and maintenance features of this seat. The ejection gun is permanently mounted in the aircraft, and acts as the guide rail for the ejection seat. The ejection seat is installed in the aircraft, and locked to the ejection gun guide rails.

7.5 Operating Times, And Required Period Of Uniform Sled Velocity

For the test program as outlined in section 6.0, the maximum required period of uniform sled velocity will be for the 700 knots E.A.S. runs. A breakdown of this estimated time for the complete sequence is as follows:-

(1) Navigator's canopy opening time, with air loads tending to close.....0.5 seconds

(11) Navigator's seat ejection and clearance.....0.3 seconds

(111) Pilot's canopy opening time, with air loads tending to close.....0.5 seconds

(1v) Pilot's seat ejection and clearance.....0.3 seconds

TOTAL 1.6 seconds

7.5 (Continued)

As the above figures are based on mean data presently available, a total of 2 seconds for uniform sled velocity is thought to be necessary, in order to ensure that the first ejection is completed up to the separation stage, before the second is commenced.

7.6 Cockpit Pressures And Leak Rate

The sub-contractor will be required to provide equipment to maintain pressure in the cockpits for two of the 700 Knot (E.A.S.) test runs. The pressure to be applied will be 5.75 p.s.i. above ambient pressure.

A cabin pressure regulator may be fitted at the discretion of the sub-contractor. A safety valve must be fitted to compensate for any malfunction of the proposed pressurisation system. The estimated cockpit volume is 127 cu. ft. The total estimated leak rate is 50 to 75 standard c.f.m.

7.7 Measurements And Observations Required

The sub-contractor will be required to measure and produce data, as specified herein, correlated with time on a common basis, for each of the following functions, in each test run:-

7.7.1 Motion Of Test Vehicle:-

A continuously recorded signal is required for the longitudinal accelerations and decelerations of the test vehicle, measured half way up the pilot's seat bulkhead. A record is also required of distance travelled versus time, originating from the magnetic pick-ups provided at the track.

7.7.2 Emergency Canopy Opening:-

Signals must be recorded to show the instants of initiation of the escape process for the pilot and the navigator, and these signals must be separately recognisable for each crew member. Continuous records of the loads in the four canopy operating links are required, derived from strain gauges on the links, which must be calibrated accordingly. Continuous records of the gas pressures at two points in each canopy system are required. Continuous records are required of strains at about 12 locations on the canopy and cockpit structure, and of the pressures in the two cockpits, and of the angular displacements of the four canopies. In addition, cine-photography records are required of the latch and opening mechanism action, for each cockpit.

7.7.3 Crew Ejection

A continuous record is required of the distance travelled by each seat from its starting point, independently of land-based camera records, for the first eight feet of travel only. Accelerations of each test dummy are to be recorded continuously during the test runs, for the following motions. Three accelerometers placed at the heart location, to record the upward, downward and lateral movements of the test dummies. One accelerometer placed in the upper chest or neck, with its distance from the heart location rigidly fixed, to record the pitch of the dummies. One accelerometer placed in the head to record the pitch of the head relative to the body. All instruments are to be located in the plane of symmetry of the test dummy. The total dynamic pressure is to be continuously recorded, at the centre of the chest area, outside the suit, and in the forward facing direction, as well as the pressure inside the inflatable portion of the suit. Cine-photography records are required to show leg motions of the dummy aircrew at the beginning of the ejection process, as well as the clearance or lack of clearance around the legs during the process. Land-based "metric range" photography will be required to yield as accurately as possible a record

7.7.3 (Continued)

of the position of a target mark at the heart location, seen in side elevation, together with the orientation of the seat in pitch. It is expected that it will be possible to deduce whether or not the crew members would have cleared the fin of the aircraft from these records, as well as to observe the flight of the seats and their occupants until they reach the ground. A photographic record in the fore and aft plane to record the sideways travel of the dummy and seat after ejection is required.

7.7.4 General:-

Still photographs are required of the completed vehicle on the track, and to illustrate the dummy occupants and their equipment as installed for test, as well as to illustrate all mechanisms, instrumentation and their arrangements installed on the vehicle for test purposes. Examinations of the seat, dummies, clothing, equipment and the vehicle are to be made (in situ, where appropriate) and the observations are to be recorded by photography as well as in writing. The ambient temperature, barometric pressure, wind velocity and wind direction are to be recorded for each test run. The temperatures of the cartridges at the time of firing should be closely estimated, since they may be significantly heated by the sun after the cockpits are closed.

The names, ranks or titles, and affiliations of all witnesses present must be recorded for each run.

7.8 Weight, Distribution And Drag

The distribution of weight, frame by frame along the front fuselage only, is given on the next two pages, with separate analysis for the structure, the windscreen and canopies, the seats and the crew. The location of the overall C.G. both horizontally and vertically is given. It is considered that the drag of the test vehicle cannot be estimated with very high accuracy by this company, and that past track experience will probably enable a better estimate to be made by the sub-contractor.

PROJECT

AILERON ESCAPE SYSTEM

DATE September 10th, 1957
PREPARED BY E.J. Lynch & G. Grossmith

WEIGHT BREAKDOWN OF FRONT FUSELAGE (CONTINUED)

FORMER NO	STA (RELATIVE TO A/C DATUM	BASIC STRUC. WT LB.	WINDSCREEN & CANOPIES WT. LB.	EJECTOR SEATS WT. LB.	CREW MEMBERS WT. LB.	TOTAL
FWD. OF STA. 120	113.70	-------	14.63	-----	-----	14.63
14	120.00	47.56	7.13	-----	-----	54.69
15	129.33	39.47	19.72	-----	-----	59.19
16	137.00	40.40	27.33	-----	-----	67.73
17	147.00	43.72	42.04	-----	-----	85.76
18	157.33	47.92	58.16	7.67	45.00	158.75
19	166.66	68.40	58.24	28.21	94.28	249.13
20	176.00	102.66	43.98	18.04	75.72	240.40
21	182.26	78.08	28.33	11.23	-----	117.64
22	188.45	73.58	23.43	11.44	-----	108.45
23	194.94	86.39	30.02	11.09	-----	127.50
24	201.44	91.66	27.84	-----	-----	119.50
25	207.93	105.45	12.76	2.92	-----	121.13
26	214.43	117.34	14.04	15.10	60.00	206.48
27	219.00	95.08	25.83	26.85	100.58	248.33
28	228.00	137.92	30.45	16.70	54.42	239.49
29	237.50	119.48	27.27	15.47	-----	162.22
30	245.12	143.83	22.60	15.79	-----	182.22
31	255.00	163.03	14.64	.17	-----	177.84
	TOTALS	1601.97	528.43	180.68	430.00	2741.08

NET WEIGHT:- 2741 LB. AT STA. 198.6

WEIGHT BREAKDOWN OF FRONT FUSELAGE (Continued)

VERTICAL HEIGHT OF C.G.

'V' Arm Is Taken Relative To A/C Datum
(Above Datum Being Positive)

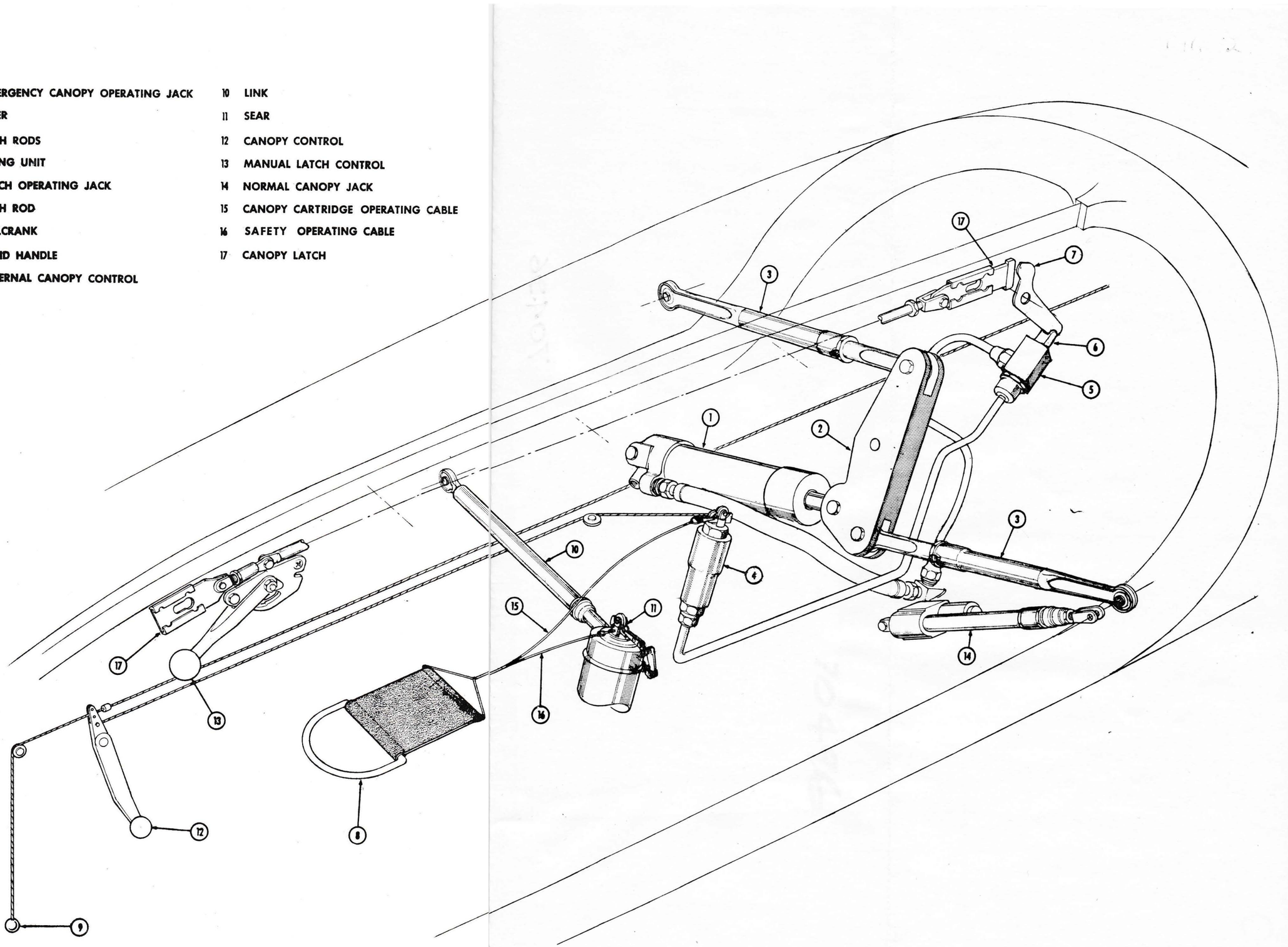
	W/T	V ARM
Basic Structure	1601.97	2.46
Windscreen & Canopies	528.43	-37.87
Ejector Seats	180.68	-16.25
Crew Members	430.00	-16.50
Net TOTAL	2741.08	12.4

ARROW ESCAPE SYSTEM

8.0 Time Schedule:-.

October 11th, 1957	-	All bids to be received.
November 1st, 1957	-	Authority to proceed to be issued to sub-contractor.
February 1st, 1958	-	Front Fuselage component to be despatched to sub-contractor.
May 1st, 1958	-	Structural Tests of Vehicle to commence.
May 15th, 1958	-	Vehicle to arrive at test track.
June 1st, 1958	-	First Test Run.

1 EMERGENCY CANOPY OPERATING JACK
2 IDLER
3 PUSH RODS
4 FIRING UNIT
5 LATCH OPERATING JACK
6 PUSH ROD
7 BELLCRANK
8 BLIND HANDLE
9 EXTERNAL CANOPY CONTROL
10 LINK
11 SEAR
12 CANOPY CONTROL
13 MANUAL LATCH CONTROL
14 NORMAL CANOPY JACK
15 CANOPY CARTRIDGE OPERATING CABLE
16 SAFETY OPERATING CABLE
17 CANOPY LATCH



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CF-105 COCKPIT CANOPY ACTUATING MECHANISM

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