AIRWORTHINESS APPROVAL NOTE NO: 21124 Issue 2

APPLICANT: CAA Internal Purposes

AIRCRAFT TYPE: Bolingbroke Mk.IV T

REGISTRATION NO: G-BPIV

CONSTRUCTOR'S NO: 10201

Approval of Fairchild Bolingbroke Mk 1V T
For the Issue of a Permit to Fly

1.0 Introduction

The Fairchild Bolingbroke Mk IV is a Canadian built version of the Bristol Type 149 Blenheim IV light bomber and reconnaissance aircraft the prototype of which first flew in 1937. It was made under licence by the Fairchild aircraft Company at Longeuil Quebec, initially, to Bristol drawings and with the aid of assemblies and components supplied from Britain. Early production aircraft were designated Bolingbroke I's but simultaneously development work proceeded in adapting the design to meet Canadian operating requirements and to use equipment and instrumentation that was more readily available from the USA. Two development versions designated Bolingbroke II and III were made for evaluation purposes, the latter aircraft being fitted with Edo floats to explore the type's suitability as a seaplane. However, neither of these versions entered production and so the definitive version for full scale manufacture became the Bolingbroke Mk IV powered similarly to the Blenheim IV by Bristol Mercury XV engines. Deliveries to the R.C.A.F. commenced at the end of 1940 with production continuing until early 1942 when the Bolingbroke Mk IV T navigation, bombing and gunnery trainer variant succeeded the bomber/reconnaissance version. A total of 457 Bolingbroke Mk IV T aircraft were produced with late production aircraft being fitted with Bristol Mercury XX engines.

Issue 2 of this AAN has been raised to correct the engine limitations.

2. Technical Description

2.1 General

The type is a twin-engined mid-winged monoplane of all metal construction with the exception of the ailerons, rudder and elevators which are fabric covered and the bomb doors which are wood with a light alloy outer skin. It is equipped with a retractable main undercarriage and a fully castoring fixed tail wheel.

2.2 Engines

Model: Bristol Mercury XX air-cooled nine cylinder single stage Supercharged radial rated at 820 hp for sea level take-off at 2,650 rpm and 4.25 lbs in^2 boost pressure. Each engine is fitted with dual Watford SP9-6 magnetos, a single booster coil, a Claudel Hobson AVT.85MB carburettor incorporating automatic boost and mixture controls and a Rotax E160 electric starter and hand crank.

2.3 Propellers

Model De Havilland Type 4/3 3-bladed, 2 pitch, non-feathering with fine and course pitch settings of 26° and 34° 45' respectively. Total pitch range available is 10°, i.e. 26° to 36°.

2.4 Structure

2.4.1 Fuselage light alloy stressed skin semi-monocoque construction consisting of front, rear and stern sections designed to be detachable at appropriate production breakjoints, Seats controls and instrumentation are provided for a maximum crew of four: - pilot and navigator/bomb aimer housed in the front fuselage forward of the wing centre section, a wireless operator stationed in the rear fuselage just aft of the wing centre section and a gunner situated in a turret located midway along the top of the rear fuselage.

Access for the pilot and navigator is provided by a sliding hatch in the cockpit roof and for the wireless operator and gunner through an inward opening hatch forward of the turret. Additionally, emergency exit hatches are provided in the fuselage floor at the bomber aimer and wireless operator stations.

2..4.2 Wings Consist of a centre section to which the front and rear fuselage sections are attached together with left and right outer planes. The centre section also incorporates the mounting points for the engines, main fuel tanks and main undercarriage. Construction of the three wing sections is similar consisting essentially of front and rear main spars, light alloy ribs, stressed light alloy skin and formed stiffeners. The spars are fabricated from light alloy webs and laminated high tensile steel angle sections booms which are further strengthened by laminated steel cornices extending the full length of the spars. Outer plane to centre section attachments consist of forked eye and fittings bolted to the spar booms which in turn bolt to heavy gauge triple link plates. Additionally, the ends of the spar webs are butt jointed by bolted front and rear vertical channel members.

2.4.3 Empennage: Consists of a single fin and tailplane of conventional light alloy stressed skin construction. The tailplane incorporates two channel section light alloy spars reinforced by laminated high tensile steel angles, which also provide the attachment points to the fuselage stern frame. Fin attachments are formed by a trailing edge post, which extends to the bottom of the stern frame and riveted angles around the bottom contour which are screwed to the stern frame and tailplane top surfaces.

2.5 Flying Controls: The ailerons, elevators and rudder control surfaces are fabric covered with the exception of the aileron leading edges and the elevator and rudder balance sections which are stressed light alloy skin. Operation of the ailerons is achieved by a control column mounted handwheel which is connected to levers on the left and right hand front spars of the centre section through a system of chain, sprockets and tie rods. From the levers, control tubes mounted on the outerplane front spars extend outboard to differential lever assemblies which in turn are connected by control tubes and adjustable links to the operating levers on the ailerons.

For elevator operation an adjustable control tube connects the base of the control column to an adjacent transverse lever assembly from which duplicated control cables run via pulleys to a lever assembly in the fuselage stern section. From this assembly a single control tube connects to the elevator operating lever. Rudder operation is provided by a freely suspended pedal assembly which operates a vertical torque-tube from which a lever and control rod connect to a transverse lever assembly similar to that installed in the elevator system. Duplicated control cables run from this assembly direct to the rudder operating levers via pulleys and finally through fairleads on the front frame of the stern section.

Trim tabs are fitted to each of the control surfaces those for the ailerons being ground adjustable only. Elevators and rudder tabs are operated by individual handwheels driving screwjacks by a system of chains and cables, the rudder tab also functions as a servo tab.

Hydraulically operated split flaps of light alloy construction are fitted to the centre and outer mainplanes. A single jack mounted in the left hand centre mainplane operates a quadrant lever which in turn actuates spanwise operating tubes to which the left hand flaps are linked by toggle assemblies. The lever is connected by cables to a similar quadrant and spanwise tube mechanism in the right hand centre mainplane for operation of the right hand flaps.

2.6 Engine/Propeller Controls Throttle, mixture and propeller pitch levers are mounted on a control pedestal to the right of the pilot's seat. Throttle and mixture lever movement is conveyed via a system of rods which operate torque shafts mounted on the centre section front spar. From the torque shafts lever operated rods connect to the carburettors. Propeller control is achieved by a system of Teleflex, flexible controls connecting the control levers to the pitch control valves on the engines.

Additionally Teleflex controls are provided on the centre instrument panel for carburettor hot air, cut-out and oil cooler shutter operation. Cowl gill operation is controlled electrically from switches on a panel on the cockpit right hand side wall.

2.7 Undercarriage Each main undercarriage assembly consists of two Vickers oleo legs pivoted about centres at the bottom of the front nacelles, a quick release axle and main wheel and inboard/outboard drag braces each comprising two knuckle jointed radius rods. Undercarriage extension and retraction is achieved by a hydraulic jack which operates after a radius rod lock jack has first disengaged the appropriate up or down locking catches. Inadvertent retraction of the main undercarriage on the ground is prevented by safety locks consisting of sliding rods actuated by compression of the outboard oleo legs which engage fittings on the bottom outboard radius rods.

Pneumatic expanding shoe brakes are fitted to the main wheels and are controlled from a lever mounted on the control column handwheel with provision for differential braking via a Dunlop control/relay valve linked to the rudder pedals. Dunlop heavy duty 36 x 1200 main wheel tyres are fitted.

The fully castoring non-retractable tail wheel is mounted on a tubular steel fork fitting attached to the lower end of the oleo shock absorber unit incorporating a self centring mechanism. A Dunlop heavy duty 5.5" x 4" tyre is fitted.

Undercarriage position indication as provided by an electrically operated indicator on the right hand side of the main instrument panel. Dual needles indicate 'up' and 'down' positions and transmission movement of each main undercarriage utilising radius rod operated transmitters and up and down lock micro switches. A warning horn sounds if either throttle is closed more than two thirds with the undercarriage up.

An undercarriage emergency lowering system is provided by a CO_2 bottle in each wheel bay which, is connected via a shuttle valve to the unlock side of its respective radius rod lock jack and then in turn to the down side of the main jack. The bottles are operated by Bowden cables from pull controls located behind the pilots left shoulder.

2.8 Hydraulic System The system operates the main undercarriage, flaps, and gun turret. It consists of a reservoir mounted behind the left hand engine firewall, a three stage gear pump driven by the left hand engine, a hand pump, filter, main and hand pump relief valves, hand pump non-return valve and a system selector valve for directing fluid to crew operated individual control valves for undercarriage, flaps and gun turret operating jacks. System pressure is indicated by a gauge on the main instrument panel.

2.9 Fuel System A light alloy fuel tank is mounted in each centre and outer wing to provide a total fuel capacity of 280 gallons. Provision is also made for jettisoning the contents of the outer wing tanks. Fuel is supplied to the carburettors by engine driven pumps which through port and starboard 3-way tank selector cocks and balance control cocks in the suction and delivery lines permits either pump to draw fuel from any of the two tanks and also if necessary to supply both engines. In the event of double pump failure, fuel would be gravity fed via non-return valves installed between the pump suction and delivery balance lines. Filters for the pump and carburettor inlet lines are mounted on the front face of each engine firewall.

Controls for the tank selector cocks are mounted on either side of the cockpit and for the balance on the left hand side to the rear of the pilot's seat. The contents of each tank is indicated on a combined gauge wired to float-operated electrical transmitters.

2.10 Oil System An independent oil system is provided for each engine consisting of interconnected light alloy main tanks (capacity 11.5 gallons) located at the top of each nacelle plus a drum-type oil cooler and a Tecalemit oil cleaner installed forward of the firewall. A relief valve set to 15 psi will by-pass oil from the cooler for engine cold starting and in the event of cooler blockage.

2.11 Engine fire Extinguisher System A CO_2 bottle located in the fuselage nose is connected via a selector/control valve to discharge rings in each nacelle and to discharge orifices at the carburettor intakes. The bottle can be mechanically discharged by a pull control knob on the selector valve after first selecting the affected engine.

2.12 Pneumatic System A single compressor driven by the right hand engine supplies air to a storage bottle in the fuselage aft of the rear spar via an oil reservoir and oil trap attached to the engine mounting behind the firewall. An air filter and ground charging point are installed adjacent to the storage bottle. System pressure is regulated by a minimum pressure/cut-out valve and is used to operate wheel brakes. System pressure and individual brake pressures are indicated by a triple pressure gauge on the pilot's instrument panel.

2.13 Vacuum System A vacuum source for driving the pilot's gyroscopic instruments is derived from a pump mounted on the right hand engine. The system incorporates an oil separator and suction relief valve and is connected to a four-way control valve which permits the pilot to select to an alternate source provided by a venturi mounted on the left hand side of the forward fuselage. The venturi system is available in the event of a pump or engine failure and incorporates its own relief valve. System pressure is indicated by a gauge mounted on the right hand of the instrument panel and which is tapped into the supply line downstream of the control valve.

2.14 Pitot Static System An electrically heated pitot/static head is mounted on a mast beneath the left hand side of the fuselage nose. Additionally, a resistance bulb is located within the mast to provide outside air temperature indication. The pitot/static head is connected by light alloy tubing to the pilot's altimeter, airspeed indicator and climb/descent indicator and to the additional altimeter and airspeed indicator located at the navigators stations.

2.15 Instruments A shock mounted blind flying panel is provided for the pilot which incorporates the following pitot/static and vacuum operated instruments:- Airspeed indicator, altimeter, climb/descent indicator, artificial horizon, turn and slip indicator and a directional gyro. A P10 compass is located to the left of the blind flying panel. Engine instrumentation is provided on a right hand panel and consists of individual gauges for indicating R.P.M. and boost pressure and combined gauges for indicating oil temperature, oil pressure and fuel pressure and for indicating cylinder head temperature and carburettor inlet temperature

2.16 Electrical System Power is provided by a single BTH Type A 12 volt 500 watt D.C. generator mounted on the left hand engine which supplies a 12 volt 35 amp general service battery located in the left hand rear fuselage forward of the bottom hatchway and an engine starting battery under the navigators main seat. A main fuse box and a panel carrying the voltage regulator, cut-outs, ammeters and voltmeter are mounted on the left hand side of the rear fuselage above the general services battery.

Immediately aft of the starting battery is a panel on which are mounted two 10 amp starter button fuses and a terminal block for two Rotax starter relays. A double pole master switch on the left hand side of the rear fuselage is installed for isolating the supplies from both batteries. Electrical services provided are:- Cockpit and crew station lighting, external navigation, formation keeping, identification and landing lights, rudder and elevator tab and flap position indicators, undercarriage position indication, engine instrumentation, pitot heat, armaments, radio and engine starting.

3. Technical Investigation

Sir William Roberts purchased the aircraft circa 1980 and shipped the aircraft to Strathallen in Scotland. Apart from dismantling the cockpit area, very little work was carried out in Scotland, although the aircraft was hangared.

After the demise of British Aerial Museum first Bolingbroke, the aircraft was purchased from Sir William Roberts and shipped to Duxford in January 1988. The aircraft then started on its total restoration to flying condition by Aircraft Restoration Ltd at Duxford. This company consisted of all the engineers and people involved with building the first aircraft.

The aircraft was fully stripped down and all work fully documented. Two engines were rebuilt and three propellers overhauled by Weston Propellers of Canada.

Full maintenance, overhaul and repair manuals were available for airframe, engines and propellers with additional structural repair schemes being provided by British Aerospace Bristol together with required materials.

The applicant intends to use the aircraft for public demonstrations and exhibitions.

4. Modifications/Repairs

A number of modifications have been embodied to incorporate more up to date equipment in certain systems and to comply with any relevant CAA Airworthiness Notices. Additionally some items have been deleted where they are no longer required.

Such structural repairs that have been found necessary have been completed to schemes provided by the Division of British Aerospace originally responsible for the military type applicants certification. A summary of the modifications and repairs is as follows:-

a) Modifications: Airframe

Mod No	Details
BB/Mod/01	Replacement of original Dunlop mainwheel tyres with Dunlop 36 x 1200 Shorts 360 tyres following investigation and recommendation by Dunlop Ltd.
BB/Mod/02	Replacement of Original Arens push/pull controls fitted to Canadian aircraft by new Teleflex controls specially made, supplied and fitted by Teleflex Ltd to the original Blenheim IV installation.

BB/Mod/03	Replacement of Sutton crew harness by Teleflex inertia reel and Aerolux harnesses using original attachment points.
BB/Mod/04	Use of swaged end fittings on the new control cables instead of spliced cable ends. Swaging was performed and tested by F.F.V. Stansted.
BB/Mod/05	Use of Ceconite 101 in place of original cotton fabric on control surfaces.
BB/Mod/06	Removal of flare chute and stowage.
BB/Mod/07	Removal of trailing aerial system.
BB/Mod/08	Deactivation of outboard fuel tanks by removal of associated pipelines and tanks. Original fuel capacity is not required and aircraft is cleared for flight with these tanks empty.
BB/Mod/09	Removal of dinghy packs and associated equipment from behind top rear engine bulkheads.
BB/Mod/10	Removal of Canadian climate baffles on exhaust ring and fitment of original British Carburettor heat systems to Blenheim IV standard.
BB/Mod/11	Replacement of cockpit and rear fuselage hand fire extinguishers with approved B.C.F. types.

Engines and Associated Systems

Mod No	Details
BB/Mod/20	Substitution of Avtolite SL30A spark plugs for Lodge RS14/3RS plugs due to unavailability of the latter type. Size, heat range and length of replacement plugs are correct for engine model and performance has been proven on ground test programme.

BB/Mod/21	To improve fire protection, original light alloy/asbestos firewalls are replaced with 20 s.w.g. stainless steel (Similar to principle used by Supermarine on late production Spitfires). No structural attachment changes involved.
BB/Mod/22	Additional N.R.V. fitted between pneumatic compressor and water trap to prevent pressure leaking back from accumulator.
BB/Mod/23	Installation of Avimo couplings to hydraulic system to permit connection of ground test rig
BB/Mod/24	Replacement of unobtainable electrically operated oil pressure, manifold pressure and fuel pressure gauges to Canadian specification by direct reading overhauled instruments as fitted to Blenheim IV aircraft.
BB/Mod/25	Use of Aeroshell 100 oil for first 50 hours then changing to Aeroshell 100W as recommended by Rolls Royce.

Electrical Systems and Radio

Mod No	Details
BB/Mod/30	Replacement of existing wiring by Nyvin type as listed on wiring diagrams.
BB/Mod/31	Installation of engine starter engaged warning lights to satisfy Airworthiness Notice 33.
BB/Mod/32	Deletion of formation and signalling lighting circuits and bomb arming circuits.
BB/Mod/33	Removal of bomb arming switches from cockpit port console in order to use console for radio systems.
BB/Mod/34	Replacement of original 12v, 25 amp batteries by Gill R35 batteries of 12v, 35 amp rating.

BB/Mod/35	Replacement of original Canadian Specification undercarriage position indicators now unobtainable, by Kollsman type 340-011-608 indicator utilising existing micro switch circuit design (Kollsman indicator is type fitted to Beech 18 aircraft).
BB/Mod/36	Installation of new radio station, see paragraph 9 for equipment fitted.
BB/Mod/37	Separate selection of Starter and Boost circuits.

b) Repairs

Significant repairs found to be required were confined to the wing centre and outer planes and the bomb doors. Transit damage necessitated complete reskinning of all wing sections for which a jig was constructed. All centre section and outer plane spars were inspected for corrosion both externally and in areas covered by cornice members. The cornice members of the centre section front spar boom had suffered from corrosion on the outer surfaces which was removed by powder blasting following which the spar was capped with 20 S.W.G. S3 material to repair schemes provided by British Aerospace, Filton Division. The left hand outer plane required 3 spar top boom angle sections and cornice members to be removed due to small areas of corrosion and various insert repairs to be made to schemes and with S535 material supplied by British Aerospace.

The right hand outer plane required only the bottom spar booms to be repaired by inserts to the angle sections. On completion of the repairs outer plane lower spar booms were capped with 20 SWG S3 strip material to a British Aerospace scheme. The S535 material used in these repairs was supplied in the annealed condition to permit forming to the required angle and cornice profiles. Forming was completed by a M.O.D. approved company, Varne Engineering Ltd with C.N.C. tooling using sample sections of angle and cornice pieces as the control items. On advice from the British Heat Treatment Centre subsequent heat treatment was completed by Mormet Heat Treatment Ltd and test pieces were cleared as meeting Specification by British Aerospace. The wings were skinned with 22 s.w.g. material, which meant that this was an increase in skin thickness over the original 24 s.w.g. material used in the outer sections of the outer planes. This factor has been assessed and found to be acceptable.

The original laminated wooden bomb doors had deteriorated badly due mainly to poor protective finishes and the use of non-waterproof glues. The doors have been remade in specially constructed jigs using aircraft grade birch plywood, selected Douglas Fir and approved adhesives. Test samples have been subjected to water immersion for seven days without delamination occurring. Original hinge and operating mechanisms have been retained.

5. Flight Testing

A flight test programme produced by Mr M B Proudfoot has been agreed with the CAA and a Flight Test Report dated 21 May 1993 has been submitted which is acceptable to the CAA. [Report Ref. FTR 8650Y]

6. Pilot's Notes, Limitations and Placards

6.1 Pilot's Notes

Pilot's notes reference AP1530B/G-MKIV, produced from the original RAF AP1530B and Canadian Airforce information have been compiled and shall be used for the operation of this aircraft.

6.2 Limitations and Placards

Limitations that are acceptable to the applicant and which shall be placarded in full view of the pilot are as follows:-

Airspeed:

6.2.1 Never exceed speed VNE - 234 mph IAS.
6.2.2 Flaps extended speed VFE - 120 mph IAS.
6.2.3 Undercarriage extended speed 120 mph IAS.

Engine:

6.2.4 Level Flight Maximum RPM (5 min limit) - 2750 at 4¼ psi boost and 235°C CHT
6.2.5 Maximum Take-off RPM - 2650 at 4¼ psi boost and 190°C CHT
6.2.6 Maximum Climbing RPM (30 min limit) - 2400 at 4¼ psi boost and 210°C CHT
6.2.7 Maximum Cruising RPM - 2400 at 2¾ psi boost and 190°C CHT
6.2.8 Oil inlet temperature - Max for Climb 80°C,
Max for cruise 70°C
Emergency 90°C for 5 minutes
Minimum for Take-off 5°C
6.2.9 Oil pressure - Normal 80 psi, minimum for 15 minutes 70 psi.

Aerobatics:

6.2.10 Aerobatics including intentional spinning - Prohibited.

Loading:

6.2.11 Maximum total weight authorised 12,000 lb.

Additional Placards:

6.2.12 Placards bearing the words "NO SMOKING" shall be fitted in both the cockpit and rear fuselage.

Permanent placards shall be installed in the aircraft in full view of all occupants worded as follows:-

"OCCUPANT WARNING: THIS AIRCRAFT HAS NOT BEEN CERTIFICATED TO AN INTERNATIONAL STANDARD"

7. Noise Certification

A Noise Certificate is not required for operation on a U.K. Permit to Fly.

8. Maximum Number of Occupants

The maximum permitted number of occupants including the pilot and for whom satisfactory seating is provided is three. The two occupants additional to the pilot shall be authorised crew members only who are required to assist with systems management and also ground handling away from base. The crew stations are located next to the pilot where assistance with fuel system and engine controls can be given and in the rear fuselage where a radio operator station was situated and which still retains electrical generating system indicators and a charge rate control. The two forward seats are equipped with full inertial shoulder harness and the rear seat which has four point attachments and is rearward facing has lap straps. The navigators and gunners stations are not required for operating the aircraft and the associated seats shall be placarded in accordance with paragraph 6.2.12.

9. Radio

The following equipment has been installed in accordance with Modification BB/Mod/36 [CAA Minor Mod 9/223/AV1864 refers]:-

King KY-197	VHF COM
KING KNS-80	VHF NAV/R-NAV/DME System with KI-206 Indicator and KA-33 cooling Fan.
KING KT-76A	TRANSPONDER. Foxtronic AFT-25 Intercomm Amplifier.

10. Weight and Balance

The aircraft has been weighed and a Weight and Balance Schedule has been prepared dated 14th May 1993.

11. Maintenance

The applicant has copies of the Ministry Air Publications for servicing, overhaul and repair of the airframe, equipment, engines and propellers for Blenheim aircraft and also Canadian Air Publications which cover details that are specific to the Bolingbroke.

Both Engines have had an Extensive condition inspection using serviceable parts and are considered suitable for further service. Total Engine hours unknown. Log books reflect zero hours since condition inspection.

Propellers have undergone a full overhaul by Weston Propellers of Canada. In consideration of this and the limited number of hours the aircraft is expected to fly, say approximately 35 per annum, inspections should be carried out at Airworthiness Notice 75 requirements, ie. every 3 years. This inspection would include NDT of the spiders and barrels.

Boroscopic inspections of the wing spar booms shall be made on an annual basis to ensure that they remain free from corrosion. Outer plane to centre section attachment, link plates and bolts were subject to NDT inspection during restoration and the need for reinspection shall be assessed annually.

A maintenance schedule reference ARC/Blenheim/Msch has been raised which addresses the detailed maintenance requirements for this aircraft.

12. Inspection

The aircraft including the modifications and repairs has been subject to stage inspections by the CAA and is in an acceptable condition for the issue of a Permit-to-Fly.

13. Approval

The aircraft and the modifications and repairs detailed in this AAN are approved for the issue of a Permit-to-Fly provided that the requirements of paragraph 6 are complied with and that a maintenance programme which includes the requirements of paragraph 11 is agreed with the appropriate CAA area office.

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AC LOVE
Surveyor (Design)
For the Civil Aviation Authority

Date .....