CANADIAN FORCES
FLIGHT SAFETY INVESTIGATION REPORT

FINAL REPORT

FILE NUMBER:	1010-CT155216 (DFS 2-3-3)
DATE OF REPORT:	28 January 2005
AIRCRAFT TYPE:	British Aerospace Hawk Mk-115 (CT155)
DATE/TIME:	041702Z July 2003
LOCATION:	15 Wing Moose Jaw, Saskatchewan
CATEGORY:	"B" Category Accident

SYNOPSIS

The solo student was on a clearhood 8A mission, his third solo flight on the Hawk. After a touch-and-go landing he requested a closed pattern from tower. Once downwind he was sequenced number three behind another Hawk on short final and a Snowbird Tutor directly ahead. In order to accommodate all aircraft, tower requested that the Snowbird extend his downwind and land behind the accident aircraft and then re-sequenced the solo student number two behind the landing Hawk. The accident pilot initiated the final turn and landed on the centreline of runway 29 Right with the landing gear in the up position. The aircraft skidded for approximately 4000 feet before exiting the left side of the runway. The aircraft came to rest in the infield approximately 4720 feet from the touchdown point and 420 feet from the edge of the runway. The pilot did not deploy the drag chute and did not eject from the aircraft. He exited the cockpit in the normal fashion and waited by the aircraft for the emergency vehicles to arrive. Tower initiated the emergency response by ringing the crash bell and all vehicles were on site within minutes.

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1. FACTUAL INFORMATION

1.1 History of the Flight

At the time of the accident there were multiple aircraft airborne within the Moose Jaw Control Zone and the Military Terminal Control Area. Three of these aircraft are of direct concern in this accident. The accident pilot, identified in this report as Hawk1, was a solo student on a clearhood 8A solo mission, the third solo on the Hawk Phase III syllabus. He had returned from the area and was practicing circuits on the inner runway (29R). Another Hawk, identified in this report as Hawk2, was also practicing circuits on the inner runway. A Tutor aircraft, identified in this report as Snowbird, was returning from the training area and was coming in for a Snowbird Pitch. Hawk1 had completed his touch-and-go and retracted his landing gear when he requested clearance for a closed pattern to the right. Tower initially denied Hawk1 the closed pattern because Snowbird was approaching the threshold of the runway. Meanwhile, Hawk2 was downwind, having levelled-off from his own closed pattern. Snowbird immediately advised tower that he was "pitching early" and pulled up and to the right to perform the Snowbird pitch. This manoeuvre is similar to a normal closed pattern. Since Snowbird had pitched early and was no longer conflicting with Hawk1, tower authorized Hawk1 to execute his closed pattern. Both Snowbird and Hawk1 pitched up at approximately the same time (Snowbird over the threshold and Hawk1 past the departure end of the runway) and consequently they arrived downwind in reverse order from when they pulled up, that is: Snowbird in front and Hawk1 behind. As the Hawk circuit speed is much faster than the Tutor's, the gap between the two aircraft gradually closed. During that time, Hawk2 was halfway through his final turn and receiving clearance for his touch-and-go. Hawk1 deployed half-flaps and called downwind. He was sequenced number three behind Hawk2 landing and Snowbird directly ahead. By this time, the gap between Snowbird and Hawk1 had narrowed considerably and, in order to enable both Snowbird and Hawk1 to carry out their intended touch-and-go, tower requested that Snowbird extend his downwind and come in behind Hawk1. Hawk1 was then re-sequenced number two behind Hawk2 on short final. At this point, Hawk1 deployed full flaps and entered the final turn to the right. Approximately half-way through the final turn tower cleared Hawk1 for the touch-and-go and asked him to confirm that his landing gear was "down and locked." Hawk1 acknowledged the clearance and verbally confirmed that the gear was down without looking at the indicators.

Hawk1 landed on the centreline of runway 29R 1,000 feet past the threshold with the landing gear in the up position. The aircraft skidded on its' belly for approximately 4000 feet before exiting the left side of the runway and coming to rest in the infield 4720 feet from the touchdown point and 420 feet off the left edge of the runway. The pilot did not deploy the drag chute and did not eject from the aircraft. He exited the cockpit in the normal fashion and waited by the

aircraft for the emergency vehicles to arrive. Tower initiated the emergency response by ringing the crash bell and all vehicles were on site within minutes.

1.2 Injuries to Personnel

The pilot was not injured in the accident. He was immediately taken to the Base Hospital by ambulance, examined by the Flight Surgeon on duty and provided toxicology samples.

1.3 Damage to Aircraft

The aircraft received B Category damage which required the aircraft be shipped to the contractor. Damage was mostly limited to the underside of the wing and the fuselage. The nose landing gear doors were eroded exposing the nose tire and allowing the aircraft to ride on the nose tire as it skidded along the runway and the infield. All lower antennae and flap hinges were scraped-off and the left flap was pushed upward.

1.4 Collateral Damage

The accident occurred on the airfield. No reservoirs were ruptured and no fluids were spilled. The aircraft destroyed a runway edge light when it exited the runway.

1.5 Personnel Information

	Pilot
Rank	Lt
Currency/Category valid	Yes
Medical Category valid	Yes
Total flying time	215
Flying hours on type	14.8
Flying hours last 30 days	14.8
Duty time last 24 hrs	3

1.6 Aircraft Information

The aircraft was serviceable prior to the accident. All maintenance and inspections were up to date. The weight and balance was within limits.

The aircraft experienced a snag in previous flights where the landing gear warning system would activate after take-off when the gear was retracted. The landing gear warning system was tested extensively after the accident and was found to function properly.

1.7 Meteorological Information

Weather at the time of the accident was CAVOK and the winds were from 280 at 10 kts.

1.8 Aid to Navigation

Not applicable.

1.9 Communications

Communications between tower and the accident aircraft were working properly and the volume of radio traffic was relatively light for Moose Jaw at the time of the accident. The student's mastery of the English language was adequate.

1.10 Aerodrome Information

All aerodrome systems were operating properly. However, the "Tasker Shacks" which had been utilized up until the mid 1990s were decommissioned in late 1995. Tasker shacks were observation posts near the threshold of the runways that were manned by qualified personnel whose sole purpose was to ensure that all aircraft had their landing gear down before landing. When an aircraft was observed on final approach without its' landing gear extended, the Tasker personnel would fire flares and use their radio transmitter to instruct all aircraft on final to overshoot.

1.11 Flight Recorders

In lieu of a flight data recorder, the Hawk utilizes a Data Acquisition Unit (DAU). After the accident, the DAU was removed and the data downloaded. The DAU did not reveal any aircraft abnormalities which would have contributed to this accident.

1.12 Wreckage and Impact Information

The aircraft remained mostly intact throughout the accident. Only small external components were scraped off as the aircraft skidded along the runway and the infield and finally came to rest approximately midway between the runways as shown in photo 1.

1.13 Medical

Toxicology samples were taken and sent to the US Army Institute of Pathology. Results were negative.

1.14 Fire, Explosives Devices, and Munitions

The pilot inserted all seat and canopy pins before exiting the aircraft. Maintenance personnel secured all explosive charges as soon as the emergency response personnel deemed the site safe. There was no post accident fire.

1.15 Survival Aspects

The fuselage area around the cockpit was not deformed and the cockpit volume remained unchanged. After the accident, the pilot exited the cockpit in the normal fashion and remained in proximity to the aircraft to await emergency personnel.

1.15.1 Crash Survivability

The crash was survivable. The cockpit maintained its survivable volume and was undamaged. The deceleration forces that the pilot was subjected to were within the tolerance level of the human body.

1.15.2 Life Support Equipment

The harness used by the pilot was effective and prevented injury. The ejection seat was not used.

1.15.3 Emergency Transmitters

The aircraft's emergency transmitters were not activated since the ejection seats were not used.

1.16 Test and Research Activities

Moose Jaw Flight Safety personnel are researching the history of the Tasker Shacks in an effort to determine why they were decommissioned. Since publication of the preliminary report the Tasker Shacks in Moose Jaw have been reactivated and are operational.

1.17 Organizational and Management Information

All training, administrative and maintenance files were reviewed and found to be in order.

2. ANALYSIS

2.1 Pilot Experience

The student pilot flying Hawk1 was a foreign student and had 215 total flying hours, all types. Approximately 200 of these hours had been logged over a five-year period on training aircraft in his native country. Furthermore, most of this flying had been done at low traffic density airfields. His 14.8 hours on the CT-155 were flown in Moose Jaw where the circuits are significantly busier than those the pilot was used to in his home country.

The downwind portion of the CT155 closed pattern is initially flown at 220KIAS and the speed decreases to allow for ancillary selection; whereas, the CT114 closed pattern is flown at 175 KIAS. Hawk1 was unfamiliar with the Snowbird break and with the Snowbird traffic pattern. However, Hawk1 soon became aware that he was overtaking Snowbird and he therefore devoted a lot of his attention to maintaining separation between his aircraft and the Snowbird while on the downwind portion of his traffic pattern.

2.2 Snowbird Break

The Snowbirds landing pattern is flown straight in from 10 DME. It is in effect a gear up low approach at speeds of over 280kts. Initial sequencing from ATC occurs at 10 DME but re-sequencing for landing occurs when the runway threshold is passed. The downwind pull-up is to 2700 MSL, which is lower than the normal traffic pattern. While on downwind the Snowbirds separate into elements, or as single ship, to prepare for landing. In doing so, they may extend beyond the normal final turn position. Additionally, students are advised to avoid low approaches to the north, when the Snowbirds are inside 10 DME, and to ensure R/T is strictly minimized. Students are made aware of these procedures through the release of a memorandum to the Aircrew Information File (AIF). The Wing Flying Orders direct pilots to review the AIF during the Snowbird try-out and training period.

The AIF method of informing students of the Snowbird pattern is considered ineffective. The infrequent nature of student encounters with the Snowbirds in the pattern does little to help the student remember the Snowbird traffic profile, which is, as indicated above, quite complex. More formal instruction is required to ensure that students have the required knowledge when they encounter a situation where the Snowbirds are in the traffic pattern.

All students are required to write a ‘solo exam’ prior to their first solo in Moose Jaw. However, this exam does not make reference to the Snowbird Break.

2.3 Language

The pilot is a foreign student and was working in his second language. While the pilot was proficient in English, working in his second language would have added to his workload in this situation.

2.4 Aircraft Design – Gear Warning

The landing gear not-down warning is given when the gear is not down and locked and all three of the following conditions occur:

a. The throttle is set to less than 85% RPM;

b. The altitude is less than 5000ft AGL (5000ft ASL with radalt off); and,

c. The IAS is less than 160 Knots.

The warning is usually given by a red GEAR warning light on the Annunciator panel with an associated flashing master warning light as well as an audible signal consisting of two sweeps of a lyrebird tone followed by a voice message "GEAR NOT DOWN, GEAR NOT DOWN". There are no further audible warnings should this tone and voice message be missed by the pilot.

The gear not-down warning system on the CT-155 may not provide sufficient stimulus to acquire the pilot's attention when the pilot is very task saturated.

2.5 Tasker Shack

The Tasker Shacks are two small shelters located at either end of the runway, in which qualified individuals sat and watched for aircraft attempting to land gear up. If an aircraft was established on short final with the landing gear in the up position, the pilot was signaled electronically by a transmission on GUARD frequency and visually by a flare shot from the Tasker Shack. The Tasker Shacks provided an independent final check to verify that all aircraft had their gear down.

Taskers had been used up until late 1995; however, due to a lack of sufficient personnel combined with a reduced flying rate, the Tasker Shack operations were terminated. From 1995 to 1999 there were a number of gear up approaches and 'scrapes' and Tasker operations were re-initiated using On-Job-Training (OJT) personnel working from the control tower. This system lasted for a few weeks but was unworkable due to limited visibility from the tower, as well as the inability to visually signal aircraft of a gear-up approach. Tasker operations were discontinued at that time.

Tasker Shack operations are an effective and proven method of providing an independent final line of defense against gear up approaches/landings.

2.6 Human Factors

The relatively low experience of this pilot meant that he would have had more difficulty coping with information processing than a more senior pilot. This factor was exacerbated by the fact that the student was working in his second language. This pilot also had little experience with a busy and fluid traffic pattern such as that experienced in Moose Jaw. The busier traffic pattern, the unfamiliar Snowbird traffic pattern, the clearance cancellation followed by the clearance to do the closed pattern, the higher rate of speed in the closed pattern and the re-sequencing all created a high workload for this pilot given his experience level. In addition, due to the speed differential between the CT-114 and the CT-155, the student pilot was preoccupied with maintaining separation from the Snowbird. All of these factors combined to task saturate the pilot such that the Pre-landing checks were not completed correctly.

When task saturated, one of the first adaptive strategies employed by the brain is to subconsciously “shed” information resulting in less information to process. In this case the pilot "shed" the gear not down warning indications. In addition, when queried to “check gear down” by Tower, the pilot responded automatically, without actually verifying the position of the landing gear. Of note, with the aircraft not configured normally (with gear and flaps down), the Final Turn portion of the traffic pattern would be more difficult to fly because the aircraft’s attitude and power selection would necessarily be different from the “training norms” the student would be used to. This would likely cause further task saturation.

Unfortunately, the final safety net that could have prevented this accident, the Tasker Shack, had been decommissioned and was not available.

3. CONCLUSIONS

3.1 Findings

3.1.1 Hawk1 received changes to his clearances and sequencing that increased his task workload.

3.1.2 Hawk1 channelized his attention on maintaining separation from Snowbird while on downwind in the closed pattern.

3.1.3 Hawk1 was unfamiliar with the Snowbird landing pattern.

3.1.4 Hawk1 did an incomplete Pre-landing Check and did not lower the landing gear.

3.1.5 Not lowering the gear resulted in a Final Turn that was more challenging to fly.

3.1.6 Hawk1 missed the visual and audio gear not down-and-locked warnings.

3.1.7 Hawk1 landed with the gear up.

3.2 Cause

The pilot landed the aircraft with the gear up, because the student was task saturated and channelized his attention. Specifically, he was planning his re-sequence to land, reducing speed, adjusting power and configuration to maintain separation on Snowbird while arriving at the 'perch' requiring the initiation of the final turn. Management of the aircraft non-standard configuration on the Final Turn increased the pilot's task saturation level.

3.3 Contributing Factors

3.3.1 Gear not-down warning system

The gear not-down warning system on the CT-155 may not provide sufficient stimulus to acquire the pilot's attention.

3.3.2 Tasker Shack

The Tasker Shacks were not in operation.

3.3.3 Snowbird Traffic Pattern

The student was unfamiliar with the Snowbird traffic pattern.

4. SAFETY MEASURES

4.1 Safety Measures Taken

a. Tasker Shack operations have been reinstated.

b. Students now receive Human Performance in Military Aviation training which includes time management strategies for use when task work load is high

4.2 Further Safety Measures Required

It is recommended that:

a. DGAEPM investigate the feasibility of changing the landing gear not down audible tone to a continuous tone and voice which will remain activated as long as the conditions of paragraph 2.4 are met.

b. The Snowbird traffic pattern be included in 15 Wing Flying Orders, and,

c. The student ‘solo exam’ be amended to include reference to the Snowbird Traffic Pattern.

4.3 Other Safety Concerns

Nil

4.4 DFS Remarks

There are two key points that need to be highlighted as a result of this investigation. The first point concerns Tasker Shacks. A review of the flight safety database reveals that there have been 115 reported occurrences of gear up landings in the period 1954-2004. Of these, approximately 43% occurred in the training environment. In addition, there have been 90 incidents that were "near wheels up landing". In this latter group, 75% involved training aircraft. These statistics support the requirement to maintain as many defences as possible from gear up landings, especially in the training environment. Tasker Shacks are a proven, effective method of protection against this type of occurrence and it was gratifying to see that 15 Wing was quick to reinstate Tasker Shack operations. However, Tasker Shacks require resources and the challenge will be to maintain this particular defence against gear up landings in a resource constrained environment.

The second point requiring emphasis is the proper use of checklists. The cause of this unfortunate accident was a breakdown in properly completing the pre-landing checklist due to several distractions (task saturation, channelized attention, and unfamiliarity with the Snowbird Traffic Pattern). Unfortunately, this type of problem is not unique to the training environment. This fact was highlighted recently by a very similar accident involving a non-CF aircraft at a CF base. In this latter case, the pilot, who had more than 10,000 flying hours, also failed to lower the landing gear and properly complete the pre-landing check because he too was distracted at a critical moment. The point that will be emphasized to all aircrew is the requirement to re-initiate checklists at an appropriate point whenever the checklist has been interrupted. For single seat fighter or trainer aircraft, this may mean restarting the checklist at the beginning. In the multi-engine communities it is standard practice, when checks are interrupted, to return at least two items previous in the list to ensure completeness. Adherence to these practices will hopefully avoid future accidents of this type.

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A.D. Hunter
Colonel
Director of Flight Safety

Annex A: Photographs

PHOTO 1: FINAL RESTING PLACE

Annex B: List Of Abbreviations

AA: Aeronautics Act

AGL: Above Ground Level

AIA: Airworthiness Investigative Authority

AIF: Aircrew Information File

ASL: Above Sea Level

ATC: Air Traffic Control

CAVOK: Ceiling And Visibility OK

CF: Canadian Forces

DAU: Data Acquisition Unit

DGAEPM: Director General Aerospace Equipment Program Manager

DME: Distance Measuring Equipment

IAS: Indicated Airspeed

Kts: Knots (Nautical Miles per Hour)

Lt: Lieutenant

MND: Minister of National Defence

MSL: Mean Sea Level

OJT: On Job Training

R/T: Radio Transmission

RadaIt: Radar Altimeter

RPM: Revolutions Per Minute

U.S.: United States