De Havilland Aircraft of Canada CS2F-1 Tracker 1517 prior to delivery in May 1957. Note the short span ailerons, the two slots in the upper surface of each wing for the roll control spoilers, the proportionately large vertical tail with its two-section control surface and the absence of transparencies in the pilots' overhead escape hatches. This Tracker had a relatively short naval career being written off in January 1960. (de Havilland Inc)

WILLING TRACKER

The Grumman S2F Tracker in Canadian Service

Part One

Robert M Stitt

GRUMMAN'S S2F Tracker is one of aviation's unsung 'greats'. Though almost entirely withdrawn from its original ship-borne anti-submarine role, the Tracker remains active in significant numbers and will certainly be earning its keep in both military and civilian service well beyond the 50th anniversary of its first flight. Canada has had a long and varied association with the Tracker. Indeed, one particularly willing example has recently entered service in its *fourth* major configuration, 35 years after it was first delivered to the Royal Canadian Navy.

The Grumman Aircraft Engineering Corporation of Bethpage, Long Island, New York, conceived its Model G-89 as a new concept in aerial anti-submarine operations; an aircraft that could single-handedly detect and destroy submarines. Prior to the G-89, the US Navy had countered the submarine threat with the single-engined Grumman AF-2 Guardian, which like the Grumman TBM Avenger before it, operated in 'hunter-killer' pairs consisting of an AF-2W radar-equipped 'hunter' and an AF-2S 'killer'. The US Navy gave approval to build two G-89 prototypes in June 1950 and the maiden flight of the first Grumman XS2F-1, BuNo 129137, took place on December 4, 1952, crewed by Fred Rowley and Norman Coutant. Initially named the Sentinel, the S2F Tracker entered US Navy service with VS-26 in February 1954 and went on to serve with 15 air arms in four major variants. As the S2F it quickly became known as the *Stoof* in US Navy usage. Stocky, and some would say unlovely in appearance, the Tracker remains an adaptable and well-liked workhorse that epitomises the Grumman *Ironworks* tradition for robust products.

Canada's Anti-Submarine Commitment

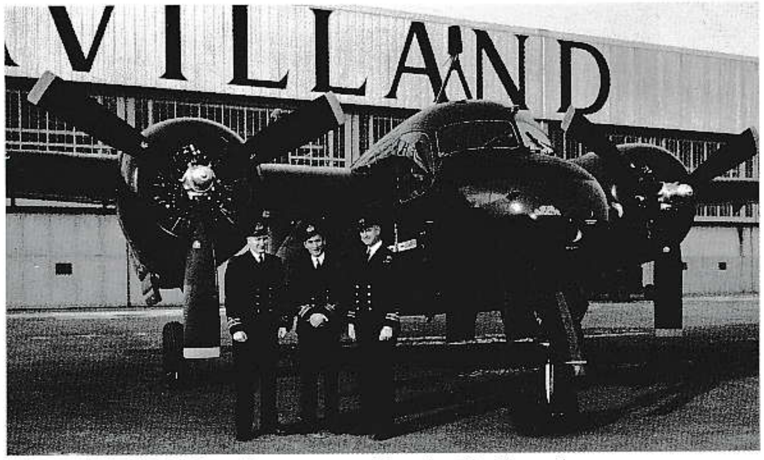
One of the lasting lessons of World War Two was the vital importance of keeping the North Atlantic shipping lanes clear of enemy submarines, thereby allowing the safe passage of essential supply convoys from North America to Europe. The increasing *Cold War* tensions of the early 1950s and the growing potency of Soviet submarines reinforced this need and the Royal Canadian Navy (RCN), as a member of the North Atlantic Treaty

The Royal Canadian Navy's AS.3M Avenger represented the ultimate development of the single-engined Grumman design in the anti-submarine role. The MAD boom sleeve and front and aft ECM **cans** *are clearly visible in this view of 53908, call-sign '389'.* (DND via Stuart Soward)

Organisation, sought ways to bolster its anti-submarine capabilities.

Canadian aircrews had established a strong naval aviation tradition during World War Two, flying Supermarine Seafires and Fairey Barracudas (among many other types) with Royal Navy squadrons. The Canadian Cabinet gave final authority to establish an air component within the RCN on December 21, 1945 and it became an operational force the following month with a squadron each of Supermarine Seafire XVs and anti-submarine Fairey Firefly FR.1s operating from a loaned Royal Navy carrier, HMS *Warrior*. By the end of 1952, the RCN was operating anti-submarine Grumman Avengers (VS 880 and VS 881 Squadrons) and Hawker Sea Fury fighter-bombers (VF 870 and VF 871) from HMCS *Magnificent*, also loaned by Britain following the return of the *Warrior* in February 1948. [Note that Canadian squadrons are correctly written *without* a dash between letters and numbers. The use of the dash is a mistaken 'carry through' from US Navy nomenclature. This is an error oft perpetuated, even *AE*'s done it in the past! — Ed]

Of the 125 former US Navy TBM-3Es received by the RCN between May 1950 and October 1952, 115 were converted by the Canadian division of the Fairey Aviation Company to anti-submarine configuration. Ninety-nine of these were AS.3 variants, equipped with AN/APS-4 anti-surface vessel (ASV) radar and identified by a pod mounted under the starboard wing; an AN/ARR-26 receiver to track soundings from the 16 air-dropped T.1946 sonobuoys; and in a few cases, a nose-mounted UPD-501 electronic-countermeasures (ECM) *can*. From 1955, Fairey delivered at least 21 improved AS.3M Avengers featuring a retractable, boom-mounted AN/ASQ-8 magnetic anomaly detector (MAD) installed in a sleeve along the port fuselage



Three of the VX 10 Squadron personnel involved in the early Canadian Tracker programme with Grumman S2F-1 X-500 at Downsview on February 15, 1955. VX 10 pilots began detachments to Grumman at Bethpage and to US Navy carriers and test establishments in the spring of 1954 in preparation for delivery of the RCN's own Trackers. Left to right are Lt Cdr Doug Ross, Tracker project officer at Downsview; Lt Cdr Bert Mead, who would later lead the Bendix PB-20F autopilot trials; and Lt Cdr Roy de Nevers, then commanding officer of VX 10. (DHC via Doug Ross)

Grumman-Built Trackers used in the Canadian CS2F programme

There has been much confusion over the histories of two Grumman-built S2F-1s used in Canada for production confirmation and equipment testing during the early days of the Canadian Tracker programme. The aircraft involved were as follows:

'X-500'

DHC negotiated the purchase from Grumman of one new S2F-1 Tracker to serve as a pattern and test airframe for the Canadian Tracker programme. Grumman supplied the aircraft with basic cockpit instrumentation and avionics, no ASW equipment and a Gloss Sea Blue US Navy paint scheme. After arrival at Downsview, DHC's Chief Test Pilot George Neal undertook one familiarisation flight on May 15, 1954, after which the aircraft was partially dismantled to check assemblies against the production jigs and tooling supplied by Grumman.

Following its pattern role, the aircraft received the serial X-500, the 'X' indicating its test function and '500' being a contraction of its interim RCN serial, 1500. X-500 was accepted by Lt Cdr Doug Ross of the Navy's test and evaluation squadron VX 10 on December 13, 1954, and was from then on jointly operated by de Havilland and the Navy to evaluate a wide variety of avionics and anti-submarine systems; the first trials were for the Bendix autopilot. On July 18, 1955, Ross, the Navy's project officer at Downsview, flew X-500 to the National Aeronautical Establishment, Uplands, to begin extensive magnetic anomaly detector (MAD) trials by which time the aircraft had been repainted in the RCN's Extra Dark Sea Grey and Sea Grey Medium scheme and marked both X-500 and 1500. Returned to Downsview towards the end of the month, the aircraft was spirited back to Uplands on July 28 when Naval Headquarters learned that a strike was pending at the DHC facility; the pilot Lt Cdr Jeffrey Harvie, who had never seen a Tracker before, relied on a pre-flight briefing given by two assistants through the overhead escape hatches. The aircraft was returned to Downsview on November 29, 1955.

During the first eight months of 1956 X-500 was employed on a variety of equipment trials that included additional development work for the MAD system and testing of the Canadian Marconi CMA301 altimeter; famous de Havilland test pilot John Cunningham flew the aircraft with George Neal on July 23 to evaluate the roll control spoiler system.

Throughout its time with DHC, X-500 was also used to evaluate the steady stream of Engineering Change Programs (ECPs) coming from Grumman's own evolving Tracker programme and was therefore in a constant state of modification; most of the 250 or so Grumman ECPs were adopted for Canadian production. As Canadian production got under way, de Havilland used X-500 to check the installation of subcontractor-built assemblies and fabrication details such as wiring runs.

By October 1956 the RCN had re-serialled X-500 as 1501. DHC brought the aircraft closer to Canadian CS2F-1 standards during the final months of 1956, though the aircraft retained its original lower fuel capacity — 314 Imp gal (1,427 litre) in four wing tanks *versus* the later 453 Imp gal (2,059 litre) in six — and the minimum of avionics to undertake further trials. It flew for the first time in this configuration in the hands of George Neal on January 8, 1957, after which the aircraft undertook trials for the *Julie* active submarine detection system and the wingtip UPD-501 ECM system. The RCN allocated 1501 to the Naval Air Maintenance School on April 26, 1957, the aircraft being delivered from Uplands to HMCS Shearwater later that year by Lt Cdr Robbie Hughes to became instructional airframe A706 for training riggers, fitters and ground marshallers; the aircraft is now on display with the Shearwater Aviation Museum. This was the only American airframe acquired by the Canadian Government and no Grumman-built assemblies were used in the production of the 99 Canadian Trackers.

The original identity of X-500 remains a mystery. Best recollections are that the aircraft was diverted from delivery to the US Navy — rather than being an additional production airframe — with a BuNo from early in the 133045-133328 serial block. This would suggest that Tracker production in the US and Canada totalled 1,268 airframes — 1,169 by Grumman and 99 by de Havilland — rather than the 1,269 normally quoted. The author would welcome any information confirming the identity of this aircraft.

BuNo 136519

The US Navy loaned the RCN a new Grumman S2F-1 Tracker, BuNo 136519 (c/n 428), the aircraft being accepted at Bethpage and flown to HMCS Shearwater on September 26, 1956, by Lt Cdrs Sheldon Rowell and Roy de Nevers. The aircraft was operated by VX 10 and used for pilot check-outs and various equipment trials, the most important of these being the Explosive Echo Ranging (EER) trials for the *Julie* active submarine localisation system. The first trials were conducted in October 1956 from Kindley Field, Bermuda, using 136519, AS.3M Avenger 53908 and an RCAF *Julie*-equipped P2V-7 Neptune. VX 10 conducted further trials from Bermuda the following month and from Guantanamo Bay, Cuba, in February 1957 using '519 and a Canadian-built Tracker, CS2F-1 1503. By April DHC had installed the AN/APN-59 radar for the CS2F-2 in '519, the aircraft being flown to NAS Patuxent River in May for trials to compare the system's performance with that of the earlier AN/APS-38. Among other projects, this US-built Tracker was used to undertake an investigation of the type's windmilling propeller characteristics. The aircraft retained its US Navy markings and serial throughout the loan and was delivered to NAS Jacksonville, Florida, for overhaul in September 1957 prior to entering US Navy service with Naval Air Reserve Training at NAS New York that December. Tracker 136519 was struck off charge on November 30, 1979.

X-500 pictured in May 1955 after repainting in RCN colours with the addition of serial 1500. This early production Grumman S2F-1 Tracker was fitted with the dorsal mast for the US Navy-style bi-pole AN/APA-69 ECM direction finding antenna (though the actual ECM equipment was not installed) and is shown with its MAD boom and ventral radar antenna radome extended. As first designed, the radome caused two problems when lowered for ASW operations; excessive drag and aircraft instability around the vertical axis. To address the drag, Grumman added a scoop with a narrow horizontal outlet nozzle to each side of the aircraft, just above the radome; the net effect was to smooth the airflow to the rear of the radome and restore some of the lost performance. The directional 'hunting' and an associated trimming problem were resolved by adding the vortex generators visible on the side of the radome. (de Havilland Inc.)

and a second ECM *can* mounted on a stub tail boom.

Total procurement also included eight TBM-3W2 *guppies*, delivered from the US in October 1952 with a bulbous ventral radar installation. The unarmed *guppies* were intended for AEW radar picket duties, protecting the fleet against incoming bombers. In practise, their long-range AN/APS-20 radar proved better suited to locating surface targets and so they were switched to the anti-submarine warfare (ASW) role, operating very effectively as part of a 'hunter-killer' team with one or two AS.3s or AS.3Ms. However, it was clear that the single-engined Avenger was reaching the end of its ability to meet changing naval aviation requirements for a self-contained airborne ASW system.

Meanwhile, the Navy had been searching for a suitable carrier to replace the straight-decked *Magnificent*. There were several surplus vessels available, including the USS *Tarawa* and HMS *Hermes*, but the final choice fell to HMS *Powerful*, a British *Majestic* Class light fleet carrier laid down for the Royal Navy in 1943 and subsequently mothballed, basically complete, at Belfast, Northern Ireland, in 1946.

HMCS **Bonaventure** *recovers one of its early complement of anti-submarine CS2F-1 Trackers. The new angled-deck allowed landings to take place while inactive aircraft remained stored on the forward deck. The two sets of catapult chocks are visible to the right of the parked aircraft.* (DND)

The main argument against acquiring the *Powerful* was its short, straight flight deck of only 680ft (207m) and relatively slow speed, both of which placed restrictions on the use of the newly-emerging naval fighter jets and on the RCN's ability to deploy an effective air group of anti-submarine aircraft, helicopters and protective fighters. Nevertheless, British connections prevailed and the Canadian cabinet approved the $21 million purchase and refit of the *Powerful* on April 23, 1952. To partially address the size limitations, the RCN had the carrier completed with an angled deck, canted approximately 8° to port, and a newly-developed steam catapult to replace the original hydraulic system.

As the refit of the *Powerful* progressed at Belfast, the Canadian government and RCN began selecting a more modern complement of ASW and protective fighter aircraft to replace the Avengers and Sea Furies. The new S2F Tracker was the clear choice for the submarine seek-and-destroy role — the Fairey Gannet was the other main contender. The limited deck space restricted fighter selection to a straight-winged type, the Navy purchasing 39 rather weary former US Navy McDonnell F2H-3 Banshees.

The Navy received approval to procure 100 CS2F Trackers and the Department of Defense Production selected de Havilland Aircraft of Canada (DHC) Limited of Downsview, Ontario as the prime manufacturing contractor in April 1954. An elaborate subcontracting plan required a wide range of Canadian companies to provide assemblies such as fuselage sections, wings, nacelles, landing gear and other components while Pratt & Whitney Canada was to build 300 1,525hp (1,138kW) R-1820-82WA Cyclone engines under licence from Curtiss-Wright.

Grumman provided the necessary production jigs and fixtures, but since the Canadian Tracker programme was relatively small with a large number of subcontractors, de Havilland determined that there would be advantages to acquiring a pattern aircraft. The Canadian government therefore approved the purchase of a Grumman-built S2F-1 as one of the 100 that would eventually be supplied to the RCN. This pre-production 'prototype' proved to be invaluable, both as a template for comparing Canadian-built components and assemblies with Grumman originals and as a test platform for new anti-submarine systems and avionics. (See boxed-off panel for further details of the two Grumman-built Trackers used in Canada.)

The 99 Trackers actually manufactured by DHC consisted of 42 CS2F-1s (confusingly allocated RCN serials 1502 to 1543 for c/ns DH-1 to DH-42) and 57 CS2F-2s (serialled 1544 to 1600 for c/ns DH-43 to DH-99). First to fly was CS2F-1 1503, crewed for the 15 minute flight by company test pilots George Neal and Tony Verrico at Downsview on May 31, 1956.

The Canadian Trackers were externally identical to their early American-built S2F-1 cousins, with the exception of various antennas, and featured the early flat-topped rear engine nacelle with square-cut aft ends; later Grumman-built aircraft were given a more elegant and aerodynamic curved rear nacelle structure with a distinctive 'hawkbill' fairing over the sonobuoy ejection tubes. The Navy took delivery of its first CS2F-1 Tracker, 1502, at the Navy's main shore base HMCS Shearwater, Halifax, Nova Scotia on October 13, 1956, following a delivery flight from Downsview conducted by Lt Cdrs Doug Ross and Roy de Nevers. The type officially came on strength on January 8, 1957 with ASW squadron VS 881 receiving its first Tracker on February 7, 1957.

In the meantime the newly-launched HMCS *Bonaventure*, as the former *Powerful* was now named (appropriately, after an island bird sanctuary), had been commissioned in Belfast on January 17, 1957. To confirm its readiness for delivery to Canada, four aircraft operated by test and evaluation squadron VX 10, Trackers 1502 and 1506 (coded '703' and '704') and Banshees 126381 and 126469 ('700' and '702'), were flown from Canada to RNAS Ford in the UK to undertake carrier flight trials in the English Channel.

The first touch-and-go was performed during the morning of April 2 by Cdr *Pop* Fotheringham in a Hawker Sea Hawk from Ford. Later that day a Fairey Gannet, also from Ford, made the first actual landing to conduct loading trials on the arrester wires and catapult, to be followed by Fotheringham in a Sea Hawk, Lt Cdr Sheldon Rowell in Tracker 1502 and Lt Cdr Ken Nicholson in 1506; the two Banshees landed the next day. The Trackers, Banshees and *Bonaventure* were then put through a very successful series of trials, at the end of which the carrier set course for Canada, arriving in Halifax harbour on June 24, 1957.

The first Tracker to join the RCN's second ASW unit, VS 880, was received in October 1957, the squadron conducting its last Avenger flight on December 13 of that year. Following retirement, many of the surplus Avengers were snapped up by Canadian specialist operators like Skyway Air Services and Hicks and Lawrence for forest fire control and aerial spraying operations. The final RCN Avenger flight took place on June 13, 1960.

VS 880's Trackers joined the *Bonaventure* in January 1959, undertaking pilot carrier qualification flights (*Carquals*) in February and March, and on July 7 VS 881 merged with VS 880, becoming the RCN's sole fixed-wing ASW squadron and the largest squadron in Commonwealth history with a complement of 24 operational CS2F-1s and 450 personnel including 75 pilots. All RCN Trackers during the *Bonaventure* era were shore-based at HMCS Shearwater, with the exception of a handful of non-ASW CS2F-1s detached to Patricia Bay in British Columbia for fleet support duties as radar targets and for coastal surveillance operations.

After completion of the 42 CS2F-1s, de Havilland switched production to the CS2F-2 with an improved MAD system, uprated radar and minor airframe refinements. The first of the 57 'Mk IIs', 1544, entered service with VS 880 in January 1960, the new variant replacing the CS2F-1 in front-line service. Seventeen CS2F-1s were subsequently modified by Fairey and transferred to the Netherlands for operation from the carrier HRMS

CS2F-2 Trackers of VS 880 being prepared for take-off on HMCS **Bonaventure** *in early 1962.* (Seth Grossmith)

Karel Doorman while the remaining 'Mk Is' were progressively relegated to training or utility roles.

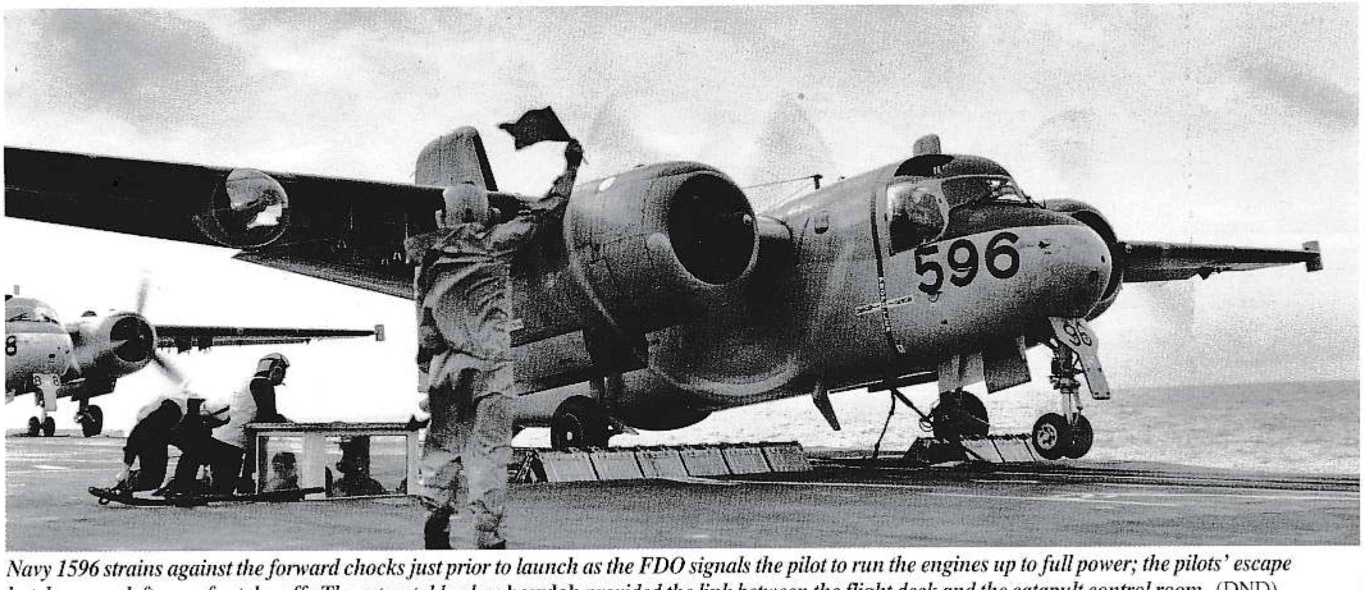
DH-57 Begins its Singular Career

The 57th Canadian Tracker (c/n DH-57) began its flying career as a typical CS2F-2 from the Downsview production line. Navy 1558 flew for the first time on November 5, 1959, crewed by de Havilland Canada Test Pilot Ted Johnson and observer Peter Tymchuk on a two hour 25 minute flight; Tony Verrico and Johnson conducted two further test flights on November 17 and 25 respectively, totalling a further two hours and 25 minutes. The RCN's resident VX 10 acceptance pilot, Lt Joe Sosnkowski, subsequently evaluated the new Tracker over six acceptance flights between December 4, 1959, and January 11, 1960, totalling 6.6 flight hours, the aircraft departing for HMCS Shearwater three days later. As de Havilland's ability to meet the RCN's production standards increased, the acceptance requirements were reduced to just one or two flights.

During the next month, 1558 served with utility squadron VU 32, being used to conduct 'Mk II' pilot training as well as to provide gunnery, radar and communications calibration support services during the work-up of the *Bonaventure*. Navy 1558 then joined operational squadron VS 880 on February 26, 1960 to begin her ship-borne anti-submarine duties. As it turned out, this was to be only the first of several distinguished and demanding careers.

Design for a Life at Sea

Aircraft design is always a compromise between mission requirements such as range, speed, endurance and payload, and opposing constraints such as weight, configuration, powerplant performance and cost. This is especially true for carrier aircraft since every aspect of ship-borne operation conspires to make the designer's task nearly impossible. Naval aircraft are required to be abruptly launched by catapult; violently retrieved onto a small,



Navy 1596 strains against the forward chocks just prior to launch as the FDO signals the pilot to run the engines up to full power; the pilots' escape hatches were left open for take-off. The retractable glass **howdah** *provided the link between the flight deck and the catapult control room.* (DND)

Heavily-loaded CS2F-2 1592 taxies tail-low towards the* Bonaventure*'s catapult. The hold-back cable, visible behind the tail bumper, was designed to fracture with the aircraft at full power and with sufficient tension from the catapult. This aircraft was lost on February 16, 1969, when the launch bridle failed during the launch, sending the luckless Tracker over the bow before reaching flying speed. The crew, including the co-pilot who passed through the ship's propellers, was rescued by the Sikorsky HO4S plane-guard. (Seth Grossmith)

often pitching surface; and to fit within the confines of a crowded deck and the aircraft lift to the hangars below. The anti-submarine aircraft must have sufficient endurance to complete a mission lasting several hours, be able to manoeuvre safely at low level, and carry enough equipment and ordnance to detect, track and destroy an invisible target.

At a time when Grumman's swept-wing F9F-8 Cougar jet fighter had already entered US Navy service, the new piston-engined Tracker must have appeared rather unglamorous, even dated. However, despite the more pedestrian nature of its mission and the many design constraints, Grumman succeeded in producing a remarkably compact, tough and manoeuvrable airframe that satisfied all operational requirements and that has since shown a remarkable facility for adapting to new operational demands.

From the pilot's perspective, the Tracker was an almost ideal platform for the anti-submarine role, offering an outstanding field of view from the cockpit, aided by large bubble side windows and transparencies in the overhead escape hatches, and great agility when tracking evading submarines. To conserve precious cockpit space the engine, flap and undercarriage controls were mounted in an overhead quadrant, the Tracker pilot striking a distinctive hand-hanging-on-the-throttles profile.

The two ASW systems operators sat facing forward in a cramped compartment immediately behind the cockpit bulkhead and spent most of their time in the dark, interpreting read-outs and print-outs from the various anti-submarine magnetic and electronic devices. The lower fuselage below and behind the operators was divided into two halves with the torpedo bay located on the port side — with racks of electronic equipment located on top and to the rear — and a walkway leading aft on the starboard side with crew access through a side door.

The Tracker was given a high aspect ratio wing for long range and endurance though this posed potential difficulties in accommodating the aircraft on the deck and the lift. The solution was to angle the wing-fold hinge lines outboard of the engine nacelles resulting in the wings overlapping when stowed, the right wing folding in front of the left. The wing centre section was of very heavy construction to absorb the high carrier landing loads and consisted of a normal torsion box with a front and rear spar but with double upper and lower skins sandwiching a rolled corrugated section. The folding outer wing sections were built differently, with spars fabricated from a combination of webs and vertical and diagonal supports, and upper and lower skins attached to a series of span-wise stringers; these in turn tied into the complex system of 16 wing-lock fittings at the wing-fold line.

To achieve the required low approach and manoeuvring speeds, Grumman engineers gave the Tracker a generous flap area comprising over 80% of the wing trailing edge. This left room for only small ailerons which were augmented by nearly 13ft (4m) of perforated spoiler that arced upwards from two slots in the upper side of the down-going wing during a turn. The wing also featured a fixed leading edge slot near each tip, the whole combination giving the Tracker exceptional turning and low speed capabilities with a stall speed of only 70kts (130km/h) with full flap, approach power and at the maximum landing weight of 24,500lb (11,113kg).

Without the benefit of folding nose or tail structures, the Tracker was of necessity a short-coupled design with a large vertical empennage to provide adequate directional stability. However, even the generous fin and rudder combination could not provide sufficient directional control in the event of an engine failure. Grumman's solution was the innovative Single Engine Rudder Assist (SERA, pronounced 'Sarah'), a two-section directional trimming and control surface attached to the vertical stabiliser.

The rearmost surface, with an additional servo tab, functioned as a normal mechanically-actuated rudder for cruise flight. The section closest to the fin had two purposes: a rudder trimmer driven by an electric screw

CS2F-2 1592 just prior to start-up aboard HMCS* Bonaventure*. Note the hold-down chains and the plucky chock-man laying beside the starboard mainwheel. The aircraft carries air-droppable life raft canisters on each of its centre underwing pylons. (Seth Grossmith)

jack for normal flight and a hydraulically-driven power assist system for the critical approach and take-off phases. With the SERA system selected, the rudder and rudder trimmer acted together to produce an impressive sweep of approximately 40° each side, enabling the Tracker to achieve a minimum control speed with one engine failed of only 85kts (158km/h). The rudder also featured an unusual T-shaped trailing edge which effectively increased the width and therefore the effectiveness of the vertical control surface.

A further interesting control feature was the use of a spring link between the retractable tail bumper and the elevator control circuit. Lowering the heavy undercarriage had the potential of creating a large forward shift in the centre of gravity, causing a marked nose-down trim change and effectively reducing the pitch control range. The spring device counteracted this undesirable characteristic by providing an automatic nose-up trim change without control input from the pilot, thereby maintaining full nose-up elevator travel for the demanding carrier approach and landing.

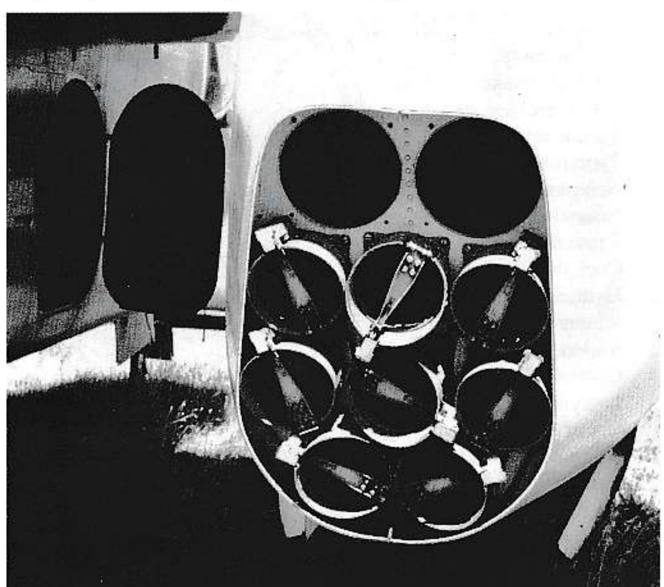
While employing mostly conventional construction methods, Grumman made extensive use of spot welding on the Tracker to join the aluminium skin to the internal structure. This method dramatically reduced the labour required by drilling and riveting but also provided a foothold for corrosion in the marine environment by removing the skin cladding at the welds, a situation that was to cause future Tracker operators some concern and additional work.

Perhaps the Tracker's least endearing characteristic was the noise from its nine-cylinder, single-row Wright R-1820 piston engines. Though extremely reliable and easy to maintain, they produced substantial noise through their short exhaust stacks and considerable vibration; it was said that if only half of the noise could be turned into thrust, the Tracker would be supersonic!

Sub Hunting

Hunting a submarine is a cat-and-mouse game. While the unseen prowler below tries to sink the vital convoy's cargo ships with torpedoes or missiles, the fleet's surface and airborne ASW resources work to ensure

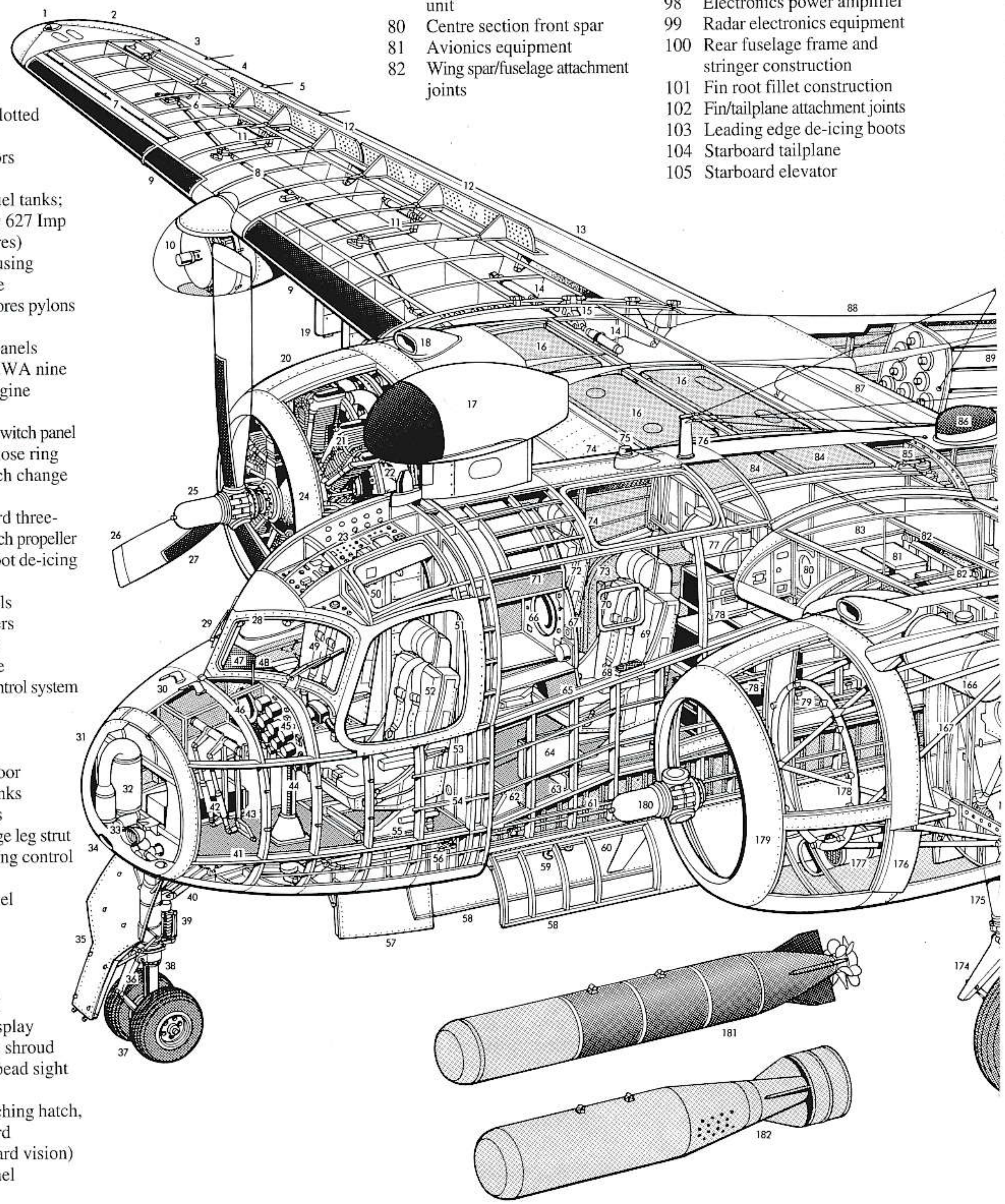
Rare shot of CS2F-2 Tracker 1558 captured in its element on March 6, 1963 during a five-aircraft Joint Maritime Warfare School (JMWS) Operational Team Training detachment to Bermuda. The rectangular store on the central wing pylon is a long-burning smoke float, used to mark personnel requiring rescue. The loops visible on the MAD head housing are eddy current compensator coils, added to counter the various magnetic fields induced by the Tracker in flight. (DND)



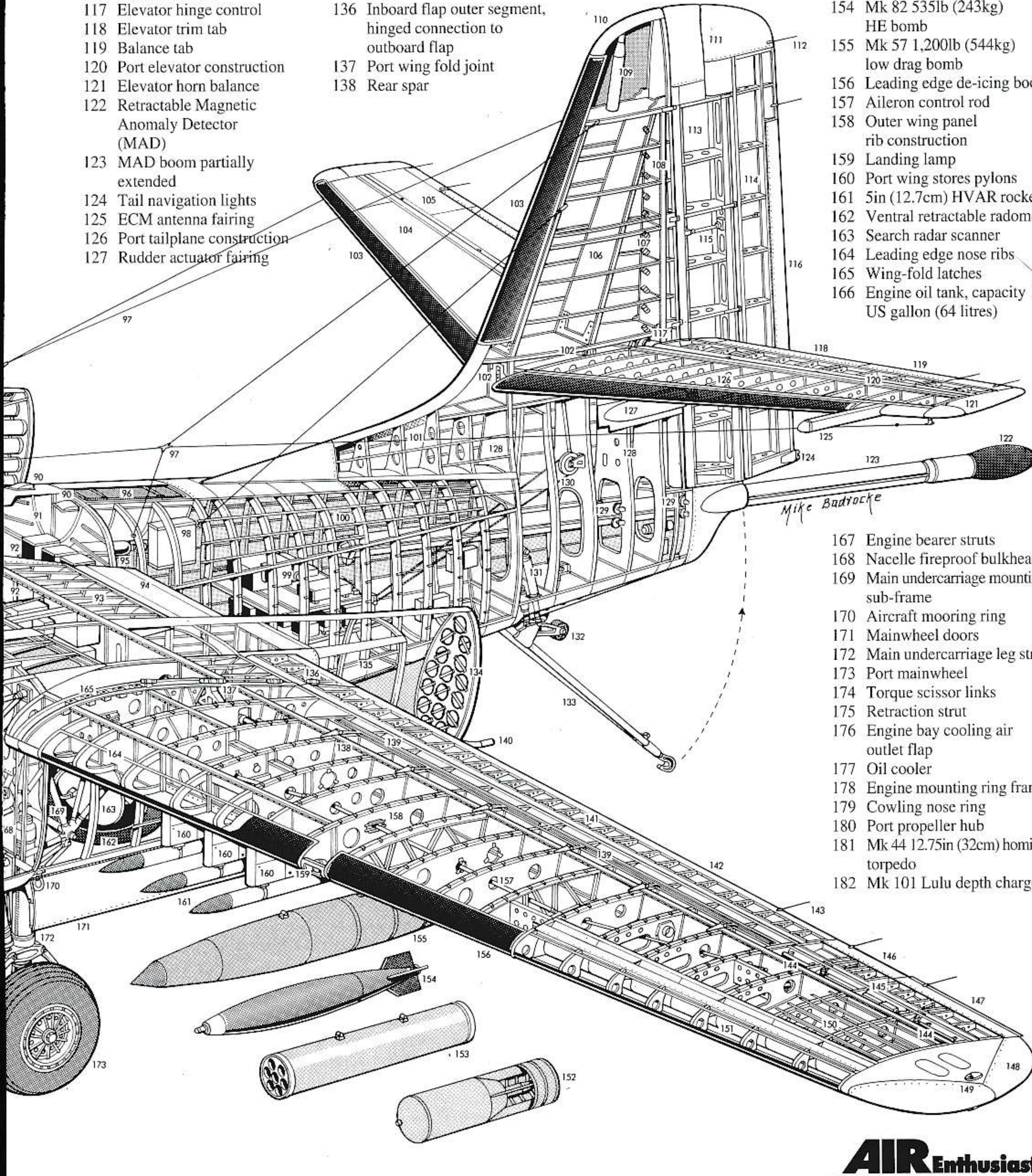
Sonobuoy ejector tubes in the rear of the starboard engine nacelle; the two upper tubes were not used in Canadian service. The crew entrance door is visible to the left. (Author)

Grumman S2F-1 Tracker

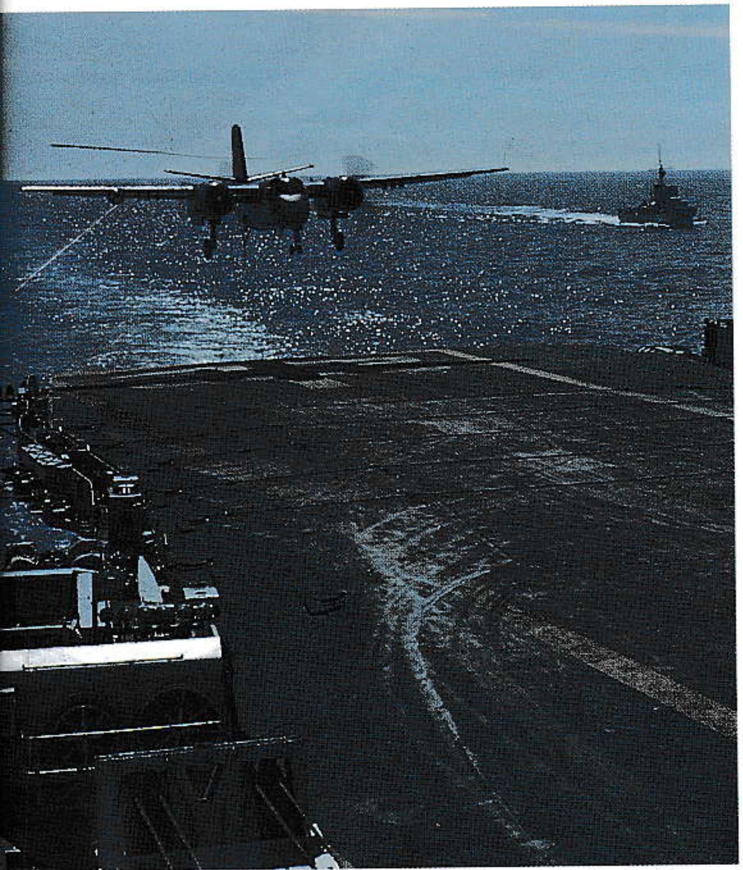
1 Starboard navigation lights
2 Wing tip ECM fairing
3 Starboard aileron
4 Aileron tab
5 Static dischargers
6 Aileron hinge control
7 Fixed leading edge slot
8 Aileron and spoiler control rods
9 Leading edge de-icing boots
10 Steerable searchlight, 85 million candlepower
11 Spoiler actuators
12 Starboard spoiler panels, open
13 Outboard single slotted Fowler-type flap
14 Wing fold actuators
15 Hinge link
16 Starboard wing fuel tanks; total fuel capacity 627 Imp gallons (2,850 litres)
17 ECM antenna housing
18 Carburettor intake
19 Starboard wing stores pylons (three)
20 Engine cowling panels
21 Wright R1820-82WA nine cylinder radial engine
22 TACAN aerial
23 Cockpit overhead switch panel
24 Engine cowling nose ring
25 Propeller hub pitch change mechanism
26 Hamilton Standard three-bladed variable pitch propeller
27 Propeller blade root de-icing boots
28 Windscreen panels
29 Windscreen wipers
30 Pitot heads (two)
31 Hinged nose cone
32 Environmental control system equipment
33 Taxiing lamp
34 Fresh air intake
35 Nosewheel leg door
36 Torque scissor links
37 Twin nosewheels
38 Nose undercarriage leg strut
39 Nosewheel steering control
40 Retraction strut
41 Cockpit floor level
42 Hydraulic brake accumulators
43 Rudder pedals
44 Control column
45 Instrument panel
46 Cockpit radar display
47 Instrument panel shroud
48 Pilot's ring and bead sight
49 Co-pilot's seat
50 Cockpit roof ditching hatch, port and starboard
51 Bulged (downward vision) side window panel
52 Pilot's seat
53 Cockpit rear bulkhead
54 Cockpit section framing
55 Adjustable seat mounting
56 Underfloor control linkages
57 Nosewheel doors
58 Weapons bay doors
59 Centre-line catapult strop hook
60 Crash barrier hook
61 Underfloor weapons bay, port side only
62 Footrest
63 Sloping cabin floor section
64 Chart case
65 Fuselage main longeron
66 Radar operator's display
67 Radar control panel
68 Internal step
69 Radar operator's seat
70 Cabin window panel
71 Instrument and display consoles
72 MAD operator's seat
73 Starboard side crew entry door
74 Ditching hatch, port and starboard
75 Anti-collision light
76 Aerial mast
77 Hydraulic reservoir
78 Avionics equipment racks
79 Torpedo carrier and release unit
80 Centre section front spar
81 Avionics equipment
82 Wing spar/fuselage attachment joints
83 Port wing fuel bay tanks
84 Centre section fuel tanks
85 Central flap drive unit
86 D/F loop aerial
87 Starboard inboard flap segment
88 Nacelle tail fairing
89 Sonobuoy launch tubes (16)
90 Avionics equipment cooling air inlet ducts
91 Cabin rear bulkhead
92 Aft avionics racks
93 Flap shroud ribs
94 Port inboard flap segment
95 Life raft inflation bottle
96 Life raft stowage
97 HF aerial cables
98 Electronics power amplifier
99 Radar electronics equipment
100 Rear fuselage frame and stringer construction
101 Fin root fillet construction
102 Fin/tailplane attachment joints
103 Leading edge de-icing boots
104 Starboard tailplane
105 Starboard elevator



106 Tailfin construction
107 Vortex generators
108 Sternpost
109 Duplex antenna
110 Fin tip aerial fairing
111 Rudder horn balance
112 Static dischargers
113 Auxiliary fore rudder
114 Main rudder construction
115 Trim tab control
116 Rudder trim tab
117 Elevator hinge control
118 Elevator trim tab
119 Balance tab
120 Port elevator construction
121 Elevator horn balance
122 Retractable Magnetic Anomaly Detector (MAD)
123 MAD boom partially extended
124 Tail navigation lights
125 ECM antenna fairing
126 Port tailplane construction
127 Rudder actuator fairing
128 Tail assembly attachment main frames
129 MAD boom roller guides
130 Elevator cable control
131 Arrester hook jack and damper
132 Retractable tail bumper
133 Deck arrester hook
134 Port nacelle sonobuoy launchers
135 Rear fuselage ventral access hatch
136 Inboard flap outer segment, hinged connection to outboard flap
137 Port wing fold joint
138 Rear spar
139 Port spoiler housing
140 Fuel vent
141 Flap rib construction
142 Port outboard Fowler-type flap
143 Static dischargers
144 Aileron balance weights
145 Port aileron construction
146 Aileron trim tab
147 Spring tab
148 Wing tip ECM aerial fairing
149 Port navigation lights, above and below
150 Wing stringers
151 Fixed leading edge slot rib construction
152 Mk 54 350lb (159kg) depth charge
153 LAU-32B/A rocket launcher, seven 2.75in (7cm) rockets
154 Mk 82 535lb (243kg) HE bomb
155 Mk 57 1,200lb (544kg) low drag bomb
156 Leading edge de-icing boot
157 Aileron control rod
158 Outer wing panel rib construction
159 Landing lamp
160 Port wing stores pylons
161 5in (12.7cm) HVAR rockets
162 Ventral retractable radome
163 Search radar scanner
164 Leading edge nose ribs
165 Wing-fold latches
166 Engine oil tank, capacity 17 US gallon (64 litres)



167 Engine bearer struts
168 Nacelle fireproof bulkhead
169 Main undercarriage mounting sub-frame
170 Aircraft mooring ring
171 Mainwheel doors
172 Main undercarriage leg strut
173 Port mainwheel
174 Torque scissor links
175 Retraction strut
176 Engine bay cooling air outlet flap
177 Oil cooler
178 Engine mounting ring frame
179 Cowling nose ring
180 Port propeller hub
181 Mk 44 12.75in (32cm) homing torpedo
182 Mk 101 Lulu depth charge

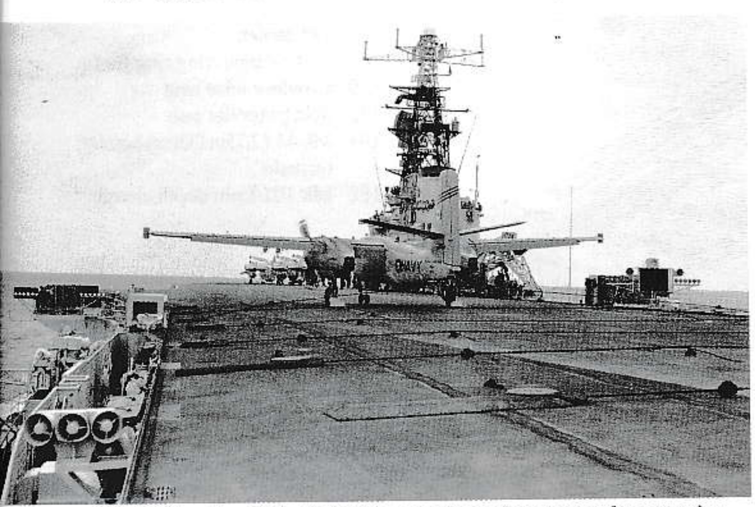


Tracker 1532 of VX 10 makes a textbook approach while the plane-guard destroyer stands by. The source lights for the primary Mirror Landing System are visible to the right. (Seth Grossmith)

safe passage of the vessels and, if possible, destroy the deadly intruder. It is a complex task that requires constant practise.

The RCN's Trackers operated from the *Bonaventure* in the deep water anti-submarine role, part of a 'hunter-killer' team that included Canadair Argus long-range patrol aircraft (LRPs, see page 74), surface ships, ship-borne helicopters and escort submarines. The LRPs patrolled well ahead of the fleet while the Trackers operated at a range of 100 to 150 miles (160 to 240km), meanwhile the Sikorsky HO4Ss and, from May 1963, Sikorsky CHSS-2 Sea Kings, provided the close-in ASW capability. The *Bonaventure* normally carried a complement of 12 Trackers and up to four were airborne on task around the clock during the frequent NATO exercises, invariably under the watchful eye of thinly disguised Soviet 'trawlers' toting elaborate aerial arrays.

The CS2F-2 Tracker carried a formidable array of anti-submarine



CS2F-2 Tracker 1570 of VS 880 comes to an abrupt stop after engaging **Bonaventure***'s number five wire. The original stand-by Mirror Landing System is visible on the right side of the deck while the newer primary Fresnel system, installed during the 1967 refit, is seen on the left. This Tracker was written off on September 20, 1973.* (DND)

systems including the *Jezebel* long range, low frequency passive underwater listening system; the *Julie* medium range active detection system; an AN/ASQ-8 magnetic anomaly detector (MAD) mounted at the end of a retractable tail boom; and a smoke marker ejector system, all managed by the third operator on the port side; a retractable AN/APN-59 antenna and radar system (replacing the AN/APS-38 of the CS2F-1) and wing-tip UPD-501 radar emission detectors, monitored by the fourth operator on the starboard side; and 16 AN/55Q-2B sonobuoys housed in ejector tubes in the rear of the engine nacelles and a 70 million candlepower AN/AVQ-2C carbon arc controllable searchlight located on the leading edge of the starboard wing, each under the control of the co-pilot.

A typical anti-submarine operation began with a catapult launch from the deck of the *Bonaventure*, a confined, potentially dangerous place measuring only 107ft (32.6m) at its widest point. After a detailed briefing, the crews boarded their aircraft and following start-up, each pilot cautiously taxied in turn towards the first set of safety chocks on the catapult. After attachment of the steel wire launch bridle and hold-back cable by the deck crew, the pilot released the brakes, allowing the aircraft to idle forward to the second set of chocks. The catapult was then tensioned, pulling forward on the bridle while the hold-back restrained the aircraft in a nose-high launch position. The pilot had meanwhile prepared his aircraft for take-off with 2° nose down elevator trim, two-thirds flap, SERA 'on' and roof hatches open.

When the Flight Deck Officer (FDO) signalled that the aircraft was ready for launch, the pilot applied full power with his right hand, clasping the overhead throttles and a T-shaped catapult grip together to counter the sudden acceleration while holding the control column neutral with his braced left arm. Satisfied that the engine temperatures and pressures were normal, the pilot announced: 'Yes-yes-yes', thrust his head back into his headrest and waited while the co-pilot gave the 'ready' salute to the FDO. After what could seem like an eternity, but was at most only a couple of seconds, the forward chocks retracted, the hold-back fractured and the Tracker surged forward. The BS-4 steam catapult provided a smooth 3.5g acceleration, boosting the Tracker to a single-engine safety speed of 105kts (195km/h) as the pilot applied forward pressure on the control column to counter a strong nose pitch-up. Once airborne, the crew checked the various ASW systems prior to arriving at the search area.

The CS2F Tracker was equipped with, for its day, a very advanced autopilot, the Bendix PB-20 Automatic Flight Control System (AFCS). The system, evaluated by VX 10 between 1957 and 1960 under RCN Project Directive 15, was designed for 'hands off' control of the aircraft from beginning the take-off roll until levelling off at a selected altitude. The PB-20 allowed the CS2F to be operated safely in minimal weather conditions, on land and at sea, and provided both an ILS automatic landing and catapult launch capabilities. The 'Cat Launch' mode could maintain control of the aircraft following an engine failure while the pilot concentrated on raising the undercarriage and flaps and feathering the propeller on the faulty powerplant; this was a potentially very useful capability in bad weather or at night but in practise was never popular with the Tracker crews. The flight test programme took place at both HMCS Shearwater and NAS Patuxent River and was led for the RCN by Lt Cdr Bert Mead of VX 10. Trials aircraft included 1503, 1504, 1505, 1507, 1544, 1545, 1546, 1549, 1573 and 1574; Tracker 1558 also undertook at least one PB-20 trials flight.

The first action on arrival over a potential submarine location was for the co-pilot to eject a pattern of sonobuoys from the rear of the engine nacelles. The pilot then orbited the search area while the two systems operators analysed print-outs of frequency scans from the *Jezebel* long range detection system; these would indicate any tell-tale engine, propeller or shaft noises captured and transmitted by the sonobuoys. This was the beginning of a slow-paced, deliberate game; suspecting that there was a submarine nearby and finding it were two very different things and for the moment the submarine had the advantage.

If a submarine was using its radar to detect the surface forces, the Tracker's wing-tip ECM *cans* would pick up the transmissions and the fourth operator would try to distinguish a bearing to the submarine from other radar 'noise'. The submarine commander therefore had only a few seconds to use his radar before being detected and his periscope was always vulnerable to visual and radar detection. On the other hand, the Tracker crew could only use their radar briefly or risk revealing their patrol routeing.

Once a contact was made, the co-pilot dropped additional sonobuoys to help better define the search area; he also called the surface ships, warning them to turn to avoid the area and requesting the assistance of a destroyer with an ASW Sea King. The systems operators now took control of the search, vectoring the helicopter to a prime search location where the

CP-121 12155 photographed from a Canadair CP-107 Argus near CFB Trenton on August 31, 1972, wearing the Canadian Armed Forces' overall light grey-green scheme. Though Canada no longer operated its own carrier, the remaining front-line Trackers retained their full complement of systems for in-shore ASW operations until December 1973. (Larry Milberry)

crew used their dipping sonar from the hover. For the Tracker crew the passive search turned to active localisation as the they used their *Julie* system to pin-point the suspected submarine's exact position.

After ejecting a further series of sonobuoys, the crew systematically bombed the search area with Mk 15 practise depth charges (PDCs), stored in 15-unit dispensers on the outboard side of each engine nacelle. The noise from each explosion acted like a sonar pulse and was picked up by the sonobuoys after bouncing off the target. One echo would locate the target somewhere on the circumference of a range ring around a sonobuoy, two echoes would indicate either of the two points where two range rings intersected, and three echoes would fix the suspected submarine's position exactly; the Doppler effect would indicate if the target was moving towards or away from each sonobuoy.

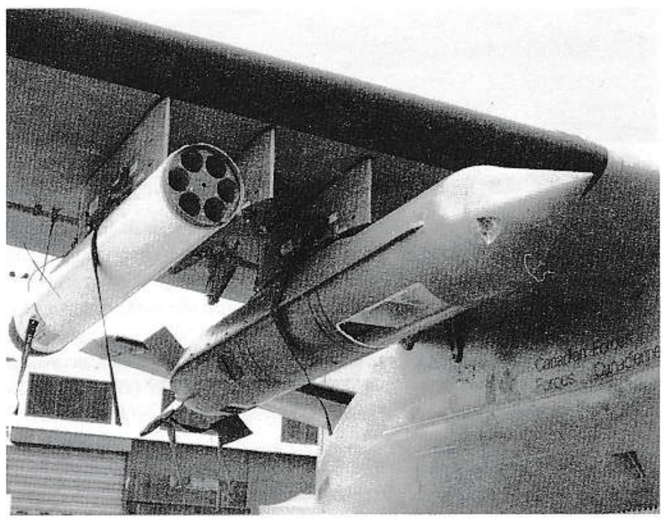
The next step was to ensure that the target was indeed a man-made vessel rather than a whale or school of fish. The tail-mounted magnetic anomaly detector (MAD) system confirmed that the contact was a submarine by indicating the slight variations in the Earth's magnetic field caused by its steel hull. The MAD system had an effective separation range of only 1,500ft (457m) between the aircraft and the submarine but gave a very good indication of a positive contact.

At the moment the pen trace from the MAD system displayed the strongest contact signature, its operator fired the retro-ejector. This cannon-like device installed within the lower starboard fuselage used compressed air to propel a short-burning smoke float rearwards at the same velocity as the aircraft's forward groundspeed; the groundspeed was set by the co-pilot on a rotary air pressure controller calibrated in knots. Since the speed of the Tracker and the projectile were the same, the smoke float dropped vertically from the aircraft to the surface, providing an aiming point for munitions at the last known target location.

The manoeuvrable Tracker was an excellent platform for tracking any evasive action taken by the submarine and pilots became very comfortable making 45° banked turns down to only 50ft (15m) above the water. During exercises the Tracker crew dropped practise depth charges on the submarine to indicate it had been detected. In wartime, the submarine would have received the *coup de grâce* from a Mk 43 or later model acoustic homing torpedo, two of which were carried in the torpedo bay with up to four more mounted on the wing pylons. Depth charges were no longer used since they had to detonate within 10ft (3m) of the submarine to be effective. Because of their versatile detection capability, the RCN Trackers were often used to assist destroyers and helicopters with practise weapons delivery (*Vectacs* or vectored attacks) and contact verification (*Madvecs* or MAD verification).

The operation complete, each Tracker returned to the *Bonaventure* for landing. This could take place in all weathers, day or night, after several hours of intensive flying but fortunately the weary Tracker aviator had two devices to help him make a safe carrier landing.

The Mirror Landing System consisted of a highly-polished curved aluminium surface with source lights located approximately 170ft (52m)



CP-121 Tracker 12161 of MR 880 equipped with a day-night photo pod and a CRV-7 rocket pod. The photo-flash system featured with a forward strobe flash and vertical and oblique 72mm cameras to the rear. (Terry Panopalis)

The IMP Group converted a single CP-121 Tracker to turboprop configuration based on the P&WC PT6A-67AF. The flared forward nacelle for the R-1820 'round' engine remained unmodified so the aircraft could be converted back to piston-engined configuration, resulting in the generous cowling. The Tracker's two-door port-side torpedo bay is shown to advantage. (IMP Group)

CP-121s of MR 880 at CFB Summerside during the type's 'close-out' in March 1990 wearing the Tracker's final overall mid-grey, low-visibility paint scheme. The imposing structure to the rear is the former CP-107 Argus 'alert barn'. (Jeff Rankin-Lowe/SIRIUS)

in front of the mirror; there was one set on each side of the deck, the starboard unit being a stand-by system. The lights converged to form an orange ball of light, known as the 'meat ball', which lined up with horizontal green reference lights when the pilot was on the correct glidepath; the system was gyro-stabilised for deck pitching though not for rolling. The pilot was responsible for lateral line-up and red lights mounted on top of the mirror indicated when the pilot should abandon the approach (a 'wave off'). The port mirror was replaced by the much improved Fresnel lens system during the *Bonaventure's* 1967 refit.

The other landing aid was the Safe Flight speed control indicator, mounted on the instrument panel shroud ahead of the pilot. The system gave an indication of the correct airspeed and proximity to the stall in terms of angle-of-attack, allowing the pilot to make a heads-up approach with his right hand on the overhead throttles. The approach was flown at around 87kts (161km/h), depending on aircraft weight, giving the pilot good control, an excellent view of the carrier deck and the correct attitude for the unflared landing.

The *Bonaventure's* Mk 12 constant run-out arrester gear was designed for a 20,000lb (9,072kg) aircraft landing at 105kts (195km/h) and landing deceleration for the Tracker ranged between 1.3 to 1.8g from wire engagement speeds of 59 to 67kts (109 to 124km/h). On touchdown, the pilot closed the throttles but stayed prepared to apply full power in case the hook failed to engage a wire or a failure occurred and the aircraft had to go around; catching the last wire (No 6) presented the flight crew with the unnerving sensation of abruptly stopping only 20ft (6m) from the end of the deck. The flight and deck crews became very proficient at retrieving and clearing the aircraft and routinely achieved landing rates of one aircraft every 30 seconds.

While the Navy had been able to comfortably operate its Trackers from the Canadian carrier, the *Bonaventure* had proved to be too small for jet operations. The policy decision to do away with fighter aircraft in favour of a Sea King acquisition, combined with a high loss rate and metal fatigue problems, resulted in first VF 871 and later VF 870's Banshees being retired from service. By September 1962 the *Bonaventure* had became a pure ASW carrier with a complement of Trackers and helicopters.

'Mk III' Upgrades and the End of the *Bonnie*

The final Canadian Tracker, CS2F-2 1600, flew for the first time on October 17, 1960, piloted by George Neal and was accepted by the RCN on October 28. Two years later the Navy began to consider a second upgrading of the Tracker's avionics and weapons systems. Consideration was given to a variety of new equipment and VX 10 was tasked with undertaking several trial installations.

VX 10 staff recognised that adding yet more equipment within the confines of the relatively small Tracker would be a challenge and therefore instigated a study under Project Directive (PD) 111 to first rationalise the cockpit and rear cabin layouts for the existing and proposed equipment. With the study complete, the squadron initiated the reconfiguration to 'Mk III' standards under PD 26.

The heart of the new CS2F-3's improved anti-submarine capability was the Anti-Submarine Warfare Tactical Navigation System (ASWTNS), an electro-mechanical navigational and tactical display system developed by VX 10 from the American *Julie* Attack and Search Plotter (JASAP) to solve ASW plotting, display and tactical co-ordination problems. The system's analogue computer resolved the various automatic inputs from the on-board submarine search, localisation and tracking devices — radar, ECM, *Julie* and MAD — and the manual inputs by the systems operators to give a pictorial display of the navigational and tactical situation. The system was designated AN/ASN-501 in Canadian service and was subsequently introduced by the US Navy as the AN/ASN-30; the system is still in use on the Canadian Armed Forces' Sea King helicopters.

Other changes for the CS2F-3 included the addition of the AN/APN-503 Doppler set, which provided precise track deviation and groundspeed inputs for the ASWTNS, and improved *Jezebel* and *Julie* ASW sensors. Among the items deleted was the retro-ejector smoke marker system, no longer required since the crew could now 'fly' directly to a target marker on the co-pilot's ASWTNS display.

Technicians created mock-ups of the various circuits and panels — many were fabricated in a residential basement — and the assemblies were then passed to Fairey, who had facilities on the Shearwater base, for final design, fabrication and installation and testing in trials CS2F-1 1507. Once accepted by the Navy, Fairey converted 45 CS2F-2s to CS2F-3 configuration with the first aircraft, 1552, completed on July 18, 1966 and the last, 1555, on April 19, 1968.

Meanwhile, the extra equipment and a requirement to increase endurance through the addition of a 125 Imp gal (568 litre) jettisonable torpedo bay tank meant that the Tracker's gross weight of 24,500lb (11,113kg) needed to be increased by 1,500lb (680kg).

Tracker 1558 had served with VS 880 in the deep water anti-submarine role from February 1960 until September 1964. Following a period of maintenance, the RCN allocated 1558 to VX 10 on April 3, 1965, for test purposes including the flight trials for the weight upgrade programme (PD153) and long-range fuel tank jettison trials (PD67/12).

Since most of the weight upgrade issues centred around carrier suitability, VX 10 flew 1558 to the Naval Air Test Centre at NAS Patuxent River in early October 1966, for instrumentation following mock-up to 'Mk III' configuration by Fairey. The Tracker was equipped with a calibrated pitot head, a yaw and pitch vane boom, an oscillograph (a light-tracing device used to measure flutter), accelerometers, strain gauges and a photo panel. To bring the aircraft up to 26,000lb (11,793kg), the aircraft was loaded up with one instrumented and one dummy Mk 44 torpedo, two weighted dummy underwing sonobuoy pods, a water-filled long range fuel tank and full wing fuel tanks. The test flights, flown by Lt Cdrs John Arnold and Bill Fuoco, began on November 23 with assessments of stalling characteristics, take-off performance, longitudinal stability and rate of roll.

After conducting single-engine performance tests back at HMCS Shearwater, Tracker 1558 returned to NAS Patuxent River and from February 14 to 24, 1967, Arnold and Fuoco undertook land catapult launches and arrests with the Carrier Suitability Test Branch. The trials were designed to quantify minimum control speeds, changes in drag, lateral and directional stability and the impact of the higher weights on the airframe. The landings included 25ft (7.6m) off-centre arrests, using a red rag attached to the wire as a target, with planned descent rates of up to 16ft (4.9m) per second. During the trials Fuoco demonstrated what many thought to be impossible; a single-engine wave-off at the new gross weight.

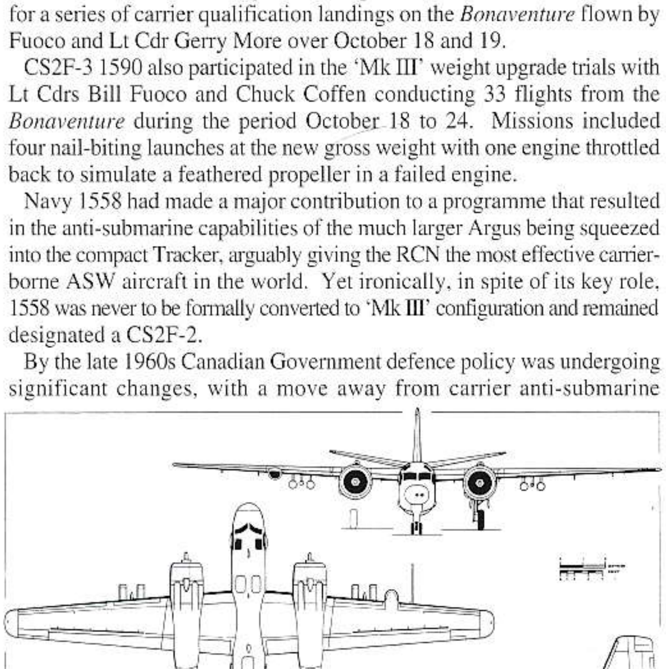
The aircraft returned to HMCS Shearwater on March 14 for additional testing under PD153 and from July 4 to 6 undertook the torpedo bay tank jettison trials. The trials showed that the tank tended to float around inside the bay with the doors open and since no one could come up with a workable jettison system, it was recommended that the tank not be used. However, crews were subsequently directed to carry the tank and fill it when required for extra endurance.

Arnold then flew 1558 to the No 6 Repair Depot at RCAF Trenton on July 7 for fault finding. With the exception of a sheared bolt in the port main undercarriage well (likely the result of one memorable 20ft/6.1m per second touchdown) and, perhaps not surprisingly, stretching of the arrester hook A-frame and distortion of the A-frame swivel assembly, the aircraft passed the rigorous inspection with a clean bill of health. To complete the 'Mk III' programme, 1558 was first flown back to the US to conduct 16 arrests aboard the US Navy's training carrier, USS *Lexington*, in the Gulf of Mexico between August 28 to September 1 and then back to Canada for a series of carrier qualification landings on the *Bonaventure* flown by Fuoco and Lt Cdr Gerry More over October 18 and 19.

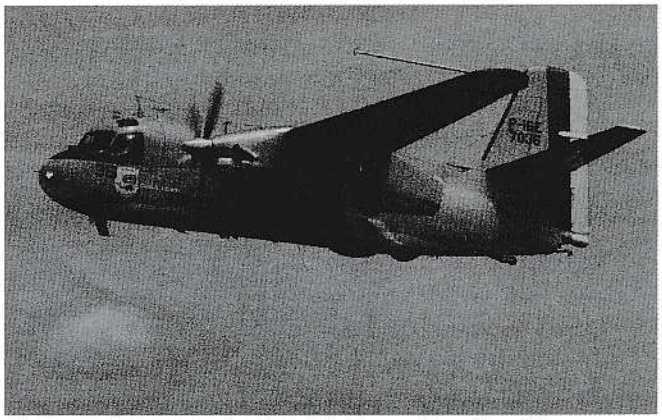
CS2F-3 1590 also participated in the 'Mk III' weight upgrade trials with Lt Cdrs Bill Fuoco and Chuck Coffen conducting 33 flights from the *Bonaventure* during the period October 18 to 24. Missions included four nail-biting launches at the new gross weight with one engine throttled back to simulate a feathered propeller in a failed engine.

Navy 1558 had made a major contribution to a programme that resulted in the anti-submarine capabilities of the much larger Argus being squeezed into the compact Tracker, arguably giving the RCN the most effective carrier-borne ASW aircraft in the world. Yet ironically, in spite of its key role, 1558 was never to be formally converted to 'Mk III' configuration and remained designated a CS2F-2.

By the late 1960s Canadian Government defence policy was undergoing significant changes, with a move away from carrier anti-submarine warfare to a new emphasis on helicopter-equipped destroyers plus a controversial decision to unify the armed forces. The government proclaimed the Canadian Forces Unification Act on February 1, 1968 and the RCN became part of the new Canadian Armed Forces (CAF).



Grumman S2F-1 Tracker. (© AIR Enthusiast 1996)



Grumman S-2E (P-16E) 7036 of the **Força Aéreo Brasileira** *following conversion by the IMP Group to turbine engine configuration. The FAB subsequently cancelled the programme to convert its fleet to P-16Hs.* (IMP Group)

These changes meant that HMCS *Bonaventure* was no longer required and Canada's carrier was retired, to be consigned to the scrap yard. This decision was received with much anguish by Canada's cadre of naval aviators who, though relatively few in number compared with their American and British colleagues, were unsurpassed in their aerial anti-submarine expertise. Carrier operational flying ceased towards the end of 1969 with the last Tracker landing taking place on December 12. Appropriately, the aircraft, CS2F-1 1532, was flown by Sheldon Rowell who had made the very first Tracker landing on the *Bonaventure* in the English Channel some 12 years earlier.

VS 880's Trackers were initially transferred from the deep water ASW role to land-based in-shore ASW operations, receiving new serials in the 12100 series on June 11, 1970 (1573, for example, became 12173), a new designation (CP-121) on July 27, and an overall light grey-green paint scheme. A further reallocation took place in December 1973 following the declaration of Canada's new 200 mile (320km) off-shore boundary. VS 880 Squadron — which became MR 880 with an attached Air Reserve unit, 420 Squadron — and utility squadron VU 33 went on to operate the Tracker in the sovereignty protection role, performing a wide variety of tasks that included fisheries, pollution, wildlife and ice patrols on the east, west and Arctic coasts. Upgrades for this surveillance role included new radar, communications and navigation systems, implemented in 1978, and the ability, from 1982, to carry up to 36 CRV-7 rockets in six underwing pods, giving the Tracker a surface vessel attack capability.

At one time it appeared that the CAF's Trackers would be given a longer lease of life through the installation of P&WC PT6A-67AF turboprops. However, a programme initiated by The IMP Group of Halifax was to result in only one prototype, CP-121 12185 (C-GTRT), flying from September 15, 1988, the government subsequently electing to retire the Tracker from the sovereignty role and turn the fisheries patrol element over to the private sector as part of defence budget cutbacks. IMP subsequently converted a prototype S-2E (P-16E) for the *Força Aéreo Brasileira* with 1,650shp (1,231kW) PT6A-67CF engines (redesignated P-16H) but this programme was also terminated following trials aboard the Brazilian carrier *Minas Gerais*.

The last CAF Trackers finally flew into retirement at CFB Comox on March 10, 1990 and CFB Summerside on April 4, 1990, some 34 years after the first flight of a Canadian-built S2F.

Meanwhile, with the *Bonnie* gone at the end of 1969, the Armed Forces had found itself with too many Trackers on strength and decided to dispose of a number of aircraft to the civilian market. Among those put up for sale was CS2F-2 1558, which had remained with VX 10 as an aircrew familiarisation trainer and utility transport following completion of the 'Mk III' weight upgrade trials in September 1967; her second career was about to begin.

The second part of *Willing Tracker* appears in the March/April 1996 *AIR Enthusiast*, published on February 2. The Author would be pleased to receive any photographs of Tracker 1558 during its RCN career.

Willing Tracker Article (AIR Enthusiast #61 and #62) - Corrections and Addendum

Part One

Page 41 ('X-500' section): Should read "Engineering Change Proposals (ECPs)"

Page 45 (rear nacelle photo caption): The two upper holes were in fact never fitted with "tubes" in Canadian service.

Page 46 and 47 (cutaway drawing): This is drawing of an "S2F-1" is actually something of a hybrid with the shorter nose section and ECM aerial of the S2F-1 and the rear nacelles, stabilizer and wingtips of the S2F-3. A few of the call-outs are also in error:

- 39: Shimmy damper (the Tracker did not have nose wheel steering)
- 116: Rudder servo tab
- 118: Elevator balance tab
- 119: Elevator trim tab
- 125: Vibration damper (a lead weight at the end of a hollow arm)
- 146: Aileron spring tab
- 147: Aileron trim tab

Page 48: The reference to the installation of the *Jezebel* long range listening system in the CS2F-2 and the subsequent installation of "improved *Jezebel*.....sensors" for the 'Mark III' (page 50) is in error. In fact *Jezebel* was only installed in the CS2F-3, as part of the 'Mark III' upgrade described on page 50. The description of the use of *Jezebel* on board a CS2F-2 on page 48 should therefore be disregarded and only applied to CS2F-3 operations. The 'Mark III' upgrade section should read "....and *Jezebel* and improved *Julie* sensors." Some CS2F-2s did have a *Jezebel* relay system which allowed the sonobuoy signals to be transmitted from the aircraft to the carrier for analysis. *Jezebel* required a large recorder, the AQA-5 in the case of the CS2F-3 Tracker.

Page 48: Should read "16 AN/SSQ-2B sonobuoys"

Page 48: The search was directed by the co-pilot — who was the aircraft's Tactical Coordinator — and not the systems operators. The co-pilot was responsible for all the on-scene control, coordination, direction and UHF communications. The operators managed the sensor equipment and any HF communication with a distant authority.

Page 50: The throttles were not closed until the pilot knew he had engaged a wire. This was very obvious because the lack of anticipated deceleration felt like the aircraft was accelerating.

Page 50: PD 26 is in error; it should read PD 153.

Page 51: The correct abbreviation for Canadian Armed Forces is CF, not CAF.

Page 51 (general arrangement drawing): This actually portrays the Grumman S2F-3 with its longer fuselage, longer-span horizontal stabilizer and rounded wingtips.

Part 2

Page 17: Ontario loses an average of 495,000 acres to wildfires each year rather than the "495" indicated.

Page 20: The Conair Firecat pictured is C-FOPV, formerly CS2F-1 1535 and OMNR tanker '55'.

Page 22: In the table, the COD Mk.I designation for DH-33 has migrated to the Mark column to the middle of the Civilian History column.

Page 24: The photo at the top of the page shows *DSC* Firecat 'T-1' under conversion to Turbo Firecat configuration in early 1995

Page 25: Alexander Linkewich and Bob Fowler are reversed in the photo of the Ontario certification crew.

Addendum

Item 60 in the cutaway, the 'Crash barrier hook', had an interesting genesis. Before the introduction of the angled-deck, carrier landings routinely took place towards aircraft parked at the bow, with a mesh barrier catching and invariably damaging aircraft that failed to pick up an arrestor cable. The barrier proved to be even less satisfactory for catching wayward multi-engined types so the US Navy introduced an overrun cable for straight-decked carriers operating the Tracker. The cable lay flush with the deck until the aircraft's nose undercarriage made contact with a small trigger net located just ahead of the cable; the cable then sprung up behind the nose wheel and was intended to catch the main undercarriage legs.

Following a spectacular accident during cable engagement trials aboard the anti-submarine carrier *USS Valley Forge (CVS-45)* on May 19, 1954, when only the starboard undercarriage of a Tracker engaged the cable and the aircraft lost a wing in the resulting gyrations, Grumman added the forward-sloping spear visible below the fuselage. Nicknamed the 'fosdick', this hollow steel appendage, together with the forward extensions to the main undercarriage scissors, helped ensure positive engagement with the cable. Eight small protrusions were also added to a strengthened nose wheel door to help engage the trigger net