CANADIAN FORCES
FLIGHT SAFETY INVESTIGATION REPORT (FSIR)

FINAL REPORT

FILE NUMBER: 1010-CF188933 (DFS 2-3-3)
DATE OF REPORT: 05 April 2006

AIRCRAFT TYPE: CF188 Hornet
DATE/TIME: 132006Z January 2005
LOCATION: Tinker Air Force Base, Oklahoma City, Oklahoma, USA
CATEGORY: "D" Category Incident

SYNOPSIS

The pilot in command (PIC) and the second pilot were enroute from Cold Lake, Alberta, to Naval Air Station (NAS) Key West, Florida, in a dual-seat CF-18 aircraft to participate in a combined training exercise. Approximately 100 nautical miles (NM) from their intended fuel stop at Tinker Air Force Base (AFB), Oklahoma, they experienced right engine oil pressure fluctuations. The engine was shut down in accordance with the checklist and an arrested landing via a visual straight in approach to the threshold of runway 12 at Tinker AFB was planned. Just prior to touchdown, the aircraft's arrestor hook caught the E-5 arrestor gear cable in the undershoot area of runway 12. The E-5 arrestor cable snapped and flying debris damaged the aircraft. The aircraft came to a stop on the runway and the pilots egressed uninjured. The aircraft sustained "D" category damage.

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1. FACTUAL INFORMATION

1.1 History of the Flight

The incident flight was part of a squadron training deployment to NAS Key West, Florida. The flight from 4 Wing Cold Lake, Alberta, to NAS Key West included a routine enroute fuel stop at Tinker AFB, Oklahoma. The CF-18 Hornet aircraft was crewed by two qualified and current pilots from the same squadron. The Pilot In Command (PIC) was in the front seat.

The aircraft departed Cold Lake on 13 January 2005 at 17:29Z. The enroute phase of the flight was uneventful until just prior to descent into Tinker AFB. At 39,000 feet, approximately 100 NM northwest of Tinker, the right engine was shut down due to fluctuating oil pressure indications. The shutdown of the right engine resulted in the loss of the number two hydraulic system. Amongst other services, the number two hydraulic system provides normal braking, normal gear lowering, and nose-wheel steering.

After shutting down the right engine, the pilots declared an emergency with Kansas City Centre Air Traffic Control (ATC) and were then informed that the active runway at Tinker was runway 30. Due to the arrival vector, fuel considerations, and the location of the BAK-12 arrestor cable system on runway 30, the pilots requested, and were cleared for, a visual approach to an arrested landing on runway 12 at Tinker AFB.

The landing gear was lowered using the emergency lowering procedure 6 NM prior to touchdown.

Runway 12/30 at Tinker AFB has two types of cable systems. The first is a bi-directional BAK-12 system which is designed to be engaged from either direction. The second system is an E-5 system, which is a unidirectional system meaning that it should only be engaged from one specific direction. The E-5 cable system installed in the Runway 12 under-run was designed to be engaged only when utilizing Runway 30.

The PIC flew a visual straight-in half-flap approach at approximately 150 knots indicated airspeed. The PIC lined-up the runway threshold coincident with the Head Up Display (HUD) velocity vector. The aircraft was initially high, and while attempting to correct back to a 3° glide path, the PIC inadvertently established a 2° glide path. At approximately 1.5 - 2 NM from the threshold of runway 12, the PIC was still unable to visually locate the BAK-12 arrestor cable. To ensure that he would not land past the BAK-12 arrestor cable, the PIC attempted to touch down on the threshold of runway 12. At 20:06Z, approximately 110 feet before the threshold of runway 12, the aircraft's arrestor hook touched down and then engaged the E-5 unidirectional arrestor cable.

The E-5 arrestor cable snapped and flying debris damaged the aircraft. On landing, the aircraft veered sharply to the left and then to the right before stabilizing its rollout near the runway centreline. The PIC used rudders to stabilize the aircraft before engaging emergency brakes to bring the aircraft to a full stop approximately 7500 feet from the threshold of runway 12. The BAK-12 arrestor cable was not engaged due to damage to the CF-18's arrestor hook.

After coming to a stop, the PIC conducted a normal shut down and both pilots then egressed the aircraft uninjured. Tinker crash, fire, and rescue services responded and met the aircraft shortly after it came to a rest. Tinker AFB personnel then initiated post-occurrence investigative actions.

1.2 Injuries to Personnel

There were no injuries.

1.3 Damage to Aircraft

The aircraft sustained "D" category damage. The trailing edge of the right aileron (Photo 1 and 2), the right trailing edge flap (Photo 3), and the leading edge of the right horizontal stabilator (Photo 4) were damaged after being struck by a 50-foot section of E-5 arrestor cable. Additionally, the aircraft arrestor hook bearing sleeve assembly was damaged (Photo 5) as it was forced into a position 70° right of centre. There was no other indication of visible damage to the aircraft. There were no fluid leaks or spills.

1.4 Collateral Damage

Minor surface gouges and minor damage to several lights on runway 12 were noted. The E-5 unidirectional runway arrestor cable and its supporting stanchions were destroyed. A 50-foot length of the arrestor cable was found on runway 12, 1500 feet from the threshold. A 10-pound arrestor cable-end was found 2277 feet from the threshold after striking and denting a chain link fence. The arrestor cable turnbuckle shear pin struck the BAK 12 arrester cable house 1145 feet from the threshold of runway 12 and caused minor chips to the concrete foundation. The Directorate of Law Claims and the Canadian Defence Liaison Staff (Washington) (CDLS(W)) were notified.

1.5 Personnel Information

Table 1: Personnel Information

	PIC	2nd Pilot	Tower Controller
Rank	CAPT	CAPT	Airman 1st Class
Aircrew Category Valid	Yes	Yes	Yes
Proficiency Check Date	17 Jun 04	12 Feb 04	Nov 04
Medical Category Valid	21 Sept 05	20 Apr 05	Yes
Total Flying Time	2568	2700	N/A
Hours on Type	986	795	N/A
Hours Last 30 Days	8.2	10.3	N/A
Duty Time - Day of Incident	9.3	9.3	7.5

1.6 Aircraft Information

CF188933 is a dual seat CF-18 Hornet aircraft and had accumulated a total of 4549.2 airframe hours at the time of incident. The aircraft was declared fully serviceable at the time of launch from 4 Wing Cold Lake. The aircraft was configured in the following manner at the time of incident:

Station 1 - Captive Air Training Missile (CATM),

Station 2 - luggage carrier with 100 pounds of contents,

Station 3 - luggage carrier with 100 pounds of contents,

Station 4 - empty,

Station 5 - external fuel tank,

Station 6 - empty,

Station 7 - external fuel tank,

Station 8 - pylon, and

Station 9 - empty.

1605 pounds of fuel remained in the aircraft after shutdown. The aircraft weight at landing was calculated to be 31,065 pounds placing the centre of gravity within acceptable limits.

1.7 Meteorological Information

The meteorological observation taken at the time of occurrence was:

KTIK Local 2019Z 35010KT 300V360 7 SKC 07/M07 ALSTG 30.11 RMK STN PRESS: 28.740 PA +1117 DA +486

The forecast valid at the time of occurrence was:

TAF KTIK 131212 35012G18KT 9999 FEW010 510006 QNH2995INS
BECMG 1415 36012G18KT 9999 SKC QNH3012INS
BECMG 0001 VRB05KT 9999 SKC QNH3017INS
BECMG 0809 09007KT 9999 SKC QNH3038INS T07/21Z TM03/11Z

1.8 Aid to Navigation

Runway 12 at Tinker AFB is equipped with a runway localiser (no glidepath) and PAPI lights, both of which were serviceable and functioning at the time of incident. All airfield runway lighting was illuminated prior to the aircraft landing.

1.9 Communications

Both pilots indicated some degree of difficulty in communicating their initial emergency call to Kansas City Centre while at altitude; they attributed this to an inherent weakness in the CF-18 radios. While on descent and during the approach, the pilots neither recalled the passage of any information on the status of runway arrestor gear equipment nor did they request it. The only ATC reference to the arrestor gear equipment was by Kansas City Centre who informed the pilots that they could expect an arrested landing on runway 30. Just prior to landing, Tinker Tower provided the aircraft final clearance to conduct an arrested landing on runway 12 without any mention of either arrestor cable system.

1.10 Aerodrome Information

Tinker AFB is located in Oklahoma City, Oklahoma, USA. The airport is designated as a hurricane evacuation airfield and can accommodate a large number of diverted aircraft. Also, being centrally located within central USA, the base is a practical fuel stop for transient aircraft.

Tinker AFB has two crossing runways. The incident runway, 12/30, is 10,000 feet long by 200 feet wide. Both runway ends have a 1000-foot asphalt overrun

area. Runway 12/30 has a total of four arrestor cables: landing runway 12 is equipped with an approach-end BAK-12 bi-directional arrestor cable located on the runway 1,000 feet past the threshold and a departure-end E-5 unidirectional arrestor cable 60 feet beyond the threshold in the overshoot area; landing runway 30 is similarly equipped with an approach-end BAK-12 bi-directional arrestor cable located on the runway 3208 feet past the threshold and a departure-end E-5 unidirectional arrestor cable 70 feet beyond the threshold also in the overshoot area (figure 3).

The BAK-12 arrestor cable system is flanked on either side of the runway by an arrestor cable equipment shack, which is conspicuously painted red and white. The pavement under the BAK-12 cable is marked by five-foot radius yellow circles, 15 feet apart from each other.

There is no equipment marking for the E-5 arrestor cable system. In accordance with the United Facilities Code 3-535-01, signs are not allowed to be displayed if the arresting gear is located in the overrun.

1.11 Flight Recorders

The aircraft was equipped with Maintenance Status Display and Recording System (MSDRS) and HUD equipment. The MSDRS data tape was retrieved and sent for analysis. However, in accordance with local squadron practices, no HUD tape was installed in the aircraft for the transit flight. There is no Cockpit Voice Recorder (CVR), or Flight Data Recorder (FDR) installed on CF-18 aircraft. If the HUD tape been installed and the mission recorded, the information provided would have greatly assisted the Flight Safety Investigation.

The aircraft also records various aircraft faults as a code on the Maintenance Monitor Panel (MMP). These codes were also identified during data download.

1.12 Wreckage and Impact Information

The aircraft's arrestor hook touched down 110 feet prior to the threshold of runway 12, 40 feet prior to the E-5 arrestor cable. The arrestor hook then engaged the E-5 arrestor cable 70 feet prior to the threshold of runway 12, snapping the cable. Debris from the arrestor cable system was scattered as far as 2277 feet away.

The left main gear touched down 54 feet prior to the threshold or 16 feet past the E-5 arrestor cable. The right main touched down 40 feet prior to the threshold or 30 feet past the E-5 arrestor cable. The nose gear then touched down on runway 12, 35 feet past the threshold. A section of the right aileron was found sheared off near the threshold. The remainder of the aircraft remained intact and rolled to a stop approximately 7,500 feet down the runway.

1.13 Medical

Both pilots were taken to the Tinker AFB hospital for medical screening and toxicological sampling. All medical processing was done in accordance with B-MD-007-000/AF-003 Canadian Forces Flight Surgeons Guideline for Flight Safety Investigations. Toxicological results from the Armed Forces Institute of Pathology in Bethesda, Maryland, were negative. A human factors board was also convened by Defence Research Development Canada, Toronto (DRDC(T)) to provide input to the Flight Safety Investigation (FSI).

1.14 Fire, Explosives Devices, and Munitions

At the time of incident, there was no armament onboard the aircraft; the 20-millimetre ammunition had been replaced with ballast.

The CF-18 Hornet carries a variety of explosive devices that include pylon emergency jettison cartridges, ejection system (canopy, seat, etc) cartridges, and fire bottle squibs. All explosive devices were either rendered safe or removed prior to initiating the investigation.

There was no post-crash fire or detonation of munitions.

1.15 Survival Aspects

There were no survival aspects relevant to this investigation.

1.16 Test and Research Activities

A detailed external and internal visual inspection identified the damage listed in paragraph 1.3. On-site non-destructive testing of the arrestor hook keel assembly and flap and aileron hinges indicated no further damage. Additionally, aircraft symmetry and landing gear rigging checks also indicated no further damage.

Aircraft fuel and engine, aircraft-mounted accessory drive, and variable exhaust nozzle oil samples and the right engine oil pressure transmitter and oil pressure transmitter wire harness assembly were quarantined and sent to the Quality Engineering Test Establishment, Gatineau, for testing. The right variable exhaust nozzle samples indicated a condition code red contamination; this was possibly due to the high degree of external contamination at the sample site. The variable exhaust nozzle oil system is self-contained and does not interact with either the engine or accessory drive oil systems. It was therefore determined that this condition code red indication was of no bearing on the incident.

Testing of the right engine oil pressure transmitter (photo 6) indicated it to be serviceable, although excessive wear on the connector pins was noted. Debris from the worn pins and some oil contamination was also found in both the

transmitter and the transmitter connector. Testing of the wire harness assembly resulted in the duplication of the low oil pressure indication.

MSDRS data was sent to the National Research Council Flight Research Laboratory, Ottawa, for data retrieval.

Boeing Aircraft Corporation, as the original aircraft equipment manufacturer, and the Directorate of Aerospace Engineering Support were requested to provide baseline data on pilot line of sight visibility for visual approach flight profiles.

1.17 Organizational and Management Information

Because the incident occurred within the United States, liaison with Canadian Defence Liaison Staff Washington CDLS(W), the United States Air Force (USAF) Safety Centre, and the Canadian Desk Officer for International Affairs at the Pentagon was essential. Additionally, North Atlantic Treaty Organisation Standardization Agreement (STANAG) 3531 Safety Investigations and Reporting of Accidents/Incidents Involving Military Aircraft and/or Missiles was applicable to this investigation. STANAG 3531 makes provision for the FSI Team composition to include both members from the country of aircraft ownership and the country of occurrence. The country of occurrence, represented by the USAF, declined to participate in this FSI.

A maintenance repair party (MRP) from the Squadron of occurrence was dispatched to Tinker AFB. Due to the lack of Canadian Forces logistic and maintenance support at Tinker, the MRP temporarily integrated into the FSI's maintenance team to facilitate the survey of aircraft damage and to obtain and quarantine aircraft components. The MRP support to the FSI continued until on-site investigative efforts were completed and the aircraft was released from the Director of Flight Safety (DFS) quarantine to the MRP.

1.18 Additional Information

Runway arrestor cable systems in use within the Canadian Forces are visually identifiable by a yellow circle painted on a black cube marker; this cube marker is positioned abeam the arrestor cable on either side and can be illuminated at night. Overshoot arrestor cable systems were removed from service within the Canadian Forces in the mid-1990's.

1.19 Useful or Effective Investigation Techniques

The aircraft manufacturer has provided accurate data concerning the parallax error between the head-up display (HUD) velocity vector aim point and the arrestor hook and landing gear touchdown points.

2 ANALYSIS

2.1 General

The events leading to this occurrence began at altitude with fluctuating right engine oil pressure indications. As per the checklist the right engine was secured. Due to the inherent weakness of the CF-18 radios, it took several minutes to co-ordinate a descent with Air Traffic Control, and during this time the left engine was operated in afterburner in an attempt to maintain altitude. This resulted in an increase in the planned fuel consumption. The increase in fuel consumption was one of the factors that were considered in deciding to conduct a straight-in approach and landing to runway 12, instead of the active runway.

The loss of the right engine resulted in hydraulic abnormalities that included loss of normal gear extension, loss of normal braking, and loss of nose wheel steering. The checklist directs the crew to conduct an “approach-end arrestment, if possible” in this type of situation. It was during this approach that the tail-hook of the CF-18 contacted the E-5 unidirectional arrestor cable approximately 70 feet prior to the runway threshold.

2.2 Single Engine Procedures

2.2.1 Right Engine Oil Pressure

The initial indication of a problem was a voice alert for a right engine oil pressure problem. The pilot checklist calls for the throttle to be reduced to idle, and, if the engine does not stabilize at normal in-flight parameters, then throttle “off”. These actions were completed approximately 100 nautical miles from Tinker Air Force Base. Analysis has determined that the cause of the fluctuating oil pressure was a cracked oil pressure transmitter mount (photo 7). This mount had suffered a fatigue fracture (high cycle, low load condition) that caused premature wear of a connector pin, which in turn caused erratic oil pressure indications.

A review of occurrences indicates that there have been approximately 25 engine oil pressure transmitter/connector incidents in the past five years. Many of these incidents are the result of vibrations transmitted through the oil transmitter mount. Approximately 15 of these occurrences have resulted in single-engine landings.

The oil pressure transmitter is visually inspected every 600 engine hours during the engine periodic 2 and 4 check, and whenever the engine is inducted into engine bay; i.e. for a time expired component change. The card IE-1 of the engine periodic inspection calls for the visual inspection of the grey connector cable, and card IE-3 calls for the visual inspection of the oil pressure transmitter. The visual inspection of the oil pressure transmitter does not specifically call for a visual inspection of the mounting bracket.

2.2.2 Single Engine Considerations

Initial single engine considerations involved maintaining altitude and airspeed. In order to do so the serviceable engine was required to be operated in after-burner. This action increased the actual fuel consumption above the planned fuel consumption. Flight planning had indicated a fuel load of 2111 pounds on landing at Tinker Air Force Base. With one engine in after-burner, the actual fuel on landing would be less, so, in order to conserve fuel, the pilots elected to conduct a straight-in approach to runway 12, instead of the longer approach to the active runway 30. The investigation determined that the aircraft shut down with 1605 pounds of fuel remaining.

The loss of the right engine also affected the number two hydraulic system. This system is used for normal gear extension, normal braking, and nose wheel steering. The loss of these systems requires the pilot to conduct an “approach-end arrestment, if possible”.

2.3 Approach and Landing

2.3.1 Runway 12

The decision to conduct a straight-in approach to runway 12 was made after the crew considered such factors as fuel consumption and tailwind components. Pre-flight planning had included a cursory study of the airfield and the intent was to utilize the active runway 30, therefore no study of runway 12 was conducted. The crew were aware of the BAK-12 approach-end cable, but were unaware of its exact location. The Aircraft Operating Instructions (AOIs), chapter five, paragraph 171 states that approach-end arrestor cable is normally located 1500 – 2000 feet past the approach end of the runway. However, at Tinker Air Force Base the cables were moved to 1000 feet from the approach end of the runway in order to avoid the normal touchdown point of “heavy” aircraft.

In addition to the approach-end cable, there is an E-5 arrestor cable located 70 feet prior to the approach end of runway 12. The E5 (figure 2) is a unidirectional emergency arresting system. This system uses several lengths of ships' anchor chain as the energy absorber. The system is designed so that as an aborting aircraft engages the arrestor gear it causes the anchor chain to fold back on itself. The result is that the amount of drag progressively increases as the aircraft decelerates. In the case of this accident the arrestor gear was engaged by the airborne CF-18 traveling in the opposite direction. The result was that the entire drag of the anchor chain was immediately absorbed by the CF-18. A caution in the CF-18 AOIs state that “An engagement in the wrong direction with chain gear will severely damage the aircraft”.

2.3.2 Approach

Both the BAK-12 and E-5 cables are marked on the airport diagram; however, the exact distance of these cables from the threshold of the runway must be

determined using the United States Instrument Flight Rules (IFR) Supplement. The front-seat pilot indicated that he was aware of the presence of a BAK-12 arrestor cable, but was unaware of its exact location. As well, he could not visually locate the cable. Neither pilot requested the position of the cable from ATC, nor was this information passed to the crew. To ensure that he did not miss the approach-end cable he elected to land "right on the edge of the concrete". This was accomplished by placing the aircraft velocity vector on the runway threshold for a 3-degree glide path.

The CF-18 "How To Fly Manual" chapter one, section 140 states that during a normal landing (with no tail-hook) "the landing gear will touchdown about 250 feet short of the velocity vector aim point". Assessments by Boeing indicate that during an arrested landing (with tail-hook), the tail-hook will contact the ground 304 feet prior to the aim point for a three degree glide path, and 456 feet prior to the aim point for a two degree glide path (Figure 1). The investigation revealed that at the time of incident, the PIC did not consider the difference between the actual landing gear touchdown point and the velocity vector aim point, and he was unaware of the difference between the touchdown point of the tail-hook and the velocity vector aim point.

Analysis of the Mission System Data Recording System (MSDRS) shows the aircraft was on a four-degree glide path at two nautical miles from the runway. This continuously decreased to approximately zero degrees at touchdown. At the time of the E-5 cable engagement the aircraft was on a one-degree glide path. Boeing's analysis indicates that on a one degree glide path the tail-hook can contact the ground 911 feet prior to the aim point.

2.3.3 Landing

Approximately 110 feet prior to the threshold of runway 12 the aircraft's arrestor hook touched down. The E-5 arrestor cable was then engaged 70' prior to the threshold of runway 12. This occurred while the aircraft was still airborne. The left and right main landing gear then touched down short of the runway threshold by 54' and 40' respectively. The nose gear touched down on runway 12, 35' past the threshold.

The airborne engagement of the E-5 arrestor cable, which was configured for runway 30 overrun, resulted in the near instantaneous failure of the arresting hook and cable, and significant damage to various aircraft components (as listed in paragraph 1.3). On landing, the aircraft experienced significant and sudden directional control problems. The PIC was able to stabilize the aircraft before engaging emergency brakes. The aircraft came to a stop approximately 7500' from the threshold of runway 12. The BAK-12 arrestor cable was not engaged as intended due to damage to the aircraft arrestor tail-hook from the E-5 cable.

3 CONCLUSIONS

3.1 Findings

3.1.1 The crew experienced fluctuating oil pressure indications that necessitated securing the right engine. This resulted in the loss of the number two hydraulic system. (2.2.1)

3.1.2 The engine oil pressure transmitter mount had suffered a fatigue fracture (high cycle, low load condition) that caused premature wear of a connector pin, which in turn caused erratic oil pressure indication. (2.2.1)

3.1.3 The periodic inspection cards do not call for the visual inspection of the oil pressure transmitter mounting bracket. (2.2.1)

3.1.4 The inherent weakness of the CF-18 radios caused a delay in the communication of the emergency to ATC. (2.1)

3.1.5 Due to radio problems, the aircraft attempted to maintain altitude by utilising afterburner which resulted in an increase of fuel consumption. (2.1)

3.1.6 Due to an increase in actual fuel consumption over planned fuel consumption, the crew elected to conduct a straight-in approach to runway 12. (2.1)

3.1.7 The loss of number two hydraulics resulted in loss of normal gear extension, normal braking, and nose wheel steering. (2.2.2)

3.1.8 As per the check-list, the crew conducted an approach-end arrestor engagement. (2.2.2)

3.1.9 The crew was unaware of the location of the BAK-12 and E-5 arrestor cables, and they did not query ATC as to the location of the cables. (2.3.2)

3.1.10 The crew did not consider the difference between main wheel touch down point and velocity vector aim point. Detailed information that co-relates aim point and approach angle with tail hook and main landing gear touch down points is not available in the How to Fly Manual. (2.3.2)

3.1.11 The crew were unaware of the difference between tail-hook touch down point and velocity vector aim point. (2.3.2)

3.1.12 The PIC initially flew a very steep approach but then transitioned to a very shallow approach on short final. (2.3.2)

3.1.13 The aircraft arrestor gear touched down 110 feet prior to the runway threshold. (2.3.2)

3.1.14 The aircraft engaged the E-5 cable while still airborne. (2.3.3)

3.1.15 The E-5 cable failed due to overload almost instantaneously after being engaged by the aircraft. (2.3.3)

3.1.16 The failed cable and associated components caused damage to the arrestor hook assembly, right aileron, right flap and right horizontal stabilizer of the aircraft. (2.3.3 and 1.3)

3.2 Cause Factors

The pilot was unaware of the E-5 arrestor cable location and selected an aim point and glide path for landing which allowed the tail hook to contact the E-5 arrestor cable prior to the runway threshold. (2.3.2)

3.3 Contributing Factors

3.3.1 The design of the oil pressure transmitter (mount, wire, and connector) is prone to vibration-induced failures. (2.2.1)

3.3.2 Although the CF-18 “How To Fly” Manual states that the main wheels will touch down 250 feet prior to the pilots aim point, it does not make reference to the difference between the tail-hook touch down point and the aim point. (2.2.2)

3.3.3 The pilot was not aware of the location of the BAK 12 arrestor cable, could not visually locate it when on final, and did not query ATC on it’s location on the airfield. (2.3.2)

4 SAFETY MEASURES

4.1 Safety Measures Taken

4.1.1 Local ATC procedures at Tinker AFB were changed so that all aircraft conducting opposite direction full stop landings would be advised of the location of the E-5 unidirectional arrestor cable. (3.1.5)

4.1.2 The Royal Australian Air Force (RAAF) has identified a similar deficiency of their F-18 oil pressure transmitter systems. They have modified their oil pressure transmitter mounts to include isolation dampers. The RAAF's re-designed mount has resulted in a reduction of oil pressure caution indications. DND has finalized a license agreement with the RAAF to use their bracket design. This new "shock absorbing" mount is being trialed on Canadian CF-18 aircraft, but no decision has yet been made on a fleet wide modification. (3.1.2)

4.1.3 A review of current training was conducted to ensure that adequate emphasis is placed on the difference between the actual arrestor hook and landing gear touchdown points and the velocity vector aim point. It was determined that the current training is adequate and does not warrant a substantive change to flying training. (3.1.7)

4.2 Safety Measures Recommended

4.2.1 A visual inspection of the oil pressure transmitter mounting bracket should be conducted during any inspection that requires the oil pressure transmitter to be inspected. (3.1.3)

4.2.2 The Canadian CF-18 fleet should adapt an improved engine oil pressure transmitter bracket to replace the CF bracket as soon as possible. (4.1.2)

4.2.3 For approaches that intend to utilize the arrestor gear, the approach brief must state type and location of cables. The "How To Fly" Manual, chapter two, section 214, should be amended to include cable location and type under the "R" in "WRACEM" and "AMORTS" check. (3.1.5)

4.2.4 A caution be placed in the "How To Fly" manual section, chapter 1, section 153 warning that on a 3-degree glidepath the tail-hook will contract the ground approximately 300 feet prior to the velocity vector aim point. Figure one of this report should also be included in the "How To Fly" Manual. (3.3.3)

4.3 Other Safety Concerns

This aircraft was configured with a HUD recording capability, however it was not selected on. The HUD tape could have provided valuable information during the conduct of this investigation. As well, take-off and landings are critical phases of flight. It is recommended that the CF-18 HUD tape be on for all take-off and landings. From a Flight Safety perspective it is important that CF-18 aircraft be

equipped with an independent and crash-survivable, Cockpit Voice Recording, and Flight Data Recording, system.

4.4 DFS Remarks

This occurrence serves to highlight the problem with the CF188 oil pressure transmitter mount. In the past, the CF18 fleet has sustained false oil pressure indications, which resulted in a number of unnecessary engine shut-downs, single-engine landings, and arrested landings. As recently as August 2005 there was a single engine approach with an arrested landing that was attributed to a broken oil pressure transmitter bracket. This type of incident results in loss of mission effectiveness while it potentially places the aircrew and aircraft at higher levels of risk.

This accident may have not occurred had better communication between aircrew and Air Traffic Control been established early and timely clarification on the location of the arrestor cable been requested. It must be emphasized that ATC is not mandated to provide aircrew with the position of the various cable systems on the airfield. However, if they are asked for this information, they will provide it. Although not unique to the fighter community, there seems to be reluctance for some aircrew to ask for assistance. Therefore the message ‘When in doubt – ASK!’ needs to be continuously reinforced to all aircrew.

A.D. Hunter
Colonel
Director of Flight Safety

ANNEX A: PHOTOGRAPHS

Photo 1: Right Aileron.

Photo 2: Right Aileron

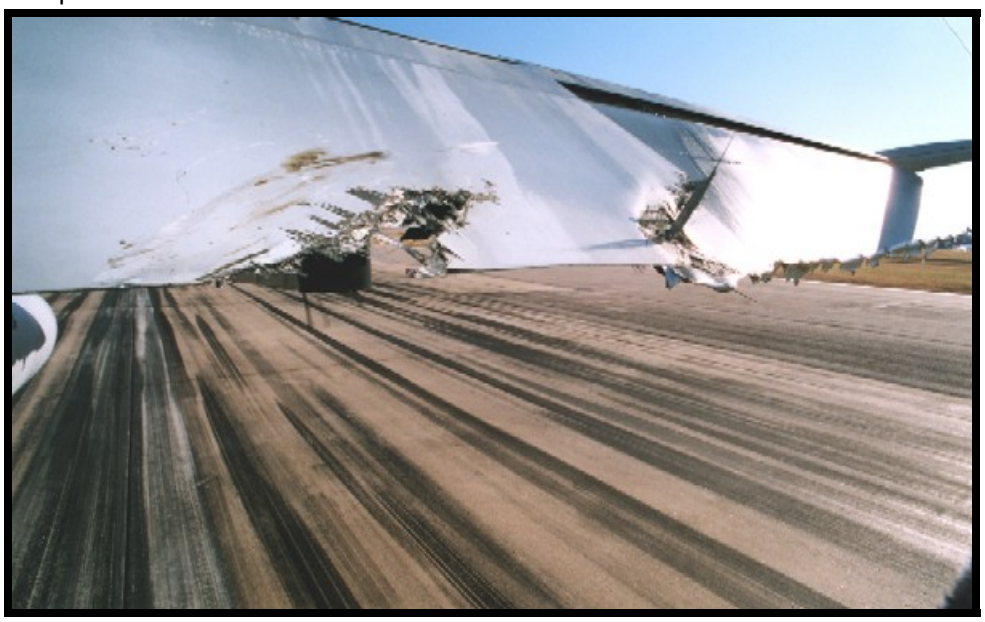

Photo 3: Right Flap.

Photo 4: Right Horizontal Stabilator.

Photo 5: Stop Arrestor Hook Assembly Showing Cracked Gear Bearing Sleeve Assembly

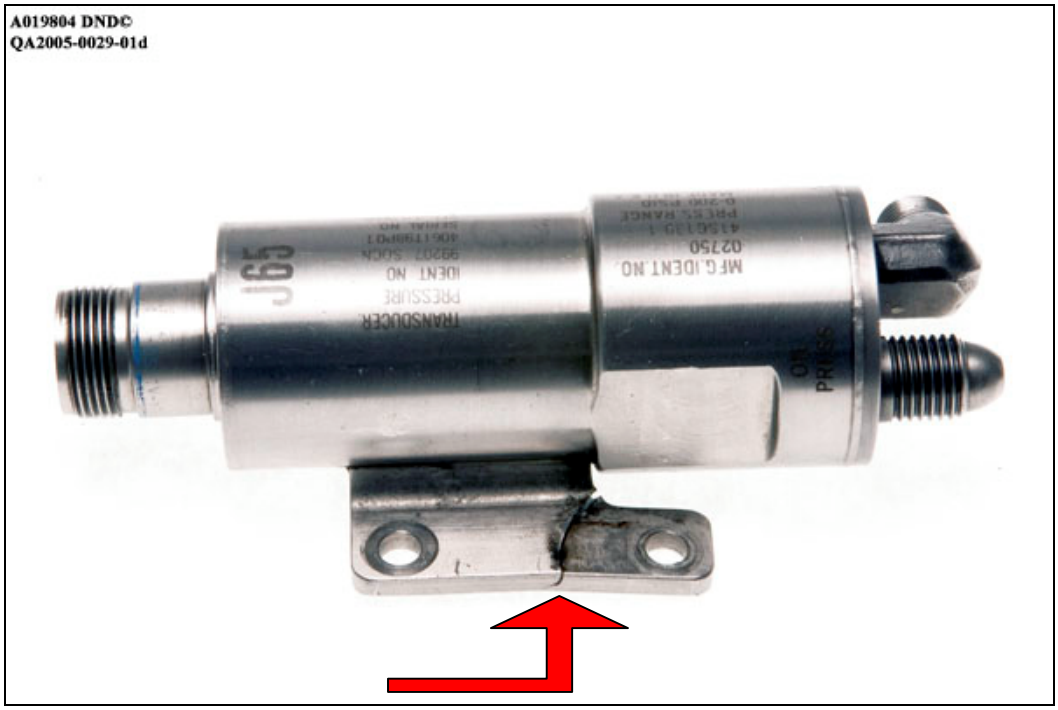

Photo 6: Oil Pressure Transmitter

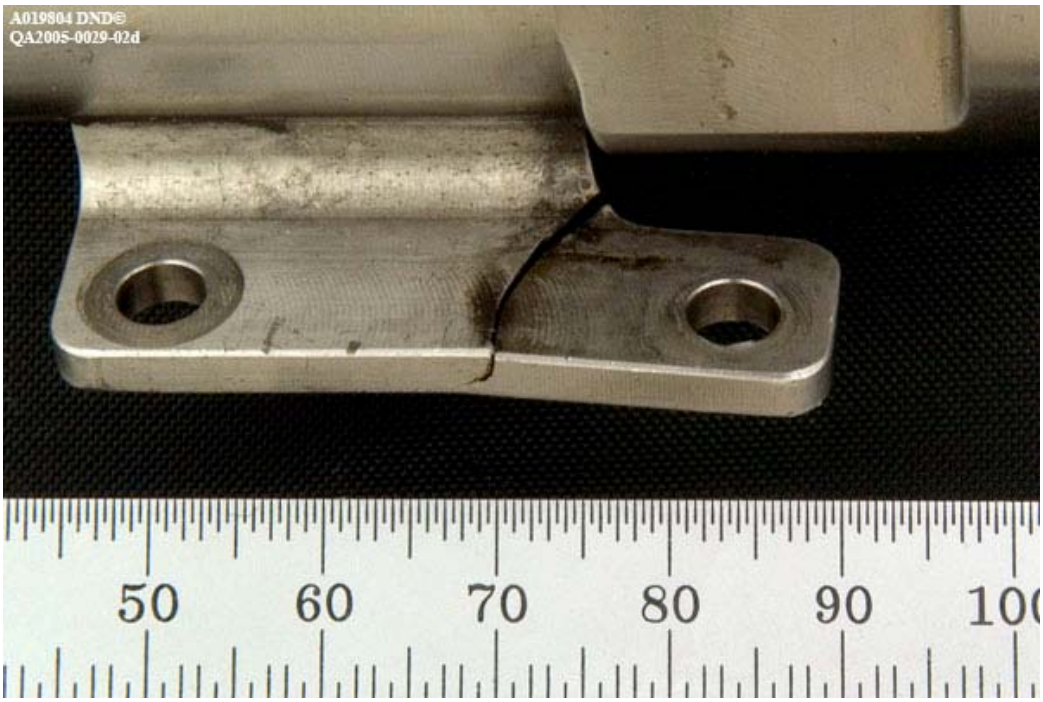

Photo 7: Close-up of cracked oil pressure transmitter mount

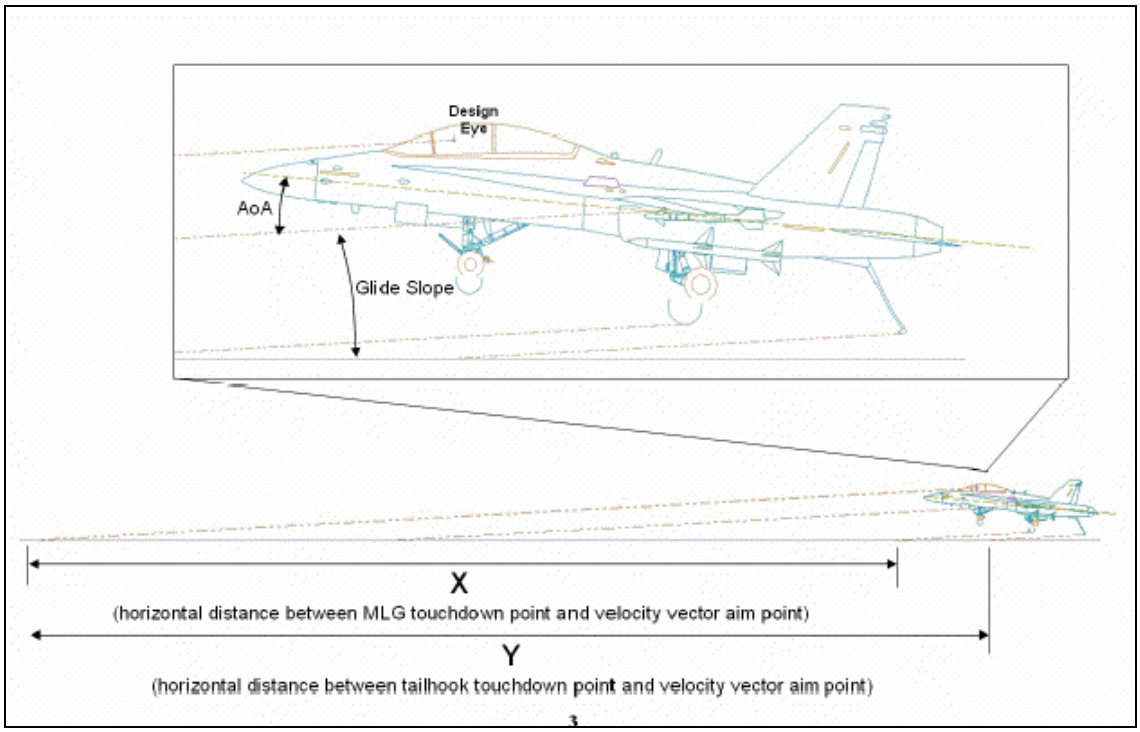

Figure 1: Angle of Attack

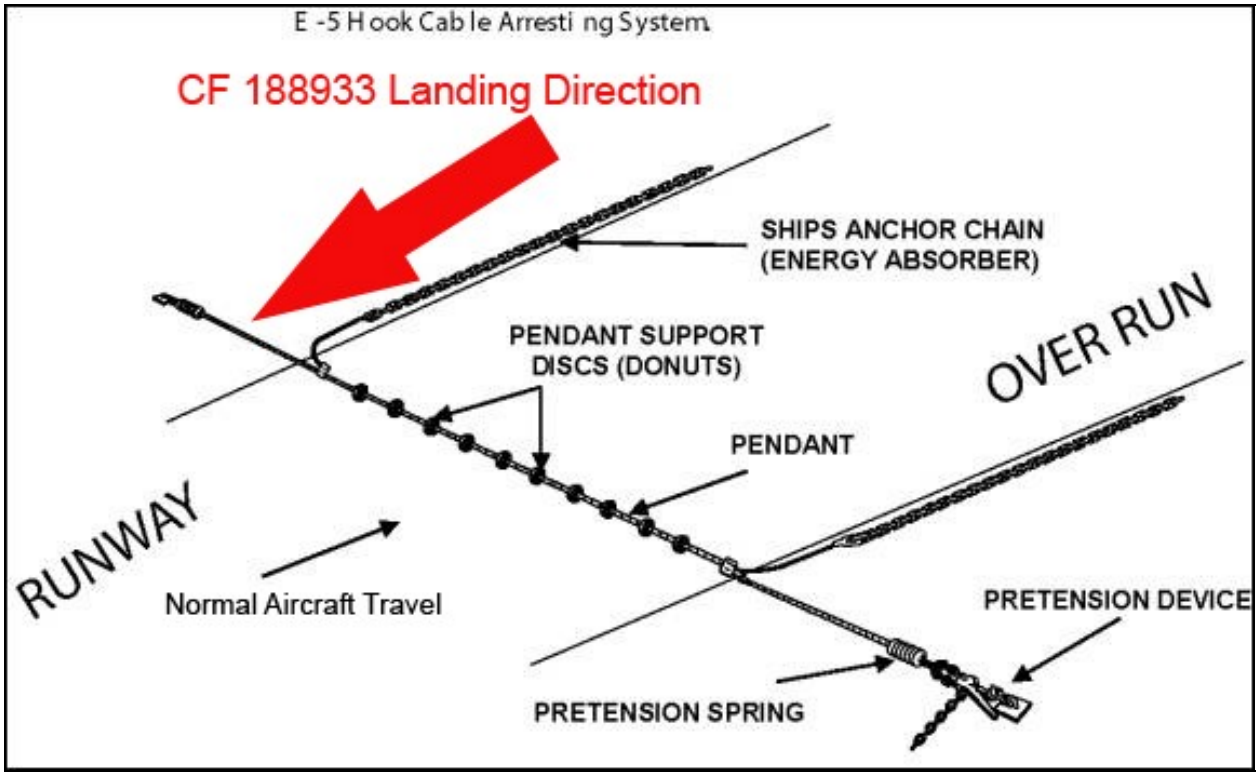

Figure 2: E-5 Arrestor System

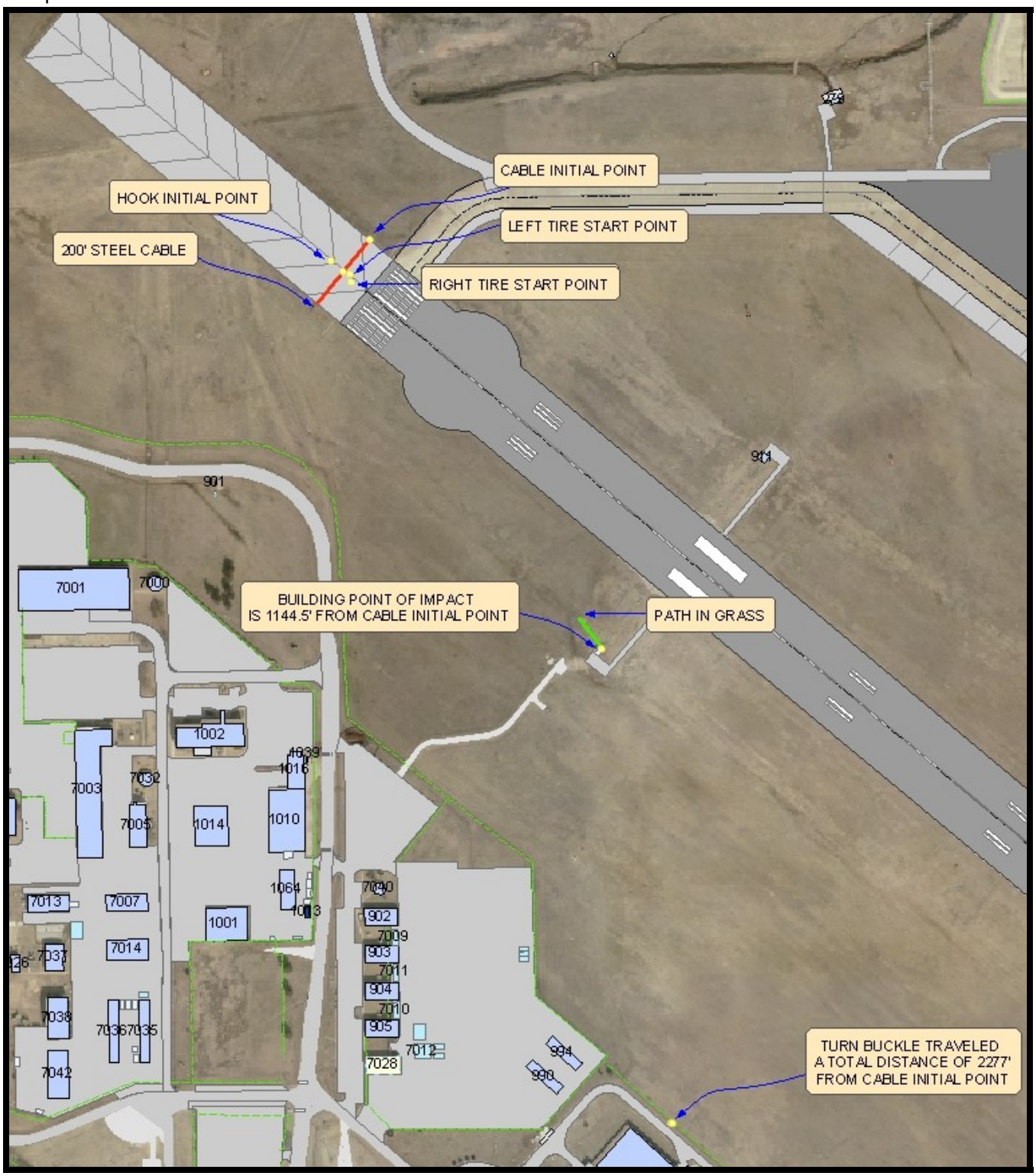

Figure 3: Tinker AFB Runway Diagram

ANNEX B: ABBREVIATIONS

AFB	Air Force Base
AOIs	Aircraft Operating Instructions
ATC	Air Traffic Control
CATM	Captive Air Training Missile
CDLS (W)	Canadian Defence Liaison Staff (Washington)
CVR	Cockpit Voice Recorder
DDI	Digital Display Indicator
DFS	Director of Flight Safety
DRDC (T)	Defence Research Development Canadian (Toronto)
FCS	Flight Control System
FDR	Flight Data Recorder
FSI	Flight Safety Investigation
HUD	Heads Up Display
KTIK	Location identifier for Tinker AFB
MMP	Maintenance Monitor Panel
MND	Minister of National Defence
MSDRS	Maintenance Signal Data Recording System
MRP	Maintenance Repair Party
NAS	Naval Air Station
NATO	North Atlantic Treaty Organization
NM	Nautical Miles
PAPI	Precision Approach Path Indicator
PFPS	Pre-Flight Planning Software
PIC	Pilot In Command

PSI	Pounds Per Square Inch
RAAF	Royal Australian Air Force
STANAG	NATO Standardization Agreement
USAF	United States Air Force