

AETE's Fab T-Birds

Ejecting Dummies, Saving Lives

“EJECT! EJECT! EJECT!” For pilots and aircrew of advanced fighter aircraft equipped with ejection seats, the powerful and adrenaline-saturated exclamation of these three words triggers an irreversible chain of events. Having pulled the rings or squeezed the trigger of the ejection-seat, the crew member in distress will be rocketed out the cockpit of the stricken aircraft. Within seconds – and safe of the aircraft – he/she will be separated from the seat and, once the parachute canopy is fully unfolded, gravity will guide the pilot safely down to earth.

Although much has changed since the introduction of the first ejection seats in the mid-forties and the World War II Luftwaffe's Heinkel He219 'Uhu' ejection seats, the technical basics and limitations of the new sophisticated and performance-optimized seats remain a constant challenge for civil and military designers and manufacturers. Stuck with never-ending

changes in technical ejection-seat and pilot specifications (such as for female pilots and increasing human body-dimensions), the development and operational introduction of survival equipment (ejection seats, personal safety harnesses) is more than ever a high-tech, well-tested and much analyzed process. Due to its dedicated life-saving mission, all survival equipment needs to be quality-controlled, air-tested, validated and certified “suitable for operational use.”

By far the most important part in this long and demanding validation process is the ‘live’ (air-)testing of the various equipment during simulated ejections. Canada's Aerospace Engineering Test Establishment (AETE), at Canadian Forces Base (CFB) Cold Lake, Alberta, is one of the few remaining test-centers.

The AETE also houses Canada's four remaining Lockheed-designed Canadair CT-133 T-Bird aircraft. One of these T-Birds is specially equipped for in-flight

‘live’ simulations of pilot-ejections, offering AETE an almost unrivaled capability to easily test its survival equipment in realistic conditions.

AETE: Canada's Exclusive Aeronautical Evaluators

Established in 1971 by amalgamating various, smaller evaluation establishments, AETE's mission is to provide cost-effective, timely, quality engineering evaluations of the airworthiness and operational effectiveness of the air force's aerospace systems.

As the exclusive flight test agency of the Canadian Forces (CF), the AETE conducts a wide variety of flight and ground testing involving every aircraft and helicopter type in the Canadian inventory. Furthermore, AETE is also responsible for the evaluation of all new systems to be installed on air-launched weapons used by Canadian military aircraft and helicopters.

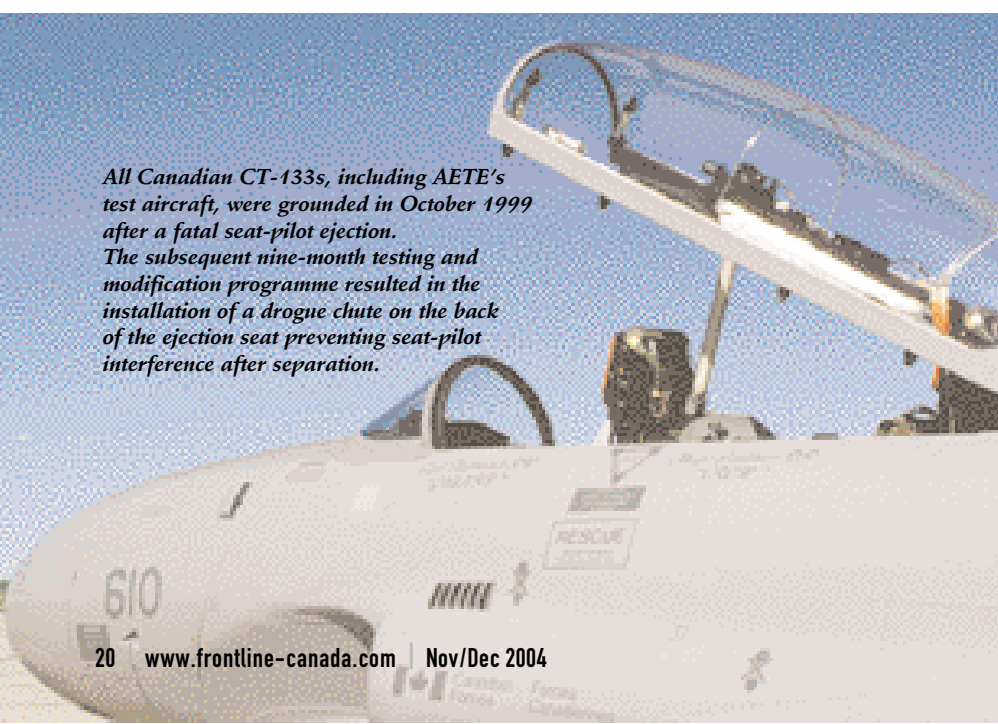
At CFB Cold Lake, homebase of 4 Wing and its three McDonnell Douglas/Boeing CF-188 Hornet squadrons, AETE uses the vast, seemingly unlimited, airspace around Cold Lake for flight test operations.

The Cold Lake Air Weapons Range contains the well-equipped Primrose Lake Evaluation Range, AETE's primary test range. For evaluation and testing purposes, three drop zones for air-launched weapons are available, all ‘guarded’ by advanced photo- and video-theodolites for data-collection, recording and transmitting. All telemetric data are transmitted in real-time to the Flight Test Control Room.

Possessing a wide variety of scientific skills and knowledge, some 230 military and civilian personnel conduct ground and in-flight testwork at the AETE.

The unit's pilots, originating from Canada's fighter, transport, and helicopter communities, have all attended one of the four recognized test pilot schools: the *Empire Test Pilot School* (ETPS) at Boscombe Down; the *Air Force Flight Test Center* (AFFTC) at Edwards, Alberta; the *Naval Test Pilot School* (NTPS) at NAS Patuxent River; or the *École du Personnel Navigant d'Essais et de Reception* (EPNER) at Istres.

AETE uses a wide variety of specially equipped and instrumented fixed-wing (jet) aircraft and helicopters, ranging from modified CF-188 Hornet fighter aircraft to CH-146 Griffon-helicopters. Both types are modified with modern digital data collection systems, providing accurate data and



All Canadian CT-133s, including AETE's test aircraft, were grounded in October 1999 after a fatal seat-pilot ejection. The subsequent nine-month testing and modification programme resulted in the installation of a drogue chute on the back of the ejection seat preventing seat-pilot interference after separation.

parameters to the test-crew. In addition, AETE uses unmodified CT-144 Tutors and Canadair CT-133 T-Birds for photo-chase and training purposes.

One of the most important – but low-key – AETE-operations is the evaluation, prototype development, and testing of Escape Systems and Aircrew Life Support Equipment. For air testing of ejection seats, AETE uses some ‘home-made’ hardware, including a specially-modified CT-133, which offers unrivaled testing capabilities.

T-BIRD: Forever Young

On 31 March 2002, after an illustrious career of almost half a century with almost all Canadian jet squadrons, the Canadian Forces finally withdrew the last of its CT-133 Silver Stars (*aka T-Birds*) from operational service. Two ‘composite’ squadrons, 414 at CFB Comox (British Columbia) and 434 at CFB Greenwood (Nova Scotia), which had been using the T-Birds for multiple support air force and navy taskings, were disbanded. The two remaining units, 417 at CFB Cold Lake (Alberta) and 439 at CFB Bagotville (Quebec), remained operational, being also equipped with CH-146 Griffon helicopters.



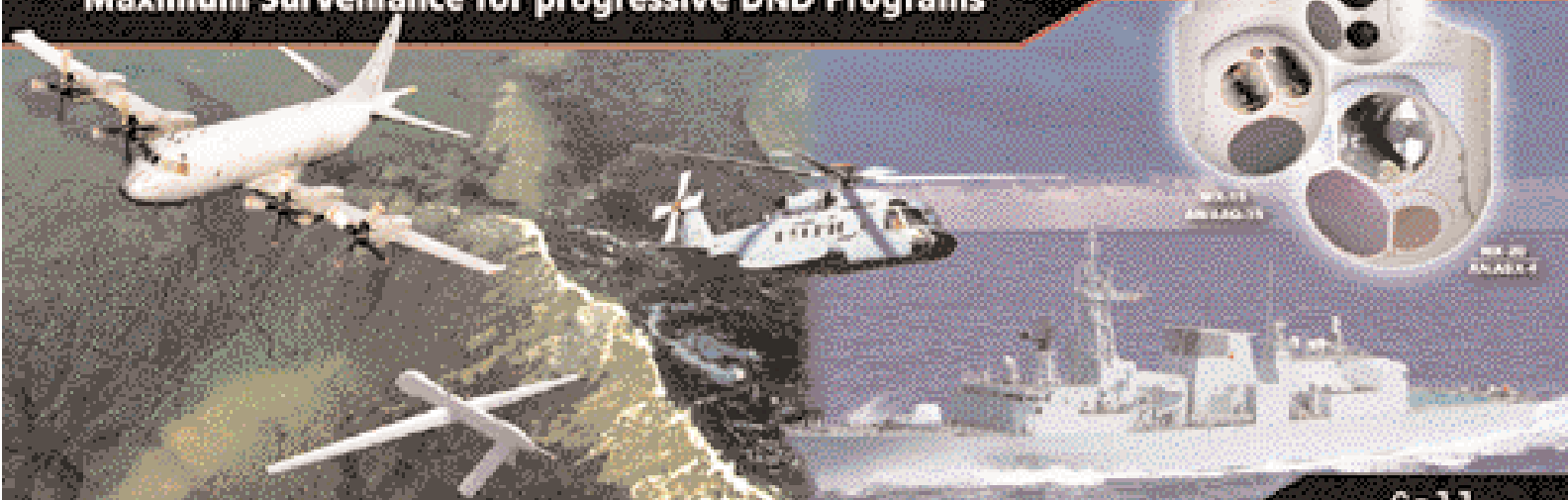
The CT-114 Tutors, and CT-133's are used for photo-chase missions over the Primrose Lake Evaluation Range during the different air-tests with the various AETE-aircraft. A qualified chase pilot and a specially trained image system technician are required for these missions.

All remaining CT-133's, some of them updated only a few years earlier, were flown to CFB Mountain View (Trenton, Ontario) for storage, pending a final decision regarding their future. The withdrawal of the ‘multi-role’ and ‘cheap to operate’ CT-133's deprived the Canadian Forces of a welcome and much-needed training asset since these aircraft were frequently used as (electronic warfare) aggressor-aircraft during air and naval exercises and as tar-

get-towing aircraft for naval-gunnery training. The CF plans to outsource some of these support services to civil contractors, who in turn might wish to acquire some of the CT-133's to perform aggressor and target towing missions.

For many years, the AETE used the venerable T-Bird for various test-supporting tasks, sometimes necessitating modifications to the aircraft's airframe. After the official withdrawal of the CT-133 from

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CF-service, structural inspections were performed and four of the withdrawn CT-133's, all modified with upgraded cockpits, were transferred to the AETE at Cold Lake. In addition two CT-133's are kept in flyable preservation at CFB Mountain View as attrition replacement aircraft. Once a week the engines of these 133's are fired up by personnel of the Mountain View-based Aerospace & Telecommunications Engineering Support Squadron (ATESS).

The influx of the 'new' aircraft enabled AETE to withdraw its 'old' 133's (including the specially modified models). One of the modified CT-133's was recently sold to a US-based warbird collector. Efforts were made to preserve the second 'purpose-modified' CT-133, together with the 'standard' photo-chase aircraft, at the local Cold Lake Museum.

Nowadays, the three general-purpose CT-133 aircraft are used for a wide variety of test-supporting and training missions. Currently, six AETE pilots are qualified on the T-Bird, only one is backseat-qualified.

Similar to other test establishments, all AETE pilots are qualified on two aircraft-types with the CT-133 being the most common candidate as a second fixed-wing qualification. Together with AETE CT-114 Tutors, the CT-133 are used for photo-chase missions during the various air tests. During these missions, flown over the Primrose Lake Evaluation Range, a qualified chase pilot and a specially trained image system technician fly the CT-133. In general, a 100 ft lateral separation is flown, enabling the high-speed film cameras in the tip tank, and 'handheld' by the back-seater, to capture all testing events on film.

Finally, these 'fifties-built' T-Birds are used to screen operational fighter and fixed-wing pilots applying for test-pilot training. Requiring four new test-pilots to be trained every year, AETE-candidates must pass a two-week test-simulation screening. Qualified instructors monitor candidates as they fly the aircraft in simulated test-environments prior to their eventual selection and training in the United States (NTPS/AFFTC) or Europe (ETPS/EPNER). The CT-133s are also used to familiarize transport-origin pilots with jet-aircraft.

All first-level maintenance and component replacement, using stocks of basic spare parts, is done by AETE-personnel at CFB Cold Lake. The aircraft are flown to 8 Wing at CFB Trenton for the regularly scheduled second-level inspections.



Ejection Seat Testing: Black Thunder & T-Bird

AETE's innovative developments in escape system testing has attracted international attention and admiration. An increasing shortage of suitable, efficient and low-cost ejection seat testing hardware triggered AETE's development of specialized ground and airborne test-platforms for ejection seat and survival equipment testing.

For ground and low-speed testing of all sorts of ejection-seats, AETE's uses a locally-modified Dodge RAM 3500 Series V10 pick-up truck which goes by the nickname: *Black Thunder*. Fitted with a flatbed, external fire extinguishers, up to five high speed cameras and a control panel in the cabinet, this Dodge – officially known as 'Ejection Seat Ground Test Vehicle' – fires test-seats up to 60 indicated air speed using Cold Lake's outer runway. Costing around 100,000 \$ per firing, these ground firings are cost-benefit effective alternatives to more expensive airborne trials. During the recent Tutor and T-Bird ejection seat modification programmes, on average six Black Thunder-ejections were incorporated in the programme.

Airborne testing of ejection seats, and impact of the ejection-process on the pilot, is done by using AETE's most remarkable asset: a specially modified CT-133 T-Bird. Ejection-seats to be tested are bolted to a special aluminum 'bathtub' in the backseat of the aircraft. At speeds from 125 to 450 knots, with 'G'-forces ranging from -1G to +4G depending on test-requirements and objectives, the pilot electrically ejects the seats, which are slightly inclined at a 12° angle, through a specially-developed half-open canopy. The 'backseat' is mechanically armed prior to take-off but electrically isolated until the actual firing, using a series of switches opening the isolated circuit and initiating the firing. To protect the pilot, a blast shield was mounted between the cockpit, isolating the back-

seat. Additional modification include the removal of all flight controls from the backseat-cockpit, the addition of firing circuits in the front cockpit and fortification of the base of the vertical fin to avoid damage from the ejection-seat exhaust. On board-cameras can be mounted in the empty tiptanks. To avoid unwanted interference with the seat/dummy movement during the ejection and seat-separation process and with the photo-tracking crew, the CT-133 pilot initiates a climb or dive immediately after the ejection before returning to CFB Cold Lake.

Photo- and Video-tracking

Photo- and video-tracking is done by image systems technicians flying in the chase-aircraft (Tutor or T-Bird) or on the ground using fixed video-theodolites, positioned around the test-area. Sometimes AETE's CH-146 Griffon-helicopters are used for photo/video collection, especially for filming seat-separation and parachute-opening.

Since no radar-deflector is mounted on the ejection seat and/or dummy-pilot, all tracking and video is done by manual tracking, demanding high skill- and experience-levels by personnel. On average, depending on the type of test programme, an average of ten seats per years have been fired using the T-Bird platform. Since 1995, second generation seats from CT-114 Tutor, CT-133 T-Bird and the US Navy Aircraft Common Ejection Seats (NACES) have been air-tested by AETE's T-33 T-Bird. In October 1999 all Canadian CT-133s, including AETE's test aircraft, were grounded after a fatal seat-pilot separation after ejection. A nine-month long and \$800,000 testing and modification programme induced the installation of a drogue chute on the back of the ejection seat preventing seat-pilot interference after mutual separation. Furthermore a bigger parachute was provided to the pilots.



Hybrid III



Hybrid III

An ‘interesting’ challenge complicating the development of an omnipotent escape system (ejection seat, safety harness and parachute canopy) capable of safely extracting pilots in distress is presented by the physical differences between the two genders (such as weight and height). The introduction of female pilots in the CF (and worldwide) means AETE tests must utilize both ‘male’ and ‘female’ dummies.

For many years to come, the development and testing of fourth generation ejection seats and survival equipment will be an important core business of Canada’s Aerospace Engineering Test Establishment and its four CT-133 T-Birds. The information (data and video-coverage) gathered by these ‘first generation aircraft’ will undoubtedly safeguard further generations of operational pilots who had not even been born when these four 1950’s-era CT-133’s were built. **FL**

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Dummies Provide Data

Far more important than testing the pure technical capabilities and aerodynamic characteristics of the ejections seats, is the in-depth testing and monitoring of the impact of ejection-process and forces on the human body. To collect all necessary ‘pilot-related’ information during seat-firing simulations, AETE’s uses several types of ‘dummies.’ The *Hybrid II*-dummies, equipped with some data-collection devices, are used to collect more advanced

data in later stages of the seat-development or modification-programme.

Finally, the data-collection efforts are fine-tuned, especially for validation and certification, by using two ‘state-of-the-art’ and highly instrumented dummies at a cost of \$250,000. These *Hybrid III*s can measure roll, pitch, and yaw rates, and monitor the exposed G-forces induced by the ejection-process. Furthermore, telemetric devices in the dummy transmit in real time to Cold Lake.

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