NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 3, 2018

Group Chairmen's Factual Report

OPERATIONAL FACTORS/HUMAN PERFORMANCE

DCA17IA148

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A. INCIDENT

Location: San Francisco International Airport (SFO)
Date: July 7, 2017
Time: 2356 PDT [1]
Airplane: Airbus A320-211, Canadian Registration C-FKCK

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[1] Pacific Daylight Time – all times in this report will be in PDT unless otherwise stated. At the time of the event Universal Time Coordinate (Zulu) was plus 7 hours.

C. SUMMARY

On July 7, 2017, about 2356 Pacific daylight time, Air Canada flight 759 (ACA759), an Airbus A320, Canadian registration C-FKCK, was cleared to land on runway 28R at San Francisco International Airport (KSFO[2]), San Francisco, California, but instead lined up on parallel taxiway C, where four air carrier airplanes (a Boeing 787 followed by an Airbus A340, another Boeing 787, and a Boeing 737) were awaiting takeoff clearance. ACA759 overflew the first airplane on the taxiway, and descended below 100 ft above the ground, and the ACA759 flight crew initiated a go around. The flight was operated under the provisions of 14 *Code of Federal Regulations* Part 129 as an international scheduled passenger flight from Toronto/Lester B. Pearson International Airport (CYYZ[3]), Toronto, Canada, with 135 passengers and 5 crewmembers on board. Night visual meteorological conditions prevailed at the time of the incident. The airplane was not damaged, and no injuries were reported.

D. DETAILS OF THE INVESTIGATION

On July 9, 2017, the Operational Factors group was formed, and a briefing of the event was provided by management. The briefing included radar data provided by the Air Traffic Control group.

On July 10, 2017, the Operational Factors Group Chairman contacted Air Canada and requested information including pilot information, training records, manuals, and other pertinent items.

On July 14, 2017, the Operational Factors and Human Performance group interviewed the incident captain via teleconference. The summary of that interview, located in the docket for this incident, is titled "Attachment 1 Operational Factors – Pilot Interview Summaries."

On July 16, 2017, the group Chairmen for the Operational Factors and Human Performance group participated in ATC Group interviews with one of the controllers that was on duty the night of the incident. The Group Chairman also toured the air traffic control tower and observed both day and nighttime operations. During each operation, the group chairman was able to observe 3 controllers at a minimum on duty, equipment available and how that equipment was used, location of the various controller positions, and the view of the arrivals to runways 28L and 28R. The summary of that interview is an attachment associated with the ATC Factual report, located in the docket for this incident.

On July 17, 2017, the Group Chairman for the Operational Factors and Human Performance group chairmen participated in ATC Group interviews with the Air Traffic Manager and the Front-Line Manager of the SFO tower facility. The summary of that interview is an attachment associated with the ATC Factual report, located in the docket for this incident.

[2] KSFO is the 4-letter ICAO identifier for San Francisco International Airport. The International Air Transport Association (IATA) and FAA use a 3-letter identifier of SFO.
[3] CYYZ is the 4-letter ICAO identifier for Toronto/Lester B. Pearson International Airport. The IATA 3-letter identifier is YYZ.

On July 18, 2017, the Operational Factors and Human Performance Group interviewed the incident First Officer, via telephone. The Operational Factors and Human Performance Group Chairmen subsequently participated in an interview with the incident controller and the Air Traffic Manager at Northern California (NORCAL) TRACON[4]. The summary of that interview is an attachment associated with the ATC Factual report, located in the docket for this incident.

On July 19, 2017, the Group Chairmen for the Operational Factors and Human Performance group participated in an interview, via teleconference, with the approach controller who vectored and subsequently cleared the Air Canada flight for the approach. The summary of that interview is an attachment associated with the ATC Factual report, located in the docket for this incident.

On July 20, 2017, the Group Chairman for Operational Factors along with the FAA group member were able to secure a helicopter flight in order to view the approach and runway lighting from the air at various points along the approach path. The helicopter flight was provided by the California Highway Patrol.

On July 24, 2017, the Group Chairmen for Operational Factors and Human Performance, along with the FAA group member and the Human Performance investigator with the TSB interviewed the flight crew of Delta Air Lines flight 521, the preceding flight into SFO, via teleconference.

On August 8, 2017, the Operational Factors and Human Performance groups reconvened at the Air Canada Airlines facility in Toronto, Ontario, Canada. The groups interviewed the Vice-President (VP) of Flight Operations, the VP of Safety, a check pilot that had recently flown with the incident captain, and a check pilot that had flown with the incident first officer during his previous upgrade training.

On August 9, 2017, the Operational Factors and Human Performance groups conducted simulator evaluations in an Airbus 320 simulator that was used by Air Canada. The groups also conducted interviews with two simulator check airmen who had recently conducted a simulator check with either the incident captain or first officer, and two line check airmen who had conducted training with the incident first officer during his unsuccessful upgrade training or during his training to return to the first officer position.

On August 10, 2017, the Operational Factors and Human Performance groups interviewed the Air Canada Airlines Assistant Chief Pilot in the A-320, two line check airmen who flew with the incident first officer following his return to the first officer seat, and re-interviewed the incident first officer and incident captain.

On August 11, 2017, the Operational Factors and Human Performance groups interviewed the Director of Training, the Director of Corporate Safety and Investigations, and the Managing Director of Crew Planning and Scheduling.

On August 24, 2017, members of the Operational Factors and Human Performance groups interviewed the Air Canada Airlines Airbus Chief Pilot via teleconference.

[4] Terminal Radar Approach Control

On August 30, 2017, members of the Operational Factors and Human Performance groups interviewed a first officer that had flown with the incident captain the night prior to the incident flight, via teleconference.

On August 31, 2017, members of the Operational Factors and Human Performance groups interviewed a captain that had flown with the incident first officer to SFO, 2 nights prior to the incident flight, via teleconference.

E. FACTUAL INFORMATION

1.0 History of Flight

AC flight 759 was a scheduled flight from YYZ to SFO. The first officer reported that he obtained the dispatch release while at his residence, before leaving for the airport. Once at the airport, the first officer was notified by the flight's dispatcher that there was a new version of the release out, after which he acquired the new release via his iPad and a hard copy from the airline's printers in the briefing room. The crew met at the gate and noted that the inbound flight's arrival delayed their departure. AC flight 759 had an original scheduled departure time of 2055 eastern daylight time (EDT) (0055Z) and an original arrival time of 2303 PDT (0603Z); however, it departed 30 minutes late. The crew discussed the weather expected enroute and reviewed their dispatch paperwork, which included NOTAMs for SFO. Both crewmembers indicated that they were aware of the closure of runway 28L, which was NOTAMed to occur at 2300 PDT (0600Z).

According to the crew, the departure from YYZ was uneventful; however, they had to maneuver around weather on the departure. The flight climbed to FL320[5] and was later given clearance from air traffic control to climb to FL360. The flight had been filed for FL320 with a step climb to FL360. The captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM). According to interviews with the flight crew, the cruise and descent were uneventful; however, about midpoint the flight had to navigate around an area of weather.

Prior to arrival into the SFO area, the first officer obtained the ATIS[6] information "Quebec" via the airplane's ACARS[7] and printed out the information[8]. Considering the weather information and the reported runway in use, the crew anticipated landing to the west and briefed for the FMS Bridge Visual Approach to runway 28R.

The captain conducted the approach briefing, which included briefing the Air Canada specific Jeppesen 19-3-1 page, FMS BRIDGE VISUAL RWY 28R[9], minimum weather requirements, an anticipated taxi route to the gate after landing, and the missed approach procedures.

[5] Flight Level 320 which is the altitude above mean sea level at a standard barometric pressure of 29.92 inches of mercury
[6] Automatic Terminal Information Service
[7] Aircraft Communication Addressing and Reporting System
[8] See Section 4.1 – ACARS Weather and the Operational Factors/Human Performance Attachment 6 - ACARS Information for further weather information.
[9] See Operational Factors/Human Performance Attachment 11 - Approach Charts

The crew was issued the DYMND 3 arrival and were cleared to descend via that arrival. Subsequently, the flight was instructed to and subsequently contacted, Northern California (NORCAL) approach.

Following their communication with NORCAL approach the flight was issued a heading and was vectored off of the arrival and later vectored back toward the initial approach point for the FMS BRIDGE VISUAL RWY 28R approach. The flight was issued traffic that the crew was to follow. They were then queried if they had the airport in sight, to which they acknowledged that the field was in sight. The flight was then cleared for the BRIDGE VISUAL RWY 28R approach and the crew was instructed to contact the SFO Air Traffic Control Tower (ATCT).

The crew reported that the approach was flown, by the autopilot, until prior to the final waypoint on the approach, which was labeled as F101D, at which point the captain disconnected the autopilot and hand flew the remainder of the approach. The captain requested that the first officer verify that their runway was clear. ATC voice recordings included the following[10]:

> 2355:45 ACA759 *Just want to confirm this is air canada seven five nine we see some lights on the runway there across the runway. Can you confirm we're cleared to land?*
>
> 2355:52[11] ATCT *air canada seven five nine confirmed cleared to land runway two eight right. There's no one on runway two eight right but you.*
>
> 2355:59 United Airlines 1 *Where's this guy going*
>
> 2356:02 United Airlines 1 *He's on the taxiway*
>
> 2356:09 ATCT instructed ACA759 to go around

During post incident interviews, the first officer reported that prior to his query to the ATCT if the runway was clear he was looking more inside the cockpit than out because, as the PM, he was required to set the missed approach altitude and the anticipated heading for a missed approach. These tasks required him to look inside at his approach chart to obtain that information. He further stated that when the captain asked him to query the control tower, he looked outside, and it "didn't look right." Although he was not certain what was incorrect, he was unable to process what he was seeing. He subsequently commanded the go around to the captain by saying "go around go around." According to the captain, that was simultaneous to him beginning the go around. During the initiation of the go around, the ATCT controller also issued go around instructions.

During the downwind leg for the second approach, the first officer asked the captain if they should "tune in the ILS[12]" to which the captain agreed.

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[10] See ATC Group Chairman Factual Report

[11] This time was an estimate. There was no ATC transcript developed for this event; however, the beginning of the statement occurred approximately 7 seconds after the beginning of the previous statement.

[12] Instrument Landing System

The remainder of the flight was uneventful.

1.1 Previous Arrival – Crew Statement[13]

The flight preceding the incident flight landed on runway 28R about 4 minutes prior to the incident. The flight crew of the preceding flight reported that the "construction lights were so bright we could not determine the location of the inboard runway, 28L." Visually acquiring the runway, both crewmembers reported questioning if they were lined up for runway 28R; however, after crosschecking with the LNAV[14] they were able to determine they were lined-up for runway 28R. They received additional confirmation about 300 feet above ground level (agl) when the captain visually acquired the painted "28R" on the paved surface of the runway. The captain of that flight further reported that the aircraft on taxiway C were stopped and had their taxi lights off, which "helped to create this misconception that taxiway C was RWY 28R."

1.2 Taxiway C – Crew Statements[15]

The airplanes waiting on Taxiway "C" for departure consisted of two Boeing 787 airplanes, one Airbus 340 airplane, and a Boeing 737 airplane. The crewmembers of those airplanes provided the NTSB with written statements.

2.0 Flight Crew Information

The incident flight crew consisted of a captain (CA), first officer (FO), and 3 flight attendants.

2.1 The Captain

According to Air Canada records, Transport Canada records, and interview statements, the following information pertained to the captain:

Age at the time of the incident:	56
Seniority Date of hire at Air Canada:	February 15, 1988
Prior aviation employment:	Canadian Airlines

The captain held a Canadian Airline Transport Pilot – Aeroplane License issued October 2, 2015. The license was endorsed with a blanket type rating for All Single Pilot Non-High Performance, Single and Multiengine Land Aeroplanes and was endorsed with type ratings on the AT42, B73A, BA31, E120, EA32[16], SECOND OFFICER DC10. He also held Group 1 Instrument Rating under the Transport Canada regulations. He also held a Category 1 Medical Certificate dated December 20, 2016, which was valid until January 1, 2018 when operating under the provisions of his Airline Transport Pilot – Aeroplane License. The validity was reduced to July 1, 2017 if used during single pilot air transport service carrying passengers. The medical certificate had a limitation of "Glasses Must Be Worn."

Prior to Air Canada, the captain was a pilot at Canadian Airlines where he was a second officer on the DC-10 and then a first officer on the B-737, until the merger with Air Canada in 2000. Prior to

[13] See Operational Factors/Human Performance Attachment 4 – Preceding Flight Crew Statements
[14] Lateral Navigation
[15] See Operational Factors/Human Performance Attachment 3 – Airplanes on Taxiway "C" Statements
[16] Airbus A320, Airbus A319, A321. SRCE Transport Canada, Standard 421 – Flight Crew Permits, Licences and Ratings https://www.tc.gc.ca/eng/civilaviation/regserv/cars/part4-standards-t42102-1393.htm

Canadian Airlines, the captain flew for Ontario Express where he flew as a first officer in the BA-3100, then as a captain in the BA-3100, then as a captain in the EMB-120 Brasilia, and subsequently as a captain on the ATR-42. Prior to Ontario Express, the captain flew for Bradley Air Services, operating Twin Otter aircraft in the Canadian Arctic.

The captain reported that he had never had any accidents or incidents during his flying career, nor had he ever failed any checkrides during his aviation career.

2.1.1 The Captain's Pilot Certificates and Ratings Held at Time of the Incident

Canadian issued AIRLINE TRANSPORT PILOT – AEROPLANE LICENCE (Issued October 2, 2015)
All Single Pilot Non-High Performance
Single-Engine Land Aeroplanes
Multiengine Land Aeroplanes
AT42, B73A, BA31, E120, EA32, SECOND OFFICER DC10

CATEGORY 1 MEDICAL CERTIFICATE (Issued December 20, 2016)
Limitations:
Glasses Must Be Worn

2.1.2 The Captain's Training and Proficiency Checks Completed

Air Canada Seniority Date	February 15, 1988
Date of Initial Command LOFT[17]	March 27, 2007
Date of CFLC[18]	April 3, 2007
Date of Intro to Command[19]	April 27, 2007
Date of Most Recent Operating Experience (OE)	March 8, 2017
Date of Most recent LOE[20]	February 24, 2017
Date of Most Recent MTV[21]	February 23, 2017
Date of Most Recent Recurrent Training	January 20, 2017

2.1.3 The Captain's Flight Times

The captain's flight times, based on Air Canada Airlines employment records and pilot provided flight times:

Total pilot flying time[22]	20,000

[17] Line Oriented Flight Training
[18] Command Final Line Check – Required by Air Canada Airlines for any pilot upgrading to captain for the first time at Air Canada
[19] Introduction to Command includes 5 hours of crew resource management and 8 hours of Command Scenarios
[20] Line Operational Evaluation
[21] Maneuvers Training and Validation
[22] Flight time was estimated by the captain. Source Attachment 1 – Crew Interview Summaries

Total Pilot-In-Command (PIC) time[23]	4,797:08
Total A320 flying time	7,063:23
Total A320 PIC time	4,797:08
Total A320 SIC[24] time	2,266:15
Total flying time last 24 hours[25]	5:52
Total flying time last 7 days[26]	11:09
Total flying time last 30 days	55:47
Total flying time last 90 days	166:12

2.1.4 The Captain's 72-Hour History

On Wednesday, July 5, the captain stated he went to bed between 0030 and 0100 EDT and awoke between 0700 and 0800 EDT. This was his day off.

On Thursday, July 6, he went to bed about 0000 EDT and awoke about 0800. He reported on duty between 1600 and 1700 and flew a round-trip to LGA. He went off duty about 2313 EDT and cleared customs, took the train to the parking lot, walked to his vehicle, and drove home. He stated that this flight "threw off his sleep cycle a little bit" since they arrived so late.

On Friday, July 7, he fell asleep between 0200 and 0300 and awoke about 0745 by his children. About 1120, crew scheduling called to notify him that he had been assigned a flight. He did not take any naps that day and reported to the airport by 1940 for the flight. The incident flight departed at 2125 EDT and this was the incident flight. Prior to the incident flight he considered himself rested. He started feeling fatigued about midpoint on the incident flight, about the time they encountered the area of thunderstorm activity.

2.1.5 The Captain's Personal Background

The incident captain was 56 years old and lived in Toronto, Canada with his wife and children. He normally obtained between 6 and 7 hours of sleep per day and felt rested following that amount of sleep. He did not consider himself either a morning or an evening person. He consistently went to bed after midnight but felt when travelling, that it was "hard to get into a rhythm." He typically had a difficult time winding down and falling asleep immediately after flights. In the three nights prior to the incident flight, he classified his sleep quality as "fair" due to his age. After a 3-day trip, he typically felt ok with the rest schedule. He did not have any history of sleep disorders. There had been no changes to his health, financial situation, or personal life within the preceding year He reported no issues with health, color vision or hearing, but stated he did not exercise as much as he would like. He did not take any prescription medications. He did drink alcohol

[23] Total PIC Time was based on the PIC time at Air Canada
[24] Second-in-Command
[25] This included the incident flight which was the only flight flown. Previous flight was completed on 06 July at 2253 EDT (0253Z)
[26] Flying time previous 7 days does **not** include the incident flight or subsequent return flight. The time consisted of a roundtrip flight on 01 July and 02 July from YYZ to Calgary International Airport (CYYC) and a round trip flight on 06 July from YYZ to KLGA.

occasionally and the last time he consumed a beverage was on Monday, July 3, however, he could not recall for certain. He did not smoke tobacco nor use illicit drugs. He did not take any medication in the 72 hours prior to the event.

2.2 The First Officer

According to Air Canada records, Transport Canada records, and interview statements, the following information pertained to the first officer:

Age at the time of the incident:	42
Seniority Date of hire at Air Canada:	December 3, 2007
Prior aviation employment:	Air Georgian

The first officer held a Canadian Airline Transport Pilot – Aeroplane License issued November 30, 2015. The license was endorsed with a blanket type rating for All Single Pilot Non-High Performance, Single and Multiengine Land Aeroplanes and with type ratings on the BE02, E170, EA32. He held a Group 1 Instrument Rating, under the Transport Canada regulations. He held a Category 1 Medical Certificate dated May 12, 2017 which was valid until June 1, 2018 when operating under the provision of his Airline Transport Pilot – Aeroplane License. The validity was reduced to December 1, 2017 if used during single pilot air transport service carrying passengers.

Prior to Air Canada, the first officer was a pilot at Air Georgian where he flew a Cessna Caravan airplane, then the Piper Cheyenne II, and then the Beech 1900D. While at Air Georgian he was also a training captain.

The first officer reported that he had never had any accidents or incidents during his flying career.

The first officer reported that he had attempted previously to upgrade to captain. After two unsatisfactory attempts, however, he elected to return to the first officer seat. Air Canada records showed that on February 6 and 7, 2017, the first officer had passed his command LOE training. On March 1, 2017, he had an unsatisfactory on his QOE[27] and a second unsatisfactory QOE on March 16, 2017.

According to the simulator instructors and checkairmen that conducted the incident first officer's upgrade attempt, the reason for the unsatisfactory upgrade was the first officer's lack of situational awareness, failure to correctly identify a mandatory altitude on an arrival, non-precision approaches, and a lack of performance to the Transport Canada required performance standards. Some of the instructors and checkairmen categorized the incident first officer as "nervous" and "a weak candidate."[28]

According to Air Canada's Flight Operation Director of Safety and Training, the incident first officer's requalification to the right seat was to complete anything that had been missed within the normal training footprint. For the incident first officer that required a MTV and LOE and an

[27] Qualifying Oriented Evaluation
[28] SRCE: Operational Factors/Human Performance Attachment 2 - Air Canada Personnel Interviews pgs. 18, 23, 35, and 69

additional OE. The OE was the only one of the required items to be conducted in the aircraft and the rest of the items were to be completed in the simulator. The Flight Operation Director of Safety and Training had no concern about the first officer's training plan as "the weak items were going to be covered."[29]

2.2.1 The First Officer's Pilot Certificates and Ratings Held at Time of the Incident

Canadian issued AIRLINE TRANSPORT PILOT – AEROPLANE LICENCE (Issued November 30, 2015)
All Single Pilot Non-High Performance
Single-Engine Land Aeroplanes
Multiengine Land Aeroplanes
BE02, E170, EA32

CATEGORY 1 MEDICAL CERTIFICATE (Issued May 12, 2017)

2.2.2 The First Officer's Training and Proficiency Checks Completed

Air Canada Seniority Date	December 3, 2007
Date of Initial QLOE[30]	March 28, 2013
Date of Most Recent Maneuvers Training	April 8, 2017
Date of Most Recent LOFT	April 9, 2017
Date of Most recent OE	April 25, 2017
Date of Most Recent Recurrent Training	December 29, 2016

2.2.3 The First Officer's Flight Times

The incident first officer's flight times, based on Air Canada Airlines employment records and pilot provided flight times:

Total pilot flying time[31]	10,000
Total SIC time in the A-320	2,343:18
Total flying time in A-320	2,343:18
Total flying time last 24 hours	5:52
Total flying time last 7 days[32]	17:57
Total flying time last 30 days	70:02
Total flying time last 90 days	148:08

[29] SRCE: Operational Factors/Human Performance Attachment 2 - Air Canada Personnel Interviews. Director of Safety and Training Pg. 69
[30] Qualifying Line Oriented Evaluation
[31] First Officer estimated the total flight time
[32] Flying time previous 7 days does **not** include the incident flight or subsequent return flight. The time consisted of a roundtrip flight on 06 July from YYZ to SFO and a round trip flight, a 1 leg flight on 2 July from Halifax Stanfield International Airport (YHZ) to YYZ, and a 3 leg flight day on 01 July which consisted of a round trip leg from YYZ to YHZ and a subsequent leg from YYZ to YHZ.

2.2.4 The First Officer's 72-Hour History

Monday, July 3 and Tuesday, July 4 were his days off. He stated that he got a "proper" night's sleep on Tuesday evening.

On Wednesday, July 5, he awoke about 0800 and took a nap in the afternoon for 90 minutes. He spent time with his children for about an hour and then got ready for work. He flew a flight to SFO that night.

On Thursday, July 6, he arrived in SFO, went to sleep about 0400 EDT and woke up about 1000 EDT. He got breakfast with his captain for that flight and went for a walk. He took a one-hour nap and flew back to Toronto that night.

On Friday, July 7, the flight to Toronto arrived about 0030 and he went to bed about 0300. He awoke about 0900. The rest of the day, he "took it easy." His wife and kids were out so he was able to sleep in. He had lunch around noon and took a 90-minute nap about 1300. He woke up from the nap, spent time with his kids, had dinner and went back to work arriving at 1910 for a 1940 report time. He departed on the incident flight to SFO that evening. He stated that both he and the captain began to feel tired about 0200-0300 EDT on Saturday, July 8.

2.2.5 The First Officer's Personal Background

The incident first officer was 42 years old and lived in Toronto, Canada with his wife and children. He felt he needed 8 hours of sleep per night to feel rested and considered himself to be a heavy sleeper. He considered himself a "normal day person" as his children did not allow him to be a night person. He stated he is normally more alert in the evenings however, about 2300, he typically felt sleepy. He would have liked to sleep until 0800 to 0900 if he could. If he was flying a night flight, he normally took a nap in the afternoon for about 90 minutes. He slept well during naps and felt rested following them. He had no history of sleep disorders or changes to his health in the past year.

He reported no changes to his health, financial situation, nor personal life within the preceding year that affected his performance. He reported no issues with health or color vision, and although he passed his medical without wearing glasses but did use them when he flew. He had no issues with his hearing and was not taking any prescription medication. He drank alcohol 3-5 times per week usually consuming a glass of wine or beer with dinner. Prior to the incident he stated his last drink was likely with dinner on Monday or Tuesday, but he could not recall. He did not smoke tobacco nor use illicit drugs. He did not take any medication that would have affected his performance in the 72 hours preceding the incident flight.

2.3 Canadian Airline Transport Pilot License[33]

According to Canadian Aviation Regulation (CAR), Standard 421 – Flight Crew Permits, Licences and Ratings, Division V-III AIRLINE TRANSPORT PILOT LICENCE, CAR 421.34 Aeroplanes – Requirements, states a pilot must meet the following requirements to obtain a Canadian Airline Transport Pilot License:

[33] SRCE: Transport Canada website Canadian Aviation Regulations (CARs)
http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part4-standards-421-1086.htm#421_34

(1) Age

An applicant shall be a minimum of twenty-one years of age.

(2) Medical Fitness

(a) An applicant shall hold a Category 1 Medical Certificate valid for an Airline Transport Pilot Licence - Aeroplane.
(b) The licence holder may exercise Private Pilot Licence - Aeroplane privileges until the end of the medical period specified for the Private Pilot Licence.
(c) The licence is maintained by a valid Category 1 Medical Certificate.

(3) Knowledge

An applicant shall have obtained a minimum of 70% in each of three written examinations on the following aviation subjects:
(a) Airline Transport Pilot Licence (Aeroplane) Meteorology, Radio Aids to Navigation and Flight Planning (SAMRA) including:

(i) general system of weather collection and dissemination,
(ii) weather map, weather forecast, weather abbreviations, symbols and nomenclature,
(iii) pressure systems and their association with fronts, cloud forms and icing conditions,
(iv) the movement of upper winds and their effect on aircraft operations,
(v) weather service circulars and instructions for air route meteorological service which are pertinent to aircraft operations, and
(vi) radio communication procedures relating to aircraft operation; and

(b) Airline Transport Pilot Licence (Aeroplane) Air Law, Aeroplane Operation and Navigation General (SARON) including:

(i) basic principles of air navigation such as formulae, instruments and other navigational aids which are commonly used in the navigation of aircraft,
(ii) basic principles of loading and weight distribution and their effect on flight characteristics,
(iii) Canadian Aviation Regulations, Air Traffic Rules and Procedures, Information Circulars and NOTAM, and
(iv) human factors, including pilot decision-making; and

(c) Instrument Rating (INRAT).

(4) Experience

An applicant shall have met the training requirements for the issue of a Commercial Pilot Licence - Aeroplane that is not restricted to daylight flying and completed a minimum of

1500 hours total flight time of which a minimum of 900 hours shall have been completed in aeroplanes. The total flight time shall include a minimum of:

(a) 250 hours pilot-in-command flight time in aeroplanes which shall include where applicable, a maximum of 100 hours pilot-in-command under supervision flight time completed in accordance with Section 421.11. The pilot-in-command and/or pilot-in-command under supervision flight time shall include a minimum of 100 hours cross-country flight time of which a minimum of 25 hours shall have been by night;

(b) 100 hours night flight time as pilot-in-command or as co-pilot of which a minimum of 30 hours shall have been acquired in aeroplanes;

(c) 100 additional hours cross-country flight time as pilot-in-command or 200 hours as co-pilot or any combination thereof, with flight time calculated in accordance with section 421.10. Flight time as pilot-in-command may be part of the 250 hours pilot-in-command flight time specified in paragraph (a); and

(d) 75 hours instrument flight time of which a maximum of 25 hours may have been acquired in approved instrument ground trainers and a maximum of 35 hours may have been acquired in helicopters. Instrument ground time shall not be applied toward the total 1500 hour flight time requirement.

(5) Skill

(a) Within the 12 months preceding the date of application for the licence, an applicant shall demonstrate in a multi-engined aeroplane with no central thrust configuration and fitted with instruments and equipment suitable for IFR flight in controlled airspace, familiarity with and the ability:

(i) to perform both normal and emergency flight procedures and manoeuvres appropriate to the aeroplane in which the flight test is conducted; and

(ii) to execute all manoeuvres and procedures set forth in Division XIV for issue of a Group 1 instrument rating.

(b) For issue of the Airline Transport Pilot Licence - Aeroplane, the Minister shall only endorse a Group 1 Instrument Rating on the licence.

(6) Credits – Experience

a) Glider

Where an applicant holds a Pilot Licence - Glider, a maximum of 50 hours flight time in gliders shall be credited towards the total 1500 hour flight time requirement.

b) Three Axis Ultra-light Aeroplanes

Where an applicant holds a Pilot Permit - Ultra-light Aeroplane, a Recreational Pilot Permit – Aeroplane, a Private Pilot Licence – Aeroplane or a Commercial Pilot Licence – Aeroplane, a maximum of 50 hours flight time in three axis ultra-light aeroplanes shall be credited towards the total 1500 hour flight time requirement.

(7) Credits for DND Applicants

Active and retired Canadian Forces personnel who hold a Canadian Forces Instrument Rating (unrestricted) in a multi-engined aeroplane (Group 1) shall be deemed to have met the skill requirement.

2.4 Canadian Medical Certificate[34]

According to Canadian Aviation Regulation, Subpart 4 – Medical Requirement; Division II – Medical Certificate; "Issuance, Renewal, Validity Period and Extension of a Medical Certificate"; Section 404.04 states, in part:

(6.1) *The validity period of a medical certificate for a commercial pilot licence, a multi-crew pilot licence — aeroplane and an airline transport pilot licence, if the holder of the licence is acting as a flight crew member for hire or reward, is 12 months.*

(6.2) *However, the validity period of a medical certificate referred to in subsection (6.1) is reduced to 6 months if*

(a) *the holder of the licence is 40 years of age or older and is conducting a single-pilot operation with passengers on board; or*

(b) *the holder of the licence is 60 years of age or older.*

(6.3) *The holder of a commercial pilot licence or an airline transport pilot licence may exercise the privileges of a private pilot licence until the end of the applicable validity period for the private pilot licence specified in subsection (*6).

3.0 Aircraft Information

Figure 1: Incident Airplane (Courtesy of Air Canada)

[34] SRCE: Canadian Aviation Regulations – Justice Laws Website http://laws-lois.justice.gc.ca/eng/regulations/SOR-96-433/FullText.html#s-404.04

The incident airplane (see figure 1) was an Airbus A320-211 (Canadian Registration C-FKCK), Serial No. 265, and was manufactured in 1992. The registered owner was GECAS[35], and was operated by Air Canada Airlines. It held a transport category airworthiness certificate dated January 17, 1992. The airplane had a maximum ramp weight of 170,667 pounds, and had a total passenger seating capacity of 154, and contained 3 flight crew seats and 5 cabin crew seats. A review of NTSB and FAA records found that the incident airplane had not been involved in any previous accidents or incidents that merited a formal investigation.[36] The incident airplane was not equipped with a GPS navigation system at the time of the incident.

The airplane was powered by two CFM56-5A1 engines, each capable of producing 25,000 pounds of thrust. Each engine was managed by a Full Authority Digital Engine Control (FADEC) system, which provided engine indications and thrust limit displays on the upper Electronic Centralized Aircraft Monitoring (ECAM) flight deck displays. Power settings for the CFM56 were based on a percentage of N1[37].

The airplane's most recent inspection occurred on June 25, 2017. At the time of the inspection, it had accrued 82,427 total hours in service.

3.1 Weight and Balance for YYZ to SFO

WEIGHT & BALANCE (maximum certificated weights in **bold**) (in kilograms)[38]	
Basic Empty Weight[39]	43,330
Galley Weight for SFO	940
Operational Empty Weight[40]	44,290
Baggage (16kg/bag)/Cargo Weight[41]	1,905
Passenger Weight (135 passengers x 82 kg/Passenger[42])	11,070
Zero Fuel Weight	57,265
Maximum Zero Fuel Weight	**61,000**
Takeoff Fuel Weight	17,400
Ramp Weight	74,665
Maximum Taxi Weight	**77,400**

[35] GE Capital Aviation Services, which according to their website was the world's leading commercial aircraft and engine lessor and lender. SRCE: https://www.gecas.com/en/index.html?TYPE=33554433&REALMOID=06-e831190a-256f-1047-87eb-84fafcf8fb65&GUID=&SMAUTHREASON=0&METHOD=GET&SMAGENTNAME=-SM-ijROHSQ5CXKhksgnGHreGbTKPWXBHbBCmHJFJA%2fQqsP6Cn7UCXohLufSvQSgJZNH&TARGET=-SM-http%3a%2f%2fwww%2egecas%2ecom%2f

[36] SRCE: http://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx

[37] N1 refers to rotational speed of the low pressure turbine as a percentage of nominal "full thrust" value.

[38] To convert from kilograms (kg) to pounds (lbs) multiple kg by 2.2046226218 pounds

[39] This weight includes the standard basic empty weight of the airplane, plus standard items such as fixed equipment, unusable fuel, system fluids, normal crewmembers, etc. SRCE: PUB 160 Chapter 5, pg. 3

[40] Basic Empty Weight plus operational items such as galley, additional crewmembers, etc. SRCE: PUB 160 Chapter 5 pg. 3

[41] Source: Operational Factors/Human Performance Attachment 8 - Ramp Reconciliation Report

[42] Source: Air Canada Weight and Balance Manual, A319/A320/A321, Publication 160, chapter 5

Taxi Fuel Burn	200
Actual Takeoff Weight	74,465
Maximum Takeoff Weight (Structural)[43]	**77,000**
Maximum Allowable Takeoff Weight	76,300
Estimated Fuel Burn	13,800
Estimated Weight on Landing	62,300
Actual Landing Weight[44]	60,309
Maximum Landing Weight	**64,500**
CG (Takeoff)	32.8
CG Range (Takeoff)[45]	23.2 – 38.6
Stabilizer Unit	0.7 Down

3.2 Dispatch Release

According to the dispatch release provided by the operator, the following was an excerpt of NOTAMS provided to the crew prior to their departure from YYZ:

TEMP WAT CHARTS NOT REQD

SFO 19.Sep.2007 1546z - UFN CN815/07 - CO NOTAM
THE DESTINATION AND/OR ALTERNATE AIRPORT IS A GROUP II FAA SPECIAL QUALIFICATION AIRPORT. THE CAPTAIN MUST MEET CERTAIN REQUIREMENTS TO OPERATE INTO THIS AIRPORT - SEE FOM 5.4.5.2 OR JEPPESEN AIR CANADA "AIRPORT QUALIFICATION" PAGE.

Runway

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z DA7026/17
SFO 07/026 SFO RWY 10R/28L CLSD 1707080600-1707081500

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z DA7025/17
SFO 07/025 SFO RWY 01R/19L CLSD 1707080600-1707081500

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z 1A2281/17
RWY 10R/28L CLSD

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z 1A2280/17
RWY 01R/19L CLSD

SFO 02.Jun.2017 1357z - 21.Jul.2017 1500z 1A1951/17
RWY 28L ALS U/S

Figure 2: Predeparture NOTAMs Provided to Incident Crew

4.0 Meteorological Information

Airport weather observations for SFO were obtained from the National Weather Service. Airport weather information found in the METAR[46] for SFO originated from an Automated Surface Observing System (ASOS). The following METARs were issued for SFO for the time period surrounding the incident:

[2256 PDT] METAR KSFO 080556Z 29012KT 10 SM CLR 17/09 A2993 RMK AO2 SLP 135 T01720094=

[43] Source: Aircraft Operating Manual Vol 1 "Limitations" P9
[44] Source: Email from a representative of Air Canada. However, the 6120.1 Accident/Incident form completed by a representative of Air Canada showed a landing weight of 142,000 pounds which converted to 64,410 Kg.
[45] CG limits are given in percentage of the reference chord length aft of the leading edge. SRCE AOM Vol 1 Limitations P4
[46] Meteorological Terminal Air Report

[2356 PDT] METAR KSFO 080656Z 29009KT 10 SM CLR 16/09 A2992 RMK ZO2 SLP 132 T01610089=

[0056 PDT] METAR KSFO 080756Z 270008KT 10 SM CLR 16/09 A2992 RMK AO2 SLP 131 T01610089=

According to the United States Naval Observatory, Astronomical Applications Department website[47], official sunset was at 2034 and the end of civil twilight was 2105, official moonrise was 1927. The moon was a waxing gibbous with 98% of the moon's visible disk illuminated.

4.1 ACARS Weather

According to Air Canada records the crew requested the ATIS information via the aircraft ACARS at 23:21:11. The ACARS provided information "Q," which was the current ATIS at the time of the incident. ATIS "Q" included the ASOS weather information that was recorded at 2256 PDT, reported using the QUIET BRIDGE VA (Visual Approach), flights were landing on runway 28R and departing from runway 1L, and included the following NOTAMs:

- Runway 28L, 10R Closed
- Runway 1R, 19L closed
- Taxiway "J" was closed
- Taxiway "S1" was closed
- Taxiway "F" closed between Taxiway "L" and Runway 1L
- Taxiway "F1" closed between Taxiway "L" and runway 1L
- Runway 28L Approach Lights System out of service
- Runway 28L/10R Centerline Lights out of service
- Multiple cranes up to 275 feet, west and south of SFO airport

[47] Source: USNO Website
http://aa.usno.navy.mil/rstt/onedaytable?ID=AA&year=2017&month=7&day=7&state=CA&place=San+Francisco

07/08/2017 06:21:11
Input SMI = DAI
Message Length = 676
<CR><LF>
<SOH>QU DDLXCXA<CR><LF>
.ATSACXA 080621<CR><LF>
<STX>DAI<CR><LF>
AN C-FKCK<CR><LF>
- /ATSACXA.TI2/KSFO ARR ATIS Q<CR><LF>
0556Z SFO ATIS INFO Q 0556Z. 31012KT 10SM CLR 17/09 A2993 (TWO NINER NINER THREE
).<CR><LF>
QUIET BRIDGE VA IN USE. LNDG RWYS 28R. DEPG RWYS 1L. NOTAMS... RWYS 28L, 10R<CR>
<LF>CLSD, RWYS 1R, 19L CLSD. TWY J CLSD, TWY S1 CLSD. TWY F CLSD BETWEEN TWY L,
RWY<CR><LF>
1L, TWY F1 CLSD BTWN TWY L, RWY 1L. RY 28L ALS OTS, RY 28L/10R CL LGTS OTS.<CR><
LF>MULTIPLE CRANES UP TO 275 FEET, WEST AND SOUTH OF SFO AIRPORT. ASSC IN USE AC
TVT<CR><LF>
TRNSPNDR WITH MODE C ON ALL TYS AND RWYS. READBACK OF ALL RWY HOLDING<CR><LF>
INSTRUCTIONS IS REQUIRED. ALL ACFT ARE RQRD TO INCL ACFT CLSGN IN ALL RDBKS AND<
CR><LF>ACKMTS. ...ADVS YOU HAVE INFO Q.281B<CR><LF>
<ETX><EOT>

Figure 3: ACARS Transmission sent to Incident Flight

4.2 NOTAMs[48]

The following NOTAMs were in effect at SFO at the time of the incident:

!SFO 11/095 SFO RWY 28R DECLARED DIST: TORA 11870FT TODA 11870FT ASDA 11870FT LDA
11236FT. 1611220012-PERM
!SFO 11/094 SFO RWY 28L DECLARED DIST: TORA 11381FT TODA 11381FT ASDA 10981FT LDA
10275FT. 1611220012-PERM
!SFO 04/189 SFO TWY S2 BTN TWY Z AND TWY S3 CLSD TO ACFT WINGSPAN MORE THAN 215FT
1604291657-PERM
!SFO 05/248 SFO TWY N CL LGT BTN TWY F AND RWY 10L/28R OUT OF SERVICE
1705291227-PERM
!SFO 11/011 SFO APRON TAXILANE H1 CLSD 1611040934-PERM
!FDC 5/7988 SFO CANCELLED BY FDC 6/0989 ON 10/16/16 00:00
!FDC 7/6636 SFO IAP SAN FRANCISCO INTL,
San Francisco, CA.
RNAV (GPS) Z RWY 28R, AMDT 5A...

[48] SRCE: Operational Factors/Human Performance Group Attachment 7 – FAA NOTAMS

LPV DA VISIBILITY RVR 1800 ALL CATS.
THIS IS RNAV (GPS) Z RWY 28R, AMDT 5B. 1706212031-PERM
!FDC 7/6632 SFO IAP SAN FRANCISCO INTL,
San Francisco, CA.
RNAV (GPS) RWY 28L, AMDT 5A...
CHART NOTE: ASTERISK, ASTERISK RVR 1800 AUTHORIZED WITH USE OF FD OR AP OR HUD TO DA. CHANGE LPV DA TO LPV DA ASTERISK, ASTERISK.
THIS IS RNAV (GPS) RWY 28L, AMDT 5B. 1706212029-PERM
!SFO 02/024 SFO OBST CRANE 2016-AWP-3215-NRA 373656N1222304W (1500FT W APCH END RWY 01L)
133FT (125FT AGL) FLAGGED AND LGTD 1702031340-2208031340
!SFO 02/023 SFO OBST CRANE 2016-AWP-3080-NRA 373654N1222303W (1500FT W APCH END RWY 01L)
133FT (125FT AGL) FLAGGED AND LGTD 1702031340-2208031340
!SFO 02/025 SFO OBST CRANE 2016-AWP-3216-NRA 373650N1222318W (1500FT W APCH END RWY 01L)
133FT (125FT AGL) FLAGGED AND LGTD 1702031340-2208031340
!SFO 02/026 SFO OBST CRANE 2016-AWP-3217-NRA 373643N1222311W (1500FT W APCH END RWY 01L)
133FT (125FT AGL) FLAGGED AND LGTD 1702031340-2208031340
!SFO 02/027 SFO OBST CRANE 2016-AWP-3218-NRA 373648N1222258W (1500FT W APCH END RWY 01L)
133FT (125FT AGL) FLAGGED AND LGTD 1702031340-2208031340
!SFO 10/047 SFO OBST CRANE (ASN 2016-AWP-2427-OE) 373536N1222306W (1.6NM SSW SFO) 100FT
(61FT AGL) LGTD 1610112035-1804112300
!SFO 03/212 SFO OBST CRANE (ASN 2016-AWP-2987-NRA) 373724N1222352W (1.1NM WNW SFO) 251FT
(245FT AGL) FLAGGED AND LGTD 1703242254-1712161200
!SFO 03/213 SFO OBST CRANE (ASN 2016-AWP-2988-NRA) 373724N1222353W (1.1NM WNW SFO) 251FT
(245FT AGL) FLAGGED AND LGTD 1703242255-1712161200
!SFO 03/214 SFO OBST CRANE (ASN 2016-AWP-2989-NRA) 373723N1222353W (1.1NM WNW SFO) 251FT
(245FT AGL) FLAGGED AND LGTD 1703242300-1712161200
!SFO 03/215 SFO OBST CRANE (ASN 2016-AWP-2990-NRA) 373723N1222355W (1.1NM WNW SFO) 251FT
(245FT AGL) FLAGGED AND LGTD 1703242308-1712161200
!SFO 03/216 SFO OBST CRANE (ASN 2016-AWP-2991-NRA) 373722N1222356W (1.1NM WNW SFO) 251FT
(245FT AGL) FLAGGED AND LGTD 1703242308-1712161200
!FDC 6/7354 SFO STAR SAN FRANCISCO INTL., SAN FRANCISCO, CA.
BIG SUR THREE ARRIVAL...FROM OVER ANJEE INT CHANGE MINIMUM HOLDING ALTITUDE TO READ: 11000FT.
1612061900-1712052359EST
!FDC 6/7361 SFO STAR SAN FRANCISCO INTL., SAN FRANCISCO, CA.

BIG SUR THREE ARRIVAL...FROM OVER BSR VORTAC TO CARME, THENCE FROM OVER CARME TO ANJEE INT REVISE MINIMUM EN ROUTE ALTITUDE TO READ: 11000FT.
1612061900-1712052359EST
!SFO 04/069 SFO OBST CRANE (ASN 2016-AWP-2357-NRA) 373703N1222260W (0.4NM WSW SFO) 251FT
(240FT AGL) FLAGGED AND LGTD 1704100700-1711301200
!FDC 6/9114 SFO STAR SAN FRANCISCO INTL, SAN FRANCISCO, RISTI FOUR ARRIVAL ADD NOTE TO READ: PROPS AND TURBO PROPS ONLY.
1611162030-1711152359
!FDC 6/9115 SFO STAR SAN FRANCISCO INTL., SAN FRANCISCO, CA. POINT REYES TWO ARRIVAL SAC VORTAC TO POPES INT, MEA 5100.
1611162030-1711152359EST
!FDC 7/5661 SFO SID SAN FRANCISCO INTL, San Francisco, CA.
SSTIK THREE DEPARTURE (RNAV)...
WESLA THREE DEPARTURE (RNAV)...
YYUNG TRANSITION NA.
ALL OTHER DATA REMAINS AS PUBLISHED. 1704051317-1711151317EST
!SFO 07/029 SFO OBST CRANE (ASN 2016-AWP-1309-OE) 373960N1222356W (3.1NM NNW SFO) 372FT
(298FT AGL) FLAGGED AND LGTD 1607071857-1711100100
!FDC 7/2076 SFO ODP SAN FRANCISCO INTL, San Francisco, CA.
TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES AMDT 9...
TAKEOFF MINIMUMS: RWY 28L, 28R, STANDARD WITH A MINIMUM CLIMB OF 415FT PER NM TO 1300.
ADD NOTE: RWY 19R, TEMPORARY CRANE 935FT FROM DER, 609FT RIGHT OF CENTERLINE, 125FT AGL/
135FT MSL (2016-AWP-2003-NRA). RWY 28L, TEMPORARY CRANE 1.39 NM FROM DER, 2831FT LEFT OF
CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). RWY 28R, TEMPORARY CRANES
BEGINNING 3043FT FROM DER, 762FT RIGHT OF CENTERLINE, UP TO 120FT AGL/ 131FT MSL
(2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA). TEMPORARY CRANE 1.31 NM FROM DER,
3581FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). ALL OTHER DATA
REMAINS AS PUBLISHED. 1703291326-1711081326EST
!FDC 7/2077 SFO SID SAN FRANCISCO INTL, San Francisco, CA.
GAP SEVEN DEPARTURE...
MOLEN EIGHT DEPARTURE...
OFFSHORE ONE DEPARTURE...
SAN FRANCISCO FOUR DEPARTURE...
TAKEOFF MINIMUMS: RWY 28L, 28R, STANDARD WITH A MINIMUM CLIMB OF 415FT PER NM TO 1300.

ADD TAKEOFF OBSTACLE NOTE: RWY 19R, TEMPORARY CRANE 935FT FROM DER, 609FT RIGHT OF
CENTERLINE, 125FT AGL/ 135FT MSL (2016-AWP-2003-NRA). RWY 28L, TEMPORARY CRANE 1.39 NM
FROM DER, 2831FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). RWY 28R,
TEMPORARY CRANES BEGINNING 3043FT FROM DER, 762FT RIGHT OF CENTERLINE, UP TO 120FT AGL/
131FT MSL (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA). TEMPORARY CRANE 1.31 NM
FROM DER, 3581FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). ALL OTHER
DATA REMAINS AS PUBLISHED. 1703291326-1711081326EST
!FDC 7/9012 SFO IAP SAN FRANCISCO INTL, SAN FRANCISCO, CA.
ILS OR LOC RWY 28L, AMDT 25A ...
ILS RWY 28L (SA CAT II), AMDT 25A ...
TERMINAL ROUTE ARCHI (IAF) TO PONKE/I-SFO 21.6 DME MINIMUM ALTITUDE 6000
1702282122-1710102119EST
!SFO 03/277 SFO OBST RIG (ASN UNKNOWN) 373723N1222353W (1.16NM WNW SFO) 96FT (86FT AGL) FLAGGED 1703311400-1710020001
!SFO 06/142 SFO APRON TXL M1, M2 CLSD 1706261717-1709010700
!SFO 05/132 SFO RWY 10R/28L NOT GROOVED 1705172226-1709010500
!FDC 7/0273 SFO CA..SPECIAL NOTICE..SAN FRANCISCO INTERNATIONAL, CALIFORNIA, RWY STATUS LGTS ARE IN AN OPR TEST ON RWY 10L/28R, RWY 10R/28L, RWY 01L/19R, RWY 01R/19L AND MUST BE COMPLIED WITH. RWY STATUS LGT ARRAYS MAY BE OFFLINE INTERMITTENTLY THROUGHOUT THE TEST
PHASE. RWY STATUS LGTS ARE RED IN-PAVEMENT LGTS THAT SERVE AS WARNING LGTS ON RWYS AND TWYS INDICATING THAT IT IS UNSAFE TO ENTER, CROSS, OR BEGIN TKOF ON A RWY. NOTE: RWY STATUS LGTS INDICATE RWY STATUS ONLY. THEY DO NOT INDICATE CLEARANCE. PILOTS AND VEHICLE OPRS MUST STILL RECEIVE A CLEARANCE FROM AIR TRAFFIC CONTROL BEFORE PROCEEDING. FOR ADDITIONAL INFORMATION VISIT:
HTTP://WWW.FAA.GOV/AIR_TRAFFIC/TECHNOLOGY/RWSL 1705231700-1708302359
!SFO 04/166 SFO TWY J CLSD 1704140651-1708012359
!SFO 02/057 SFO OBST CRANE (ASN 2016-AWP-74-NRA) 373644N1222308W (0.6NM SW SFO) 158FT
(150FT AGL) FLAGGED AND LGTD 1602111446-1708012300
!SFO 04/167 SFO TWY J CL LGT OUT OF SERVICE 1704140651-1708011200
!SFO 03/164 SFO APRON TAXILANE M CL LGT OUT OF SERVICE 1703211939-1707311300
!FDC 7/5705 SFO IAP SAN FRANCISCO INTL, San Francisco, CA.
RNAV (RNP) Z RWY 10R, AMDT 2A...
RNP 0.20 DA 409/ HAT 399 ALL CATS. TEMPORARY CRANES UP TO 131 MSL BEGINNING 3980FT

NORTHWEST OF RWY 10R (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA).
1704051332-1707301332EST
!FDC 7/5704 SFO SID SAN FRANCISCO INTL, SAN FRANCISCO, CA.
AFIVA ONE DEPARTURE (RNAV)...
GNNRR TWO DEPARTURE (RNAV)...
NIITE THREE DEPARTURE (RNAV)...
OFFSHORE ONE DEPARTURE...
SAN FRANCISCO FOUR DEPARTURE...
SNTNA TWO DEPARTURE (RNAV)...
TRUKN TWO DEPARTURE (RNAV)...
WESLA THREE DEPARTURE (RNAV)...
ADD TAKEOFF OBSTACLE NOTE: RWY 28R, TEMPORARY CRANES BEGINNING 3043FT FROM DER, 762FT
RIGHT OF CENTERLINE, UP TO 120FT AGL/ 131FT MSL (2015-AWP-1790-NRA, 2015-AWP-1839
THROUGH 1842-NRA). ALL OTHER DATA REMAINS AS PUBLISHED. 1704051331-1707301331EST
!SFO 06/018 SFO NAV ILS RWY 28L CAT II NA 1706021405-1707211500
!SFO 06/017 SFO RWY 28L ALS OUT OF SERVICE 1706021357-1707211500
!SFO 07/032 SFO OBST TOWER LGT (ASR 1205149) 374114.40N1222605.30W (5.1NM NW SFO)
1566.9FT (311.0FT AGL) OUT OF SERVICE 1707072337-1708072337
!SFO 07/031 SFO TWY D BTN RWY 10R/28L AND TWY B CLSD 1707101330-1707101800
!SFO 07/030 SFO RWY 10L/28R CLSD 1707100700-1707101430
!SFO 07/027 SFO RWY 10L/28R CLSD 1707090300-1707091500
!SFO 07/028 SFO RWY 01R/19L CLSD 1707090300-1707091500
!SFO 07/025 SFO RWY 01R/19L CLSD 1707080600-1707081500
!SFO 07/026 SFO RWY 10R/28L CLSD 1707080600-1707081500
!SFO 07/033 SFO NAV ILS RWY 28L OUT OF SERVICE 1707080600-1707081500

4.2.1 NOTAMs Provided to Crew

Prior to departure from YYZ the crew was provided a flight plan, or "briefing package" both electronically, via their company-issued iPads, and via printout, which the incident first officer printed in the company provided briefing area, prior to going to the departure gate. During the crew interviews, the incident first officer stated that, prior to leaving his residence he had downloaded their flight plan onto his company issued iPad, in order to review the route of flight. Arriving at YYZ, dispatch contacted him via his cellular phone and informed him that there had been a second release generated, which he recalled was due to an "increase in the zero-fuel weight."[49] The following NOTAMs, applicable to SFO, were provided on pages 7 through 10 of 27 pages, under the bookmark tab "AIRPORT NOTAMs," to the flight crew via the "Air Canada Flight Plan Release 2"[50]:

[49] SRCE: Operational Factors/Human Performance Attachment 1 – Flight Crew Interview Summaries pg. 13
[50] SRCE: Operational Factors/Human Performance Attachment 5 - Incident Flight's Briefing Page

DESTINATION

KSFO [SFO] - SAN FRANCISCO INTL

Airport

SFO 26.Jun.2017 1717z - 01.Sep.2017 0700z 1A2197/17
TXL M1, M2 **CLSD**

SFO 29.May.2017 1227z - PERM 1A1882/17
TWY N CL LGT BTN TWY F AND **RWY** 10L/28R **U/S**

SFO 14.Apr.2017 0651z - 01.Aug.2017 1200z 1A1302/17
TWY J CL LGT **U/S**

SFO 14.Apr.2017 0651z - 01.Aug.2017 2359z 1A1301/17
TWY J **CLSD**

SFO 10.Apr.2017 0700z - 30.Nov.2017 1200z DA4069/17
SFO 04/069 SFO **OBST CRANE** (ASN 2016-AWP-2357-NRA) 373703N1222260W
(0.4NM WSW SFO) 251FT (240FT AGL) FLAGGED AND LGTD
1704100700-1711301200
.
TEMP WAT CHARTS NOT REQD.

SFO 24.Mar.2017 2254z - 16.Dec.2017 1200z DA3212/17
SFO 03/212 SFO **OBST CRANE** (ASN 2016-AWP-2987-NRA) 373724N1222352W
(1.1NM WNW SFO) 251FT (245FT AGL) FLAGGED AND LGTD
1703242254-1712161200
.
TEMP WAT CHARTS NOT REQD.

SFO 21.Mar.2017 1939z - 31.Jul.2017 1300z 1A975/17
TAXILANE M CL LGT **U/S**

SFO 03.Feb.2017 1340z - 03.Aug.2022 1340z DA2027/17
SFO 02/027 SFO **OBST CRANE** 2016-AWP-3218-NRA 373648N1222258W (1500FT
W APCH END **RWY** 01L) 133FT (125FT AGL) FLAGGED AND LGTD
1702031340-2208031340
.
TEMP WAT CHARTS NOT REQD

SFO 03.Feb.2017 1340z - 03.Aug.2022 1340z DA2025/17
SFO 02/025 SFO **OBST CRANE** 2016-AWP-3216-NRA 373650N1222318W (1500FT
W APCH END **RWY** 01L) 133FT (125FT AGL) FLAGGED AND LGTD
1702031340-2208031340
.
TEMP WAT CHARTS NOT REQD

SFO 04.Nov.2016 0934z - PERM 1A2850/16
APRON TAXILANE H1 **CLSD**

SFO 11.Oct.2016 2035z - 11.Apr.2018 2300z DA10047/17
SFO 10/047 SFO **OBST CRANE** (ASN 2016-AWP-2427-OE) 373536N1222306W
(1.6NM SSW SFO) 100FT (61FT AGL) LGTD 1610112035-1804112300

TEMP WAT CHARTS NOT REQD

SFO 07.Jul.2016 1857z - 10.Nov.2017 0100z DA7029/17
SFO 07/029 SFO **OBST CRANE** (ASN 2016-AWP-1309-OE) 373960N1222356W
(3.1NM NNW SFO) 372FT (298FT AGL) FLAGGED AND LGTD
1607071857-1711100100
.
TEMP WAT CHARTS NOT REQD

SFO 11.Feb.2016 1446z - 01.Aug.2017 2300z DA2057/17
SFO 02/057 SFO **OBST CRANE** (ASN 2016-AWP-74-NRA) 373644N1222308W
(0.6NM SW SFO) 158FT (150FT AGL) FLAGGED AND LGTD
1602111446-1708012300
.
TEMP WAT CHARTS NOT REQD

SFO 19.Sep.2007 1546z - UFN CN815/07 - CO NOTAM
THE DESTINATION AND/OR ALTERNATE AIRPORT IS A GROUP II FAA SPECIAL
QUALIFICATION AIRPORT. THE CAPTAIN MUST MEET CERTAIN REQUIREMENTS TO
OPERATE INTO THIS AIRPORT - SEE FOM 5.4.5.2 OR JEPPESEN **AIR CANADA**
"AIRPORT QUALIFICATION" PAGE.

way

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z DA7026/17
SFO 07/026 SFO **RWY** 10R/28L **CLSD** 1707080600-1707081500

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z DA7025/17
SFO 07/025 SFO **RWY** 01R/19L **CLSD** 1707080600-1707081500

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z 1A2281/17
RWY 10R/28L **CLSD**

NEWSFO 08.Jul.2017 0600z - 08.Jul.2017 1500z 1A2280/17
RWY 01R/19L **CLSD**

SFO 02.Jun.2017 1357z - 21.Jul.2017 1500z 1A1951/17
RWY 28L ALS **U/S**

SFO 23.May.2017 1700z - 30.Aug.2017 2359z 1A1802/17
RWY STATUS LGTS ARE IN AN OPR TEST ON **RWY** 10L/28R, **RWY**
10R/28L, **RWY** 01L/19R, **RWY** 01R/19L AND MUST BE COMPLIED WITH. **RWY**
STATUS LGT ARRAYS MAY BE OFFLINE INTERMITTENTLY THROUGHOUT THE TEST
PHASE. **RWY** STATUS LGTS ARE RED IN-PAVEMENT LGTS THAT SERVE AS
WARNING LGTS ON RWYS AND TWYS INDICATING THAT IT IS UNSAFE TO ENTER,
CROSS, OR BEGIN TKOF ON A **RWY**. NOTE: **RWY** STATUS LGTS INDICATE **RWY**
STATUS ONLY. THEY DO NOT INDICATE CLEARANCE. PILOTS AND VEHICLE OPRS
MUST STILL RECEIVE A CLEARANCE FROM AIR TRAFFIC CONTROL BEFORE
PROCEEDING. FOR ADDITIONAL INFORMATION VISIT:
HTTP://WWW.FAA.GOV/AIR?TRAFFIC/TECHNOLOGY/RWSL

SFO 17.May.2017 2226z - 01.Sep.2017 0500z 1A1708/17
RWY 10R/28L NOT GROOVED

SFO 10.Feb.2017 2033z - UFN DA11095/17
SFO 11/095 SFO **RWY** 28R DECLARED DIST:
TORA 11870FT **TODA** 11870FT **ASDA** 11870FT **LDA** 11236FT.
1611220012-PERM
.
TEMP WAT CHARTS NOT REQD
OPT/**ACARS**/PERF ALREADY UPDATED WITH THIS INFORMATION

SFO 10.Feb.2017 2033z - UFN DA11094/17
SFO 11/094 SFO **RWY** 28L DECLARED DIST:
TORA 11381FT **TODA** 11381FT **ASDA** 10981FT **LDA** 10275FT.
1611220012-PERM
.
TEMP WAT CHARTS NOT REQD
OPT/**ACARS**/PERF ALREADY UPDATED WITH THIS INFORMATION

SFO 22.Nov.2016 0012z - PERM 1A2941/16
RWY 28R DECLARED DIST: **TORA** 11870FT **TODA** 11870FT **ASDA** 11870FT
LDA 11236FT
.
TEMP WAT CHARTS NOT REQD
DATA IS UPDATED IN PERF/**ACARS**/OPT

SFO 22.Nov.2016 0012z - PERM 1A2940/16
RWY 28L DECLARED DIST: **TORA** 11381FT **TODA** 11381FT **ASDA** 10981FT
LDA 10275FT
.
.
TEMP WAT CHARTS NOT REQD
DATA IS UPDATED IN PERF/**ACARS**/OPT

SID

SFO 05.Apr.2017 1331z - UFN 1A1173/17
AFIVA ONE DEPARTURE (RNAV)...
GNNRR TWO DEPARTURE (RNAV)...
NIITE THREE DEPARTURE (RNAV)...
OFFSHORE ONE DEPARTURE...
SAN FRANCISCO FOUR DEPARTURE...
SNTNA TWO DEPARTURE (RNAV)...
TRUKN TWO DEPARTURE (RNAV)...
WESLA THREE DEPARTURE (RNAV)...
ADD TAKEOFF **OBSTACLE** NOTE: **RWY** 28R, TEMPORARY **CRANES** BEGINNING
3043FT FROM DER, 762FT RIGHT OF CENTERLINE, UP TO 120FT AGL/
131FT MSL (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA).
ALL OTHER DATA REMAINS AS PUBLISHED.
.
TEMP WAT CHARTS NOT REQD

SFO 05.Apr.2017 1317z - UFN 1A1172/17
SSTIK THREE DEPARTURE (RNAV)...
WESLA THREE DEPARTURE (RNAV)...
YYUNG TRANSITION **NOT AUTHORIZED**.
ALL OTHER DATA REMAINS AS PUBLISHED.

SFO 29.Mar.2017 1326z - UFN 1A1082/17
GAP SEVEN DEPARTURE...
MOLEN EIGHT DEPARTURE...
OFFSHORE ONE DEPARTURE...
SAN FRANCISCO FOUR DEPARTURE...
TAKEOFF MINIMUMS: **RWY** 28L, 28R, STANDARD WITH A MINIMUM CLIMB OF 415FT PER NM TO 1300. ADD TAKEOFF **OBSTACLE** NOTE: **RWY** 19R, TEMPORARY **CRANE** 935FT FROM DER, 609FT RIGHT OF CENTERLINE, 125FT AGL/ 135FT MSL (2016-AWP-2003-NRA). **RWY** 28L, TEMPORARY **CRANE** 1.39 NM FROM DER, 2831FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). **RWY** 28R, TEMPORARY **CRANES** BEGINNING 3043FT FROM DER, 762FT RIGHT OF CENTERLINE, UP TO 120FT AGL/ 131FT MSL (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA). TEMPORARY **CRANE** 1.31 NM FROM DER, 3581FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). ALL OTHER DATA REMAINS AS PUBLISHED.
.
TEMP WAT CHARTS NOT REQD

SFO 29.Mar.2017 1326z - UFN 1A1081/17
TAKEOFF MINIMUMS AND (**OBSTACLE**) DEPARTURE PROCEDURES AMDT 9...
TAKEOFF MINIMUMS: **RWY** 28L, 28R, STANDARD WITH A MINIMUM CLIMB OF 415FT PER NM TO 1300. ADD NOTE: **RWY** 19R, TEMPORARY **CRANE** 935FT FROM DER, 609FT RIGHT OF CENTERLINE, 125FT AGL/ 135FT MSL (2016-AWP-2003-NRA). **RWY** 28L, TEMPORARY **CRANE** 1.39 NM FROM DER, 2831FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). **RWY** 28R, TEMPORARY **CRANES** BEGINNING 3043FT FROM DER, 762FT RIGHT OF CENTERLINE, UP TO 120FT AGL/ 131FT MSL (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA). TEMPORARY **CRANE** 1.31 NM FROM DER, 3581FT LEFT OF CENTERLINE, 350FT AGL/ 448FT MSL (2016-AWP-10862-OE). ALL OTHER DATA REMAINS AS PUBLISHED.
.
TEMP WAT CHARTS NOT REQD

Approach Procedures

SFO 02.Jun.2017 1405z - 21.Jul.2017 1500z 1A1952/17
ILS **RWY** 28L CAT II NOT AUTH

SFO 05.Apr.2017 1332z - UFN 1A1174/17
RNAV (RNP) Z **RWY** 10R, AMDT 2A...
RNP 0.20 DA 409/ HAT 399 ALL CATS. TEMPORARY **CRANES** UP TO 131 MSL BEGINNING 3980FT NORTHWEST OF **RWY** 10R (2015-AWP-1790-NRA, 2015-AWP-1839 THROUGH 1842-NRA).
.
TEMP WAT CHARTS NOT REQD

SFO 28.Feb.2017 2122z - UFN 1A722/17
ILS OR LOC **RWY** 28L, AMDT 25A ...
ILS **RWY** 28L (SA CAT II), AMDT 25A ...
TERMINAL ROUTE ARCHI (IAF) TO PONKE/I-SFO 21.6 **DME** MINIMUM ALTITUDE 6000

STAR

SFO 06.Dec.2016 1900z - UFN 1A3019/16
BIG SUR THREE ARRIVAL...FROM OVER ANJEE INT CHANGE MINIMUM HOLDING ALTITUDE TO READ: 11000FT.

5.0 Communications

There were no known radio communication difficulties at the time of the incident.

6.0 Airport Information

San Francisco International Airport was located 8 miles southeast of San Francisco, California, had a field elevation of 13.1 feet msl, and was located at a latitude/longitude of N37˚37.07'/W122˚22.31'. The airport was owned and managed by the City and County of San Francisco. The airport was serviced by an FAA Air Traffic Control Tower that was in operation

24 hours a day. The ATCT was in operation at the time of the incident. Approach radar services to the incident flight were provided by Northern California (NorCal) TRACON, located in Rancho Cordova, California. KSFO was designated by FAA as a Special Pilot in Command Qualification Airport due to the airport's close proximity to mountainous terrain.

6.1 SFO Runway Information

SFO had four paved runways designated as 10L/28R. 10R/28L, 1R/19L, 1L,19R. Runway 10L/28R was 11,870 feet long and 200 feet wide and was an asphalt/grooved runway. Runway 10R/28L was 11,381 feet long and 200 feet wide and was an asphalt/grooved runway. Runway 1L/19R was 7,650 feet long and 200 feet wide and was an asphalt/grooved runway. Runway 1R/19L was 8.650 feet long and 200 feet wide, and was an asphalt/grooved runway. At the time of the incident runway 1R/19L and 10R/28L were NOTAM closed for construction, and all the runway and approach lights to those runways were not illuminated. Runway 28R was equipped with centerline lights, touchdown zone lights, and an approach lighting system with centerline sequenced flashers (ALSF2 see example, figure 5). Runway 28R was also equipped with a 4-light precision approach path indicator (PAPI, see example, figure 4) located on the left side of the runway with a 3.00-degree glide path.

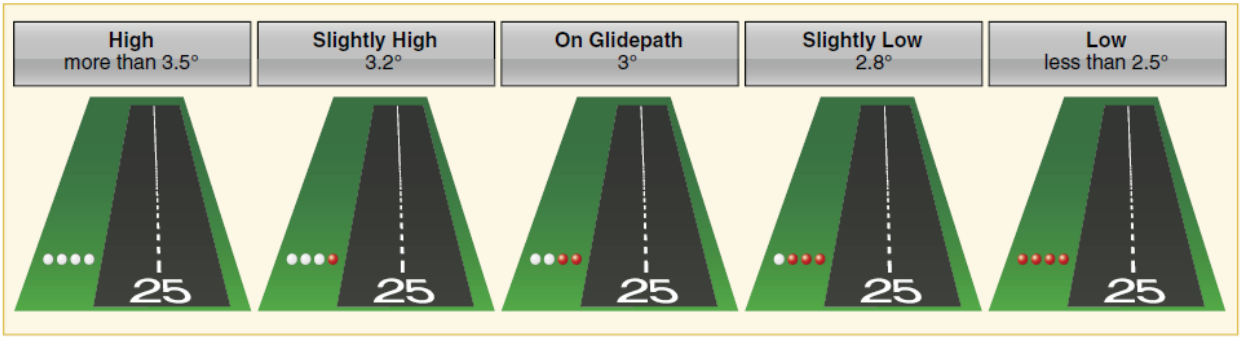


Figure 4: 4-Light Precision Approach Path Indicator (PAPI)[51]

[51] Source Pilots Handbook of Aeronautical Knowledge FAA-H-8083-25A Section 13 "Airport Operations" note runway number is not applicable to any specific runway and was utilized only for illustration purposes.

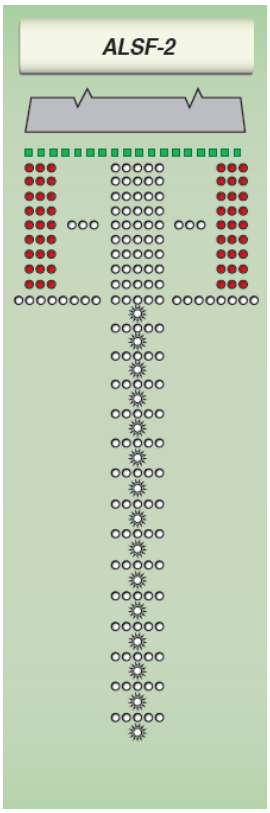


Figure 5: Approach Lighting System with centerline Sequenced Flashers (ALSF2)

According to Jepp View, chart data cycle 13-2017, which was current at the time of the event, Runway 28R was served via the following navigational aids and approaches:

- ILS or LOC[52] Rwy 28R (see Figure 9)
- ILS Rwy 28R CAT II[53] & III[54]
- ILS Rwy 28R SA[55] CAT I
- LDA[56] DME[57] Rwy 28R
- LDA PRM[58] Rwy 28R

Runway 28R was served by the following RNAV approaches:

[52] Localizer – which utilized only the lateral guidance of the ILS system and not the vertical guidance
[53] A precision instrument approach and landing with a decision height lower than 200 feet but not less than 100 feet and a visual range of not less than 1200 feet. SRCE: https://www.skybrary.aero/index.php/Precision_Approach
[54] A precision instrument approach and landing, at lower than CAT II minima, with a decision height lower than 100 feet or no decision height and visual range less than 1200 feet or no visual range limit. SRCE: https://www.skybrary.aero/index.php/Precision_Approach
[55] Special Authorization: SRCE: FAA Information for Operations (InFO) 12002, dated 2/6/12
[56] Localizer Type Directional Aid. SRCE Aeronautical Information Manual (AIM) Section 1-1-8 c
[57] Distance Measuring Equipment
[58] Precision Runway Monitor. SRCE: AIM Section 5-4-16a

- RNAV[59] (GPS) Z[60] Rwy 28R
- RNAV (GPS) X Rwy 28R
- RNAV (GPS) PRM X Rwy 28R
- RNAV (RNP[61]) Y Rwy 28R

Runway 28R was served by the following Visual approach procedures:

- TIPP TOE VISUAL Rwys 28L/R
- QUIET BRIDGE VISUAL Rwys 28L/R (see Figure 10)

Also situated between all four paved surfaces, at KSFO, was a very high frequency omni-directional radio range (VOR).

6.2 FAA Special Pilot-in-Command Qualification Airports

Air Canada Flight Operations Manual, Licensing and Qualification, date 16 May 2017, stated the following about Special Pilot-in-Command Qualification Airport:

The FAA requires special qualification prior to the use of certain airports as a destination or alternate (take-off, en route, or destination) based on an evaluation of items such as surrounding terrain, obstructions, or complex approach or departure procedures. The following meets the FAA special qualification requirements.

A Pilot-in-Command may be operating into, or out of, these airports only if:

1. *Either the Pilot-in-Command or FO has operated into, and out of, that airport within the preceding 12 calendar months as an operating flight crew member, a flight deck observer, or ADC qualified on type and monitoring the radio communication; or*
2. *The Pilot-in-Command has completed a thorough self-review of the airport facilities, approaches and procedures as found within the Jeppesen Route Manual including pictorial information provided on the Airport Familiarization pages.*

6.3 SFO Runway and Taxiway Lighting

According to photographs taken of taxiway "C", there were no taxiway edge lights and the taxiway was equipped with centerline lights (See Figure 6). *CFR* 139.311 stated in part:

> ***(c)****Lighting. Each certificate holder must provide and maintain lighting systems for air carrier operations when the airport is open at night, during conditions below visual flight rules (VFR) minimums, or in Alaska, during periods in which a prominent unlighted object cannot be seen from a distance of 3 statute miles or the sun is more than six degrees below the horizon. These lighting systems must be authorized by the Administrator and consist of at least the following:*

[59] Area Navigation

[60] When two or more straight-in approaches with the same type of guidance exist for a runway, a letter suffix is added to the title of the approach so that it can be more easily identified. SRCE: FAA Instrument Flying Handbook Chapter 5 "Approaches", pg 5-8.

[61] Required Navigation Performance

(1) *Runway lighting that meets the specifications for takeoff and landing minimums, as authorized by the Administrator, for each runway.*

(2) <u>One</u> *of the following taxiway lighting systems:*

(i) *Centerline lights.*

(ii) *Centerline reflectors.*

(iii) *Edge lights.*

(iv) *Edge reflectors.*

Figure 6: Outside Edge of Taxiway C near ILS Holdline (Courtesy of FAA)

6.4 KSFO Charts[62]

6.4.1 KSFO Airport Chart

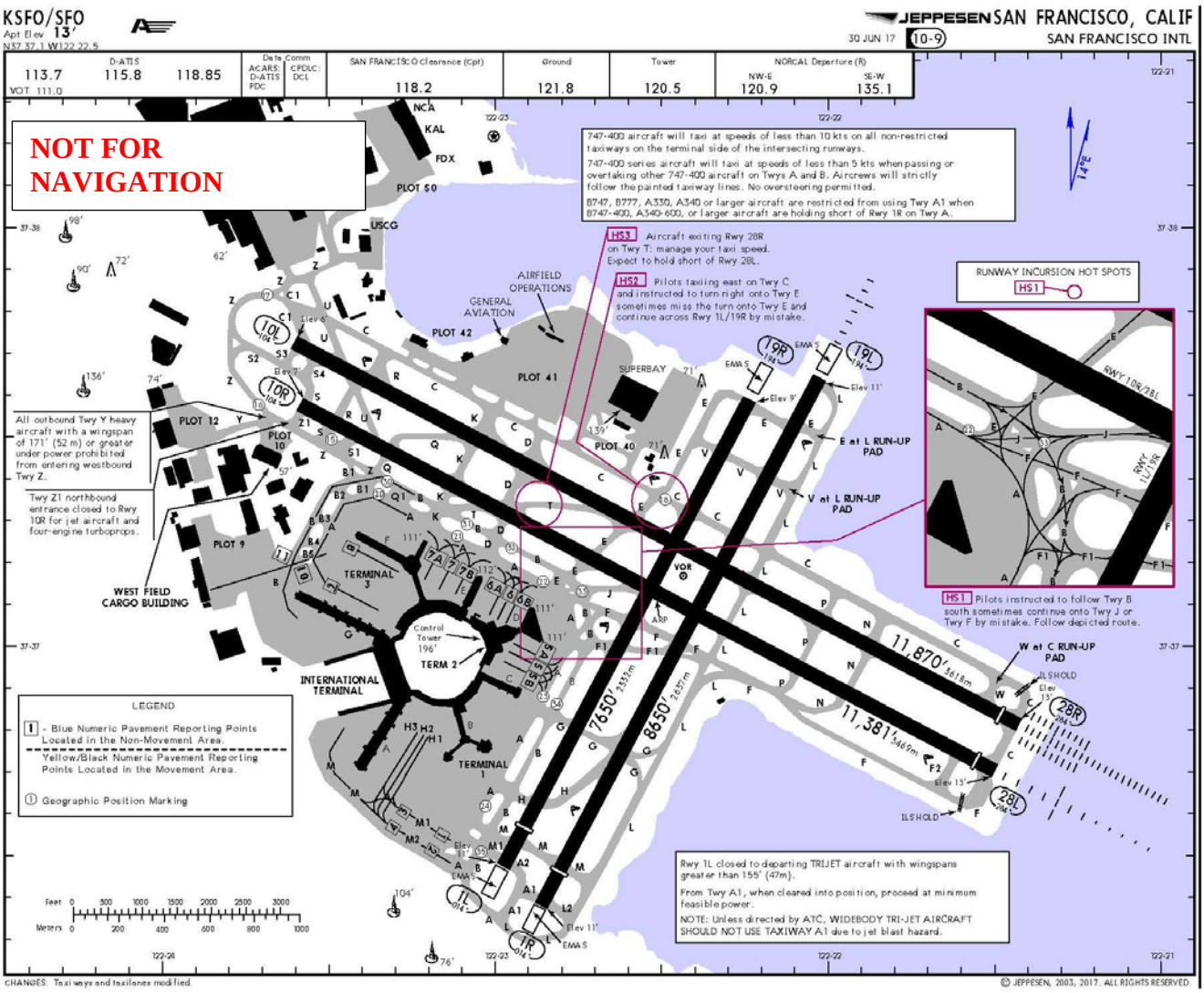


Figure 7: SFO Airport Chart

[62] See Operational Factors/Human Performance Attachment 11 - SFO Charts

6.4.2 Incident Flight's STAR[63] Chart

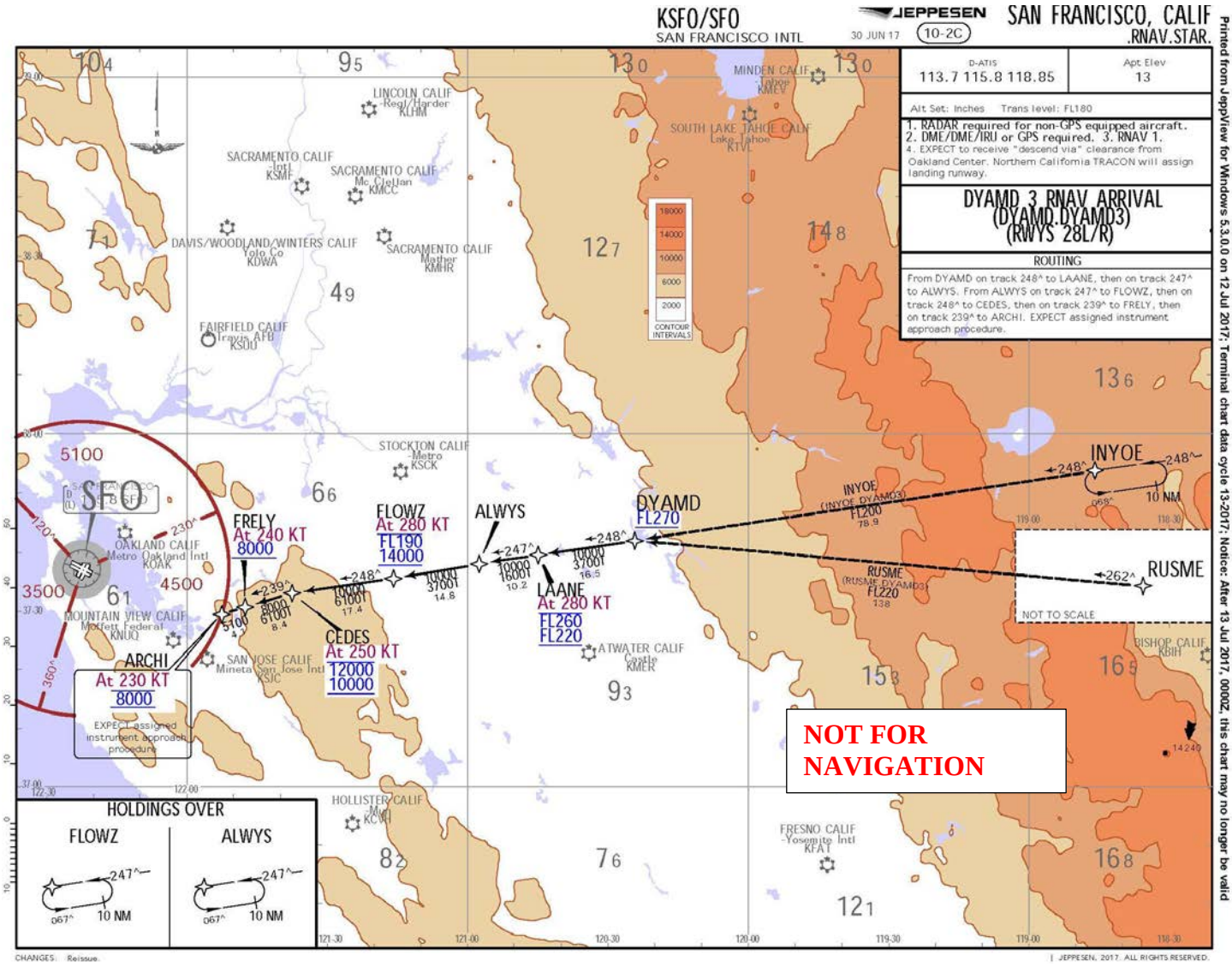


Figure 8: DYAMD 3 RNAV Arrival Chart

[63] Standard Arrival Route

6.4.3 SFO Approach Charts for Runway 28R

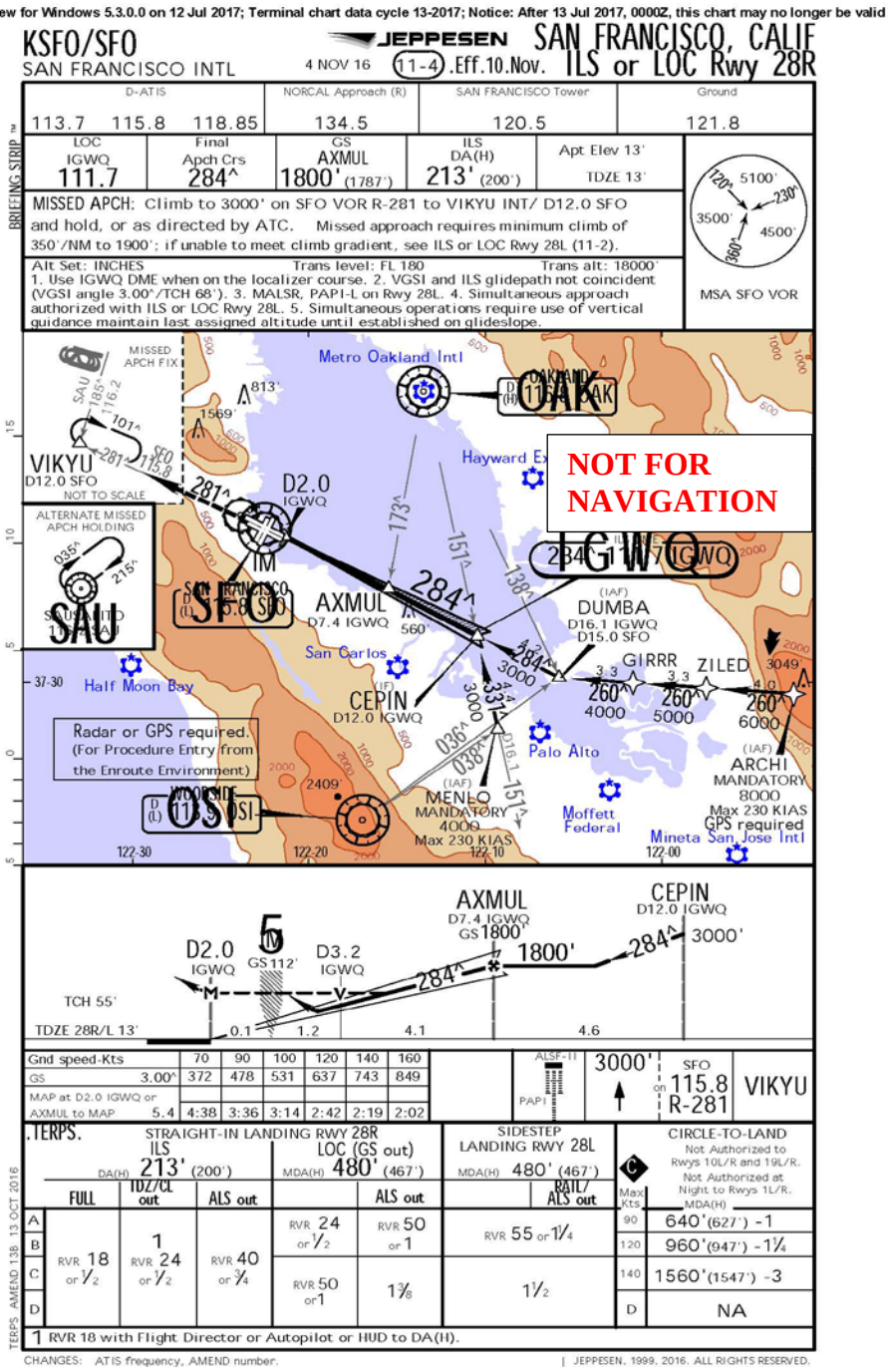


Figure 9: Instrument Landing System (ILS) Runway 28R

6.4.4 Quiet Bridge Visual

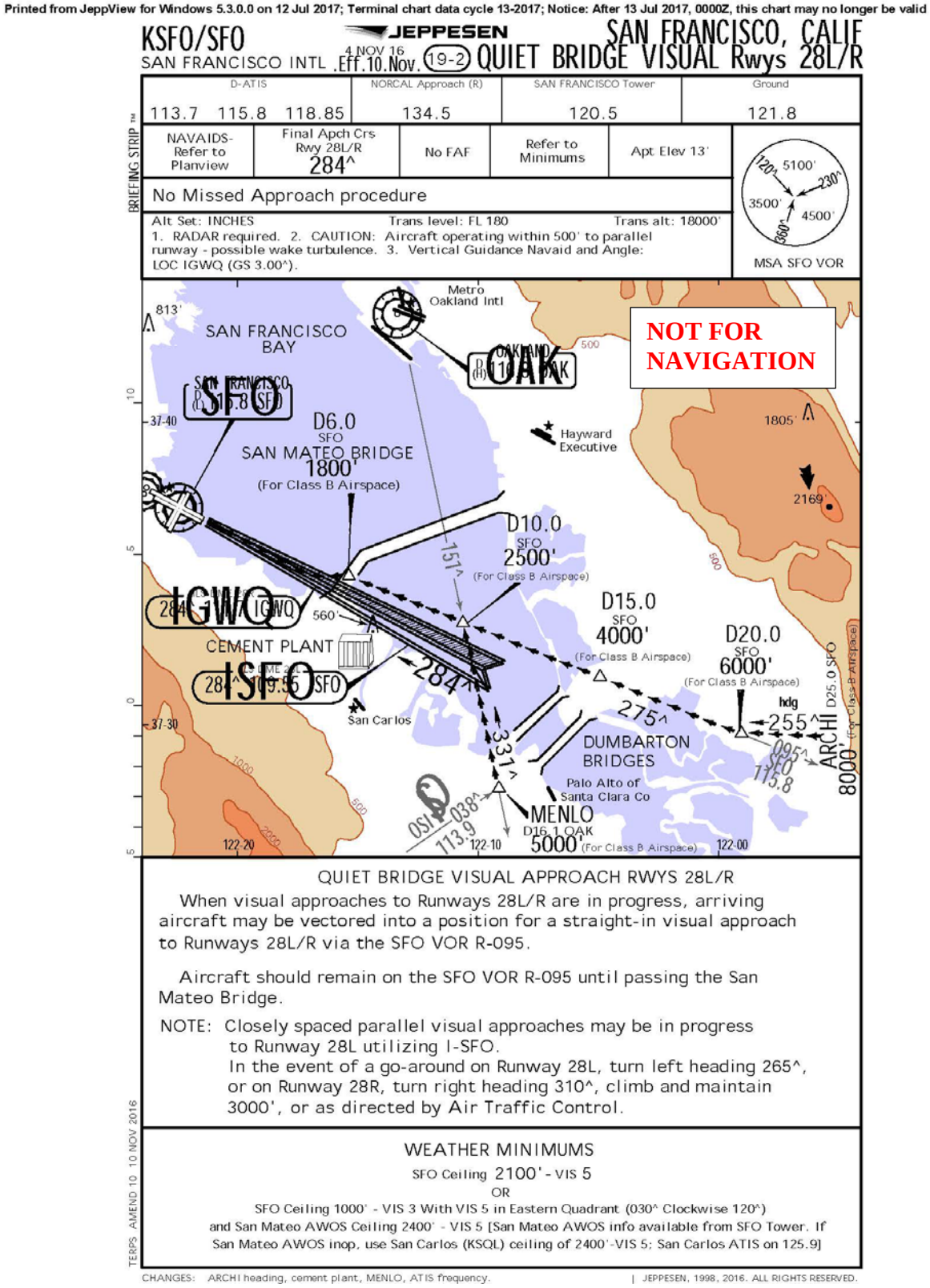


Figure 10: Quiet Bridge Visual Approach Chart Runways 28L/R

6.4.5 FMS Bridge Visual 28R[64]

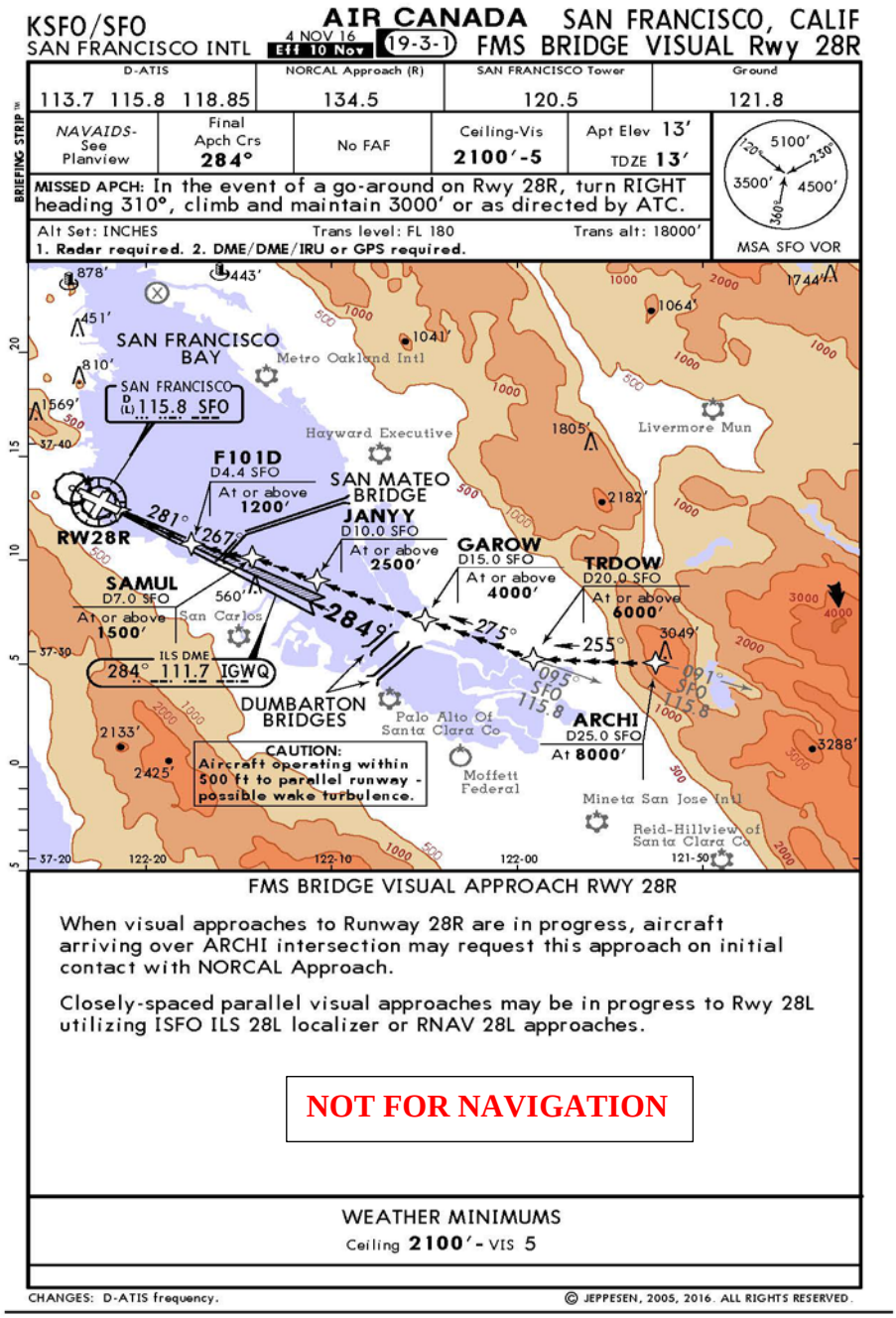
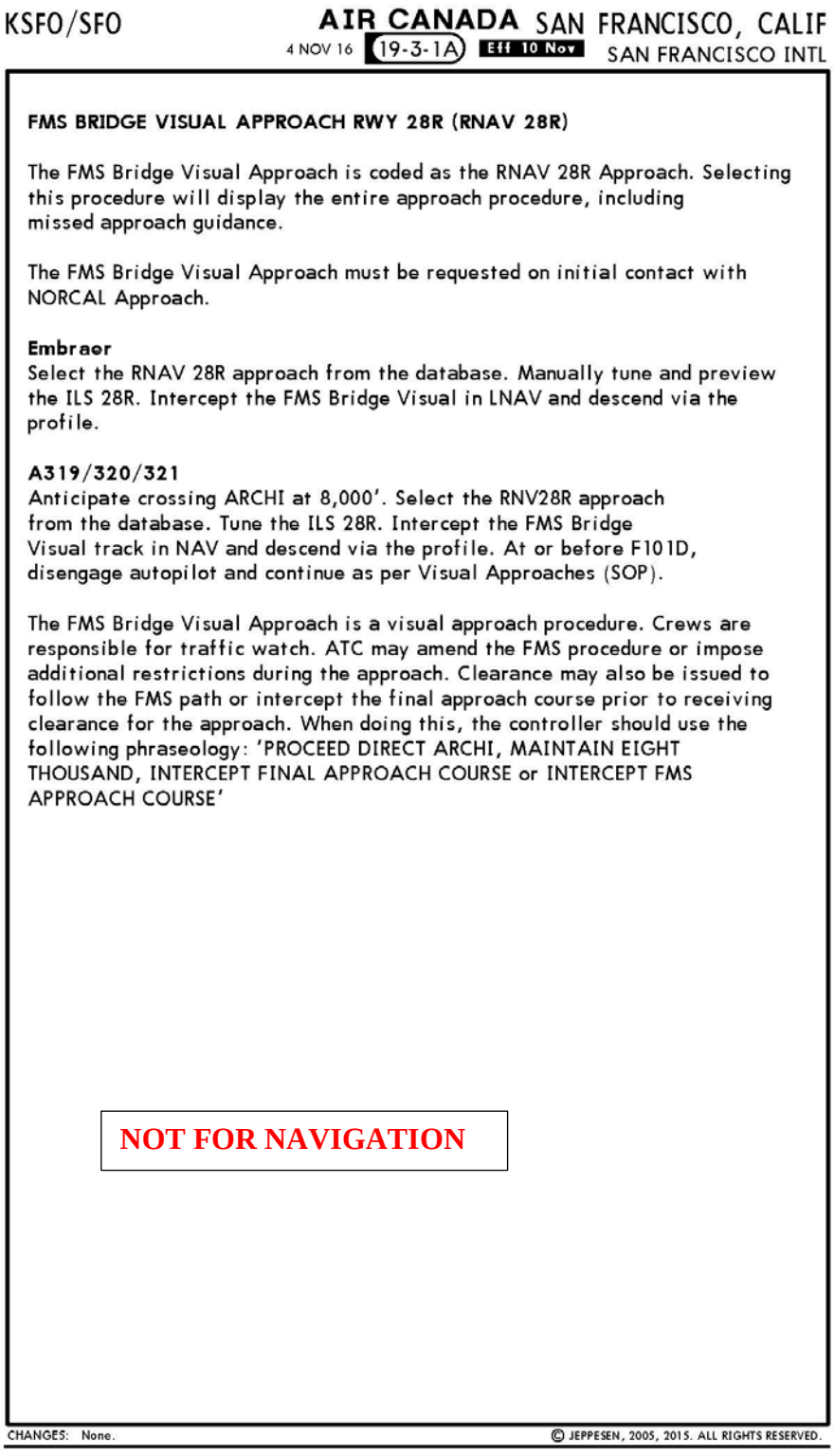


Figure 11: Air Canada Commercial Airline Overlay Tailored FMS Bridge Visual Runway 28R Chart

[64] According to a representative of Jeppesen the procedure was created and maintained by a "lead carrier" of which Air Canada was not the "lead carrier;" however, Air Canada owns the procedure source which allows Jeppesen to tailor the chart image and encode the tailored NavData procedure for Air Canada. Any updates made on the "Quiet Bridge Visual Approach" do not necessarily correspond to this approach as they are separate and different approach procedures.



KSFO/SFO

AIR CANADA SAN FRANCISCO, CALIF

4 NOV 16 (19-3-1A) Eff 10 Nov SAN FRANCISCO INTL

FMS BRIDGE VISUAL APPROACH RWY 28R (RNAV 28R)

The FMS Bridge Visual Approach is coded as the RNAV 28R Approach. Selecting this procedure will display the entire approach procedure, including missed approach guidance.

The FMS Bridge Visual Approach must be requested on initial contact with NORCAL Approach.

Embraer
Select the RNAV 28R approach from the database. Manually tune and preview the ILS 28R. Intercept the FMS Bridge Visual in LNAV and descend via the profile.

A319/320/321
Anticipate crossing ARCHI at 8,000'. Select the RNV28R approach from the database. Tune the ILS 28R. Intercept the FMS Bridge Visual track in NAV and descend via the profile. At or before F101D, disengage autopilot and continue as per Visual Approaches (SOP).

The FMS Bridge Visual Approach is a visual approach procedure. Crews are responsible for traffic watch. ATC may amend the FMS procedure or impose additional restrictions during the approach. Clearance may also be issued to follow the FMS path or intercept the final approach course prior to receiving clearance for the approach. When doing this, the controller should use the following phraseology: 'PROCEED DIRECT ARCHI, MAINTAIN EIGHT THOUSAND, INTERCEPT FINAL APPROACH COURSE or INTERCEPT FMS APPROACH COURSE'

NOT FOR NAVIGATION

CHANGES: None.

Figure 12: Air Canada Commercial Airline Overlay FMS Bridge Visual Approach Chart 28R (Page 2)

6.4.6 FMS Database

According to a representative of Air Canada, the coding in the FMS database for the FMS Bridge Visual Approach (see Figure 13) indicated that after the initial fix (IF), the waypoints were defined by track to fix (TF), including the waypoint associated with the runway threshold. A TF does not include a heading or course[65].

KSFO	RNV28R	B	APP	28R	18000	ARCHI	WPT	IF				8000					
KSFO	RNV28R	B	APP	28R	18000	TRDOW	WPT	TF				6000A					
KSFO	RNV28R	B	APP	28R	18000	GAROW	WPT	TF				4000A					
KSFO	RNV28R	B	APP	28R	18000	JANYY	WPT	TF				2500A					
KSFO	RNV28R	B	APP	28R	18000	SAMUL	WPT	TF				1500A					
KSFO	RNV28R	B	APP	28R	18000	F101D	WPT	TF				1200A					-2.99
KSFO	RNV28R	B	APP	28R	18000	RW28R	RWY	TF	Y	Y		60					-2.99
KSFO	RNV28R	B	APP	28R	18000	RW28R	RWY	FM			309.99	3000A			SFO		

Figure 13: Air Canada's FMS Bridge Visual Approach - Database Information

7.0 Company Overview

According to Air Canada's website[66], they were Canada's largest domestic and international airline serving more than 200 airports on six continents. Air Canada began air service on September 1, 1937 as Trans-Canada Air Lines (TCA). In 1964 TCA changed its name to Air Canada.

At the time of the incident, Air Canada consisted of the following subsidiaries: Air Canada, Air Canada Express[67], and Air Canada Rouge[68]. Air Canada had 222 total aircraft, of which 173 aircraft were flown by Air Canada and 49 aircraft were flown by Air Canada Rouge. At the time of the incident, Air Canada operated 42 A320-200 aircraft.

8.0 Management Organization

8.1 Duty Pilot

Air Canada's Flight Operations Manual, Chapter 3 "Organizational Structure, Publications, and Documentation" section 3.1.3 defined the duty pilot as:

> *Duty Pilot means the Air Canada or Air Canada rouge Flight Operations manager who is acting in the Duty Pilot position. The Duty Pilot, independent of being an Air Canada or Air Canada rouge manger, acts on behalf of either Air Canada or Air Canada rouge. The Duty Pilot is responsible to the respective Air Canada or Air Canada rouge Flight Operations Senior Management for all operational and administration decisions during times when other managers are not available."*

8.2 Air Safety Reports

Air Canada's Flight Operations Manual, Chapter 3, "Safety Management System" section 2.5.1 defined Air Safety Reports (ASR) as:

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[65] "A track to fix leg is intercepted and acquired as the flight track to the following waypoint. Track to a fix legs are sometimes called point-to-point legs for this reason." Source: FAA Aeronautical Information Manual Chapter 1 "Area Navigation" 1-2-2(a) http://tfmlearning.fly.faa.gov/Publications/atpubs/AIM/Chap1/aim0102.html

[66] SRCE: https://www.aircanada.com/ca/en/aco/home/about.html

[67] The airlines operating Air Canada Express flights on behalf of Air Canada were: Jazz Aviation LP, Sky Regional Airlines Inc., Air Georgian Ltd., and Exploits Valley Air Services.

[68] Began service on July 1, 2013 and was considered Air Canada's "vacation airlines."

ASRs are de-identified and accessible by all levels of management who are required to regularly review, provide feedback, and monitor the progress of analysis and investigations.

Feedback on submitted reports is provide to the original reporter.

Data with the SIMS is analyzed and used to develop organizational objectives and goals and to monitor the health of SMS. All corrective actions are developed, implemented, and monitored as directed in the Safety Management Manual.

The section further goes on to say in part:

The ASR is an electronic or paper medium through which employees are able to identify hazards, incidents, and accidents which impact the operational safety of Air Canada. ASRs enable the employ to clearly identify all issues surrounding the reportable event and form the original record of any event in the safety Information Management System (SIMS).

Electronic ASRs may be submitted on the ACaeronet or Flight Ops/Flight Standards, Safety & Quality/SIMS eReporting. This method should be used in most cases as it provides immediate input into the safety system and allows the submitting flight crew member to monitor the status of their report.

All accidents, incidents and reportable safety events listed in FOM 12.2 Definitions, Procedures, and Report shall be reported to Flight Dispatch. Flight Crews should also file an ASR. In addition to these items, an ASR should be filed for:

1. *Any event where safety standards are significantly reduced.*
2. *Any event which may provide useful information for the enhancement of flight safety.*
3. *A hazard which poses a direct threat to the safety of the Air Canada operations., even in situations where an incident or occurrence has not yet taken place, but has the potential of occurring at some time.*
4. *Any time an employee feels there is a potentially safety or more efficient way to execute a task or complete an assignment in the interests of operational safety.*

The Flight Operations Manual, section 12.2 "Definitions, Procedures, and Report" provided, in part, the following guidance:

Any aircraft accident, incident, emergency, or other safety related event which may require investigation, monitoring or tracking shall be reported to Dispatch as soon as possible[69]. In addition, the flight crew should file an ASR when time permits.

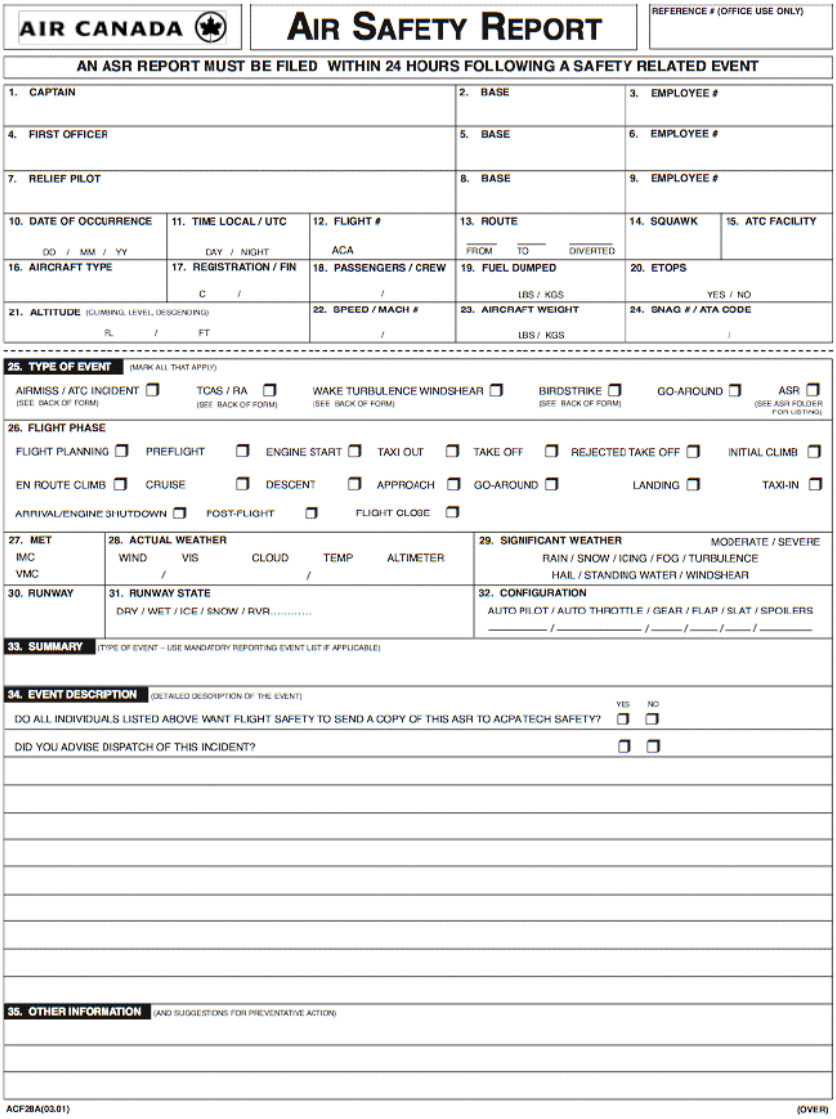
The section further provided 47 examples of incident, emergencies and reportable safety events, of which the following were included:

[69] At the time of the event Air Canada did not define the phrase "as soon as possible"

- *Unusual or abnormal aircraft handling*
- *Significant Navigation errors or technical navigation problems*
- *Breach of Air Regulations, ATC irregularities, or near miss*
- *An unstable approach*
- *A go-around*
- *Any other hazard that poses a direct threat to flight safety*

8.2.1 Air Safety Report

The following (see Figure 14 and 15) was an example of an Air Safety Report (ASR) as provided to all crewmembers in the Flight Operations Manual, Appendix 1, Section 13.15



AIR CANADA

AIR SAFETY REPORT

REFERENCE # (OFFICE USE ONLY)

AN ASR REPORT MUST BE FILED WITHIN 24 HOURS FOLLOWING A SAFETY RELATED EVENT

1. CAPTAIN			2. BASE	3. EMPLOYEE #	
4. FIRST OFFICER			5. BASE	6. EMPLOYEE #	
7. RELIEF PILOT			8. BASE	9. EMPLOYEE #	
10. DATE OF OCCURRENCE DD / MM / YY	11. TIME LOCAL / UTC DAY / NIGHT	12. FLIGHT # ACA	13. ROUTE FROM TO DIVERTED	14. SQUAWK	15. ATC FACILITY
16. AIRCRAFT TYPE	17. REGISTRATION / FIN C /	18. PASSENGERS / CREW /	19. FUEL DUMPED LBS / KGS	20. ETOPS YES / NO	
21. ALTITUDE (CLIMBING, LEVEL, DESCENDING) FL / FT		22. SPEED / MACH # /	23. AIRCRAFT WEIGHT LBS / KGS	24. SNAG # / ATA CODE /	

25. TYPE OF EVENT (MARK ALL THAT APPLY)

AIRMISS / ATC INCIDENT ❒ (SEE BACK OF FORM) TCAS / RA ❒ (SEE BACK OF FORM) WAKE TURBULENCE WINDSHEAR ❒ (SEE BACK OF FORM) BIRDSTRIKE ❒ (SEE BACK OF FORM) GO-AROUND ❒ ASR ❒ (SEE ASR FOLDER FOR LISTING)

26. FLIGHT PHASE

FLIGHT PLANNING ❒ PREFLIGHT ❒ ENGINE START ❒ TAXI OUT ❒ TAKE OFF ❒ REJECTED TAKE OFF ❒ INITIAL CLIMB ❒

EN ROUTE CLIMB ❒ CRUISE ❒ DESCENT ❒ APPROACH ❒ GO-AROUND ❒ LANDING ❒ TAXI-IN ❒

ARRIVAL/ENGINE SHUTDOWN ❒ POST-FLIGHT ❒ FLIGHT CLOSE ❒

27. MET IMC VMC	28. ACTUAL WEATHER WIND VIS CLOUD TEMP ALTIMETER / /	29. SIGNIFICANT WEATHER MODERATE / SEVERE RAIN / SNOW / ICING / FOG / TURBULENCE HAIL / STANDING WATER / WINDSHEAR
30. RUNWAY	31. RUNWAY STATE DRY / WET / ICE / SNOW / RVR.....	32. CONFIGURATION AUTO PILOT / AUTO THROTTLE / GEAR / FLAP / SLAT / SPOILERS ____ / ____ / ____ / ____ / ____ / ____

33. SUMMARY (TYPE OF EVENT – USE MANDATORY REPORTING EVENT LIST IF APPLICABLE)

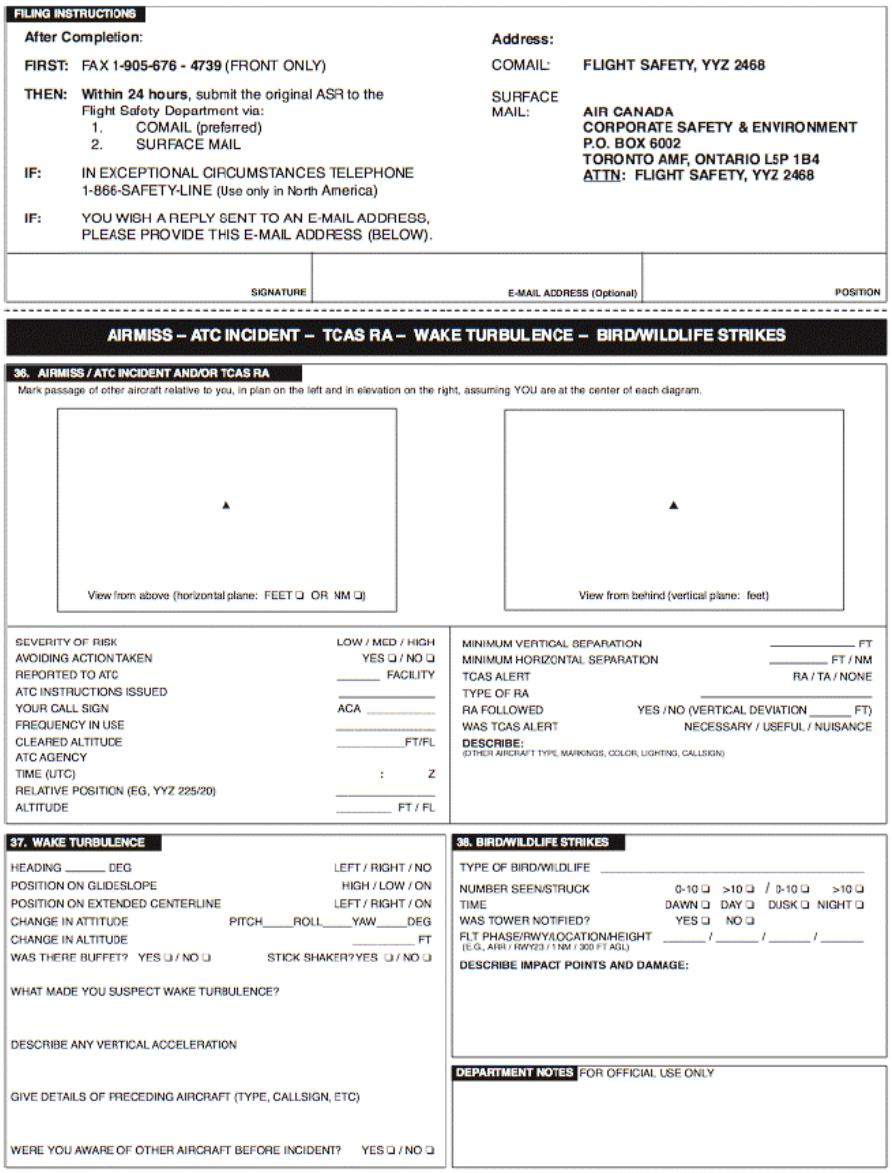
34. EVENT DESCRIPTION (DETAILED DESCRIPTION OF THE EVENT)

	YES	NO
DO ALL INDIVIDUALS LISTED ABOVE WANT FLIGHT SAFETY TO SEND A COPY OF THIS ASR TO ACPATECH SAFETY?	❒	❒
DID YOU ADVISE DISPATCH OF THIS INCIDENT?	❒	❒

35. OTHER INFORMATION (AND SUGGESTIONS FOR PREVENTATIVE ACTION)

ACF28A(03.01) (OVER)

Figure 14: Page 1 – Air Safety Report



FILING INSTRUCTIONS

After Completion:

FIRST: FAX 1-905-676 - 4739 (FRONT ONLY)

THEN: Within 24 hours, submit the original ASR to the Flight Safety Department via:
1. COMAIL (preferred)
2. SURFACE MAIL

IF: IN EXCEPTIONAL CIRCUMSTANCES TELEPHONE 1-866-SAFETY-LINE (Use only in North America)

IF: YOU WISH A REPLY SENT TO AN E-MAIL ADDRESS, PLEASE PROVIDE THIS E-MAIL ADDRESS (BELOW).

Address:

COMAIL: FLIGHT SAFETY, YYZ 2468

SURFACE MAIL: AIR CANADA
CORPORATE SAFETY & ENVIRONMENT
P.O. BOX 6002
TORONTO AMF, ONTARIO L5P 1B4
ATTN: FLIGHT SAFETY, YYZ 2468

SIGNATURE | E-MAIL ADDRESS (Optional) | POSITION

AIRMISS – ATC INCIDENT – TCAS RA – WAKE TURBULENCE – BIRD/WILDLIFE STRIKES

36. AIRMISS / ATC INCIDENT AND/OR TCAS RA

Mark passage of other aircraft relative to you, in plan on the left and in elevation on the right, assuming YOU are at the center of each diagram.

View from above (horizontal plane: FEET ❑ OR NM ❑)

View from behind (vertical plane: feet)

SEVERITY OF RISK LOW / MED / HIGH
AVOIDING ACTION TAKEN YES ❑ / NO ❑
REPORTED TO ATC _____ FACILITY
ATC INSTRUCTIONS ISSUED _____
YOUR CALL SIGN ACA _____
FREQUENCY IN USE _____
CLEARED ALTITUDE _____FT/FL
ATC AGENCY
TIME (UTC) : Z
RELATIVE POSITION (EG, YYZ 225/20) _____
ALTITUDE _____ FT / FL

MINIMUM VERTICAL SEPARATION _____ FT
MINIMUM HORIZONTAL SEPARATION _____ FT / NM
TCAS ALERT RA / TA / NONE
TYPE OF RA _____
RA FOLLOWED YES / NO (VERTICAL DEVIATION _____ FT)
WAS TCAS ALERT NECESSARY / USEFUL / NUISANCE
DESCRIBE:
(OTHER AIRCRAFT TYPE, MARKINGS, COLOR, LIGHTING, CALLSIGN)

37. WAKE TURBULENCE

HEADING _____ DEG LEFT / RIGHT / NO
POSITION ON GLIDESLOPE HIGH / LOW / ON
POSITION ON EXTENDED CENTERLINE LEFT / RIGHT / ON
CHANGE IN ATTITUDE PITCH____ROLL____YAW____DEG
CHANGE IN ALTITUDE _____ FT
WAS THERE BUFFET? YES ❑ / NO ❑ STICK SHAKER? YES ❑ / NO ❑

WHAT MADE YOU SUSPECT WAKE TURBULENCE?

DESCRIBE ANY VERTICAL ACCELERATION

GIVE DETAILS OF PRECEDING AIRCRAFT (TYPE, CALLSIGN, ETC)

WERE YOU AWARE OF OTHER AIRCRAFT BEFORE INCIDENT? YES ❑ / NO ❑

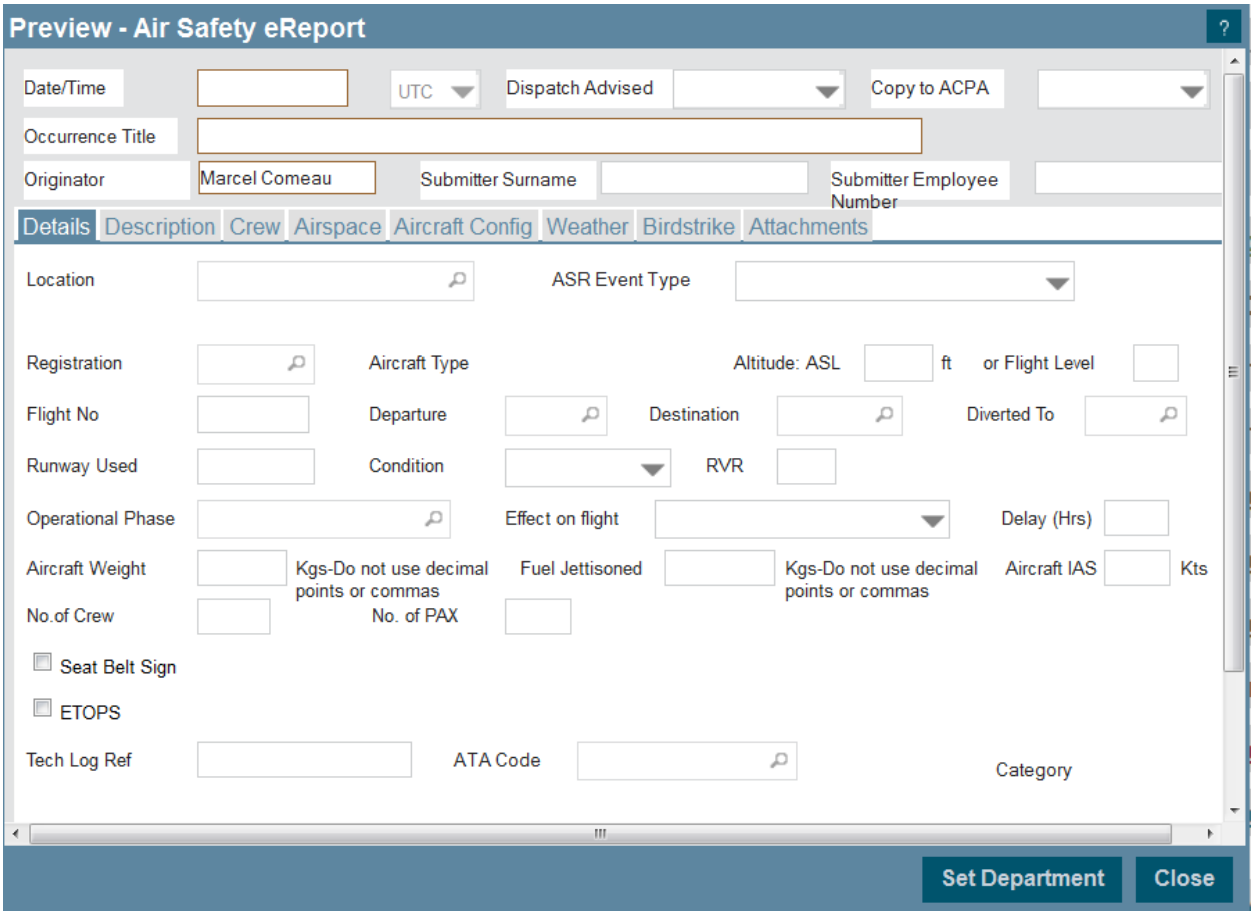
38. BIRD/WILDLIFE STRIKES

TYPE OF BIRD/WILDLIFE _____
NUMBER SEEN/STRUCK 0-10 ❑ >10 ❑ / 0-10 ❑ >10 ❑
TIME DAWN ❑ DAY ❑ DUSK ❑ NIGHT ❑
WAS TOWER NOTIFIED? YES ❑ NO ❑
FLT PHASE/RWY/LOCATION/HEIGHT _____ / _____ / _____ / _____
(E.G., ARR / RWY23 / 1 NM / 300 FT AGL)
DESCRIBE IMPACT POINTS AND DAMAGE:

DEPARTMENT NOTES FOR OFFICIAL USE ONLY

Figure 15: Page 2 – Air Safety Report

Electronic Air Safety eReport



9.0 Relevant Systems, etc.

9.1 Descent Mode

Air Canada's Aircraft Operating Manual – Volume 2, A319/A320/A321, Section 22-30 "Auto Flight – Flight Guidance" provided the following guidance pertaining to "Descent Mode", as it pertains to the incident airplane:

> *The DES mode guides the aircraft along the descent path computed by the FMGS. The system computes the flight path backwards from the deceleration point up to the top of descent (T/D), with respect to the speed and altitude constraints at the deceleration point, the guidance begins the deceleration to VAPP, to be reached at 1,000 ft. above touchdown on the final descent path.*
>
> *Internally, the computer divides the descent path into various segments, depending on the relative positions of the constraints. It starts at top of descent (T/D) by setting up an "idle"" segment that takes the aircraft down to the first constraint, and follows this with "geometric" segments between constraints.*
>
> *The descent profile takes into account wind data and data from the lateral and vertical flight plans and it is based upon the managed descent speed profile. It does not take holding patterns into consideration.*

The descent profile has several segments:

- *A repressurization segment. When necessary, this produces a repressuriation rate for the cabin during descent. It is a function of the destination airport altitude and the selected cabin rate (defaulted to -350 ft./min but this can be modified)*
- *Idle path segment. The AP/FD controls the speed and the autothrust stays at idle thrust. The guidance computes this profile from the top of descent or the end of the repressuirziation segment to the first vertical constraint that cannot be flown at idle thrust.*
- *Geometric path segments. The AP/FD controls the vertical path, and autothrust controls the speed. These segments take the aircraft from the first constraint to the deceleration point.*

The descent mode is a managed mode that may be engaged during cruise. It can be armed or engaged in descent and approach phases (except if the FCU selected altitude is higher than the present aircraft altitude).

ARMING CONDITIONS

Ident.: 2-22_30-70-50-00010522.0001001 / 23 DEC 15
Applicable to: **ALL**

The DES mode is armed when an ALT CSTR is captured and all the following conditions are met:
– FCU selected altitude is lower than present altitude
– NAV, LOC* or LOC mode is engaged
– Takeoff or go-around phase is not active
– Flight profile is available.

DISARMING CONDITIONS

Ident.: 2-22_30-70-50-00010523.0002001 / 23 DEC 15

Applicable to: **ALL**

The DES mode is disarmed if one of the following conditions is met:
- Engagement of another vertical mode
- FCU selected altitude is set above the aircraft current altitude
- Loss of NAV, LOC*, or LOC mode
- Switching to the go-around phase
- Loss of vertical flight path validity
- Setting the FCU selected altitude at an altitude constraint while ALT CST* was engaged. (ALT* engages and DES mode disarms).

ENGAGEMENT CONDITIONS

Ident.: 2-22_30-70-50-00010524.0002001 / 23 DEC 15

Applicable to: **ALL**

The DES mode can be engaged, when the following conditions are met:
- The FCU selected altitude is lower than present altitude
- NAV, LOC*, or LOC mode is engaged
- Takeoff, climb, or go-around phase is not active
- Vertical flight path is valid
- TO, G/S, LAND, FINAL or GA mode is not engaged, and:
  - The aircraft sequences a waypoint with an ALT CSTR, and DES mode is armed. The DES mode engages automatically, or
  - The flight crew presses the ALT knob , while ALT CST* or ALT CST is not engaged, or
  - The flight crew presses the ALT knob , while ALT* or ALT is engaged, but the current altitude is not an effective altitude constraint of the F-PLN.

NOTE: *When DES mode is engaged:*
- *The V/S - FPA window of the FCU shows dashes*
- *The managed LVL/CH dot on the FCU lights up.*

DISENGAGEMENT CONDITIONS

Ident.: 2-22_30-70-50-00010525.0001001 / 23 DEC 15

Applicable to: **201-213, 215-222, 225-226, 228, 232, 235-239, 241-242, 258, 260-261, 264-271, 274-275, 280, 282, 285-287, 401-405, 408, 411, 415-416, 451-460**

The DES mode is disengaged, if one of the following conditions is met:
- The NAV mode is lost or disengaged and the V/S or FPA mode engages
- Another vertical mode engages
- The flight crew selects an altitude on the FCU that is higher than the aircraft present altitude and the V/S (FPA) engages on current V/S (FPA)
- NAV mode is lost due to a discontinuity in the descent profile. AP/FD reverts to basic mode.

Refer to AOM 2-22_30-75 General .

Ident.: 2-22_30-70-50-00010565.0001001 / 23 DEC 15
Applicable to: **ALL**

FMA DISPLAY

When DES mode is engaged, the system arms ALT and displays the applicable target altitude on the PFD altitude scale.

– If the next predicted level-off is an altitude constraint, ALT is magenta on the FMA second line and the PFD displays the altitude constraint magenta above the altitude scale.

When the aircraft flies at the altitude constraint (ALT CSTR), the system arms DES blue.

When the aircraft meets the constraint, DES engages again automatically.

– If the next predicted level-off is the FCU altitude, ALT is blue on the FMA and the PFD displays the FCU selected altitude in blue.

Typical FMA in DES

9.1.1 Flight Mode Annunciator

The flight mode annunciator (FMA) is located on each pilot's primary flight display (PFD). Air Canada's Aircraft Operating Manual – Volume 1, A319/A320/A321, Section "Introduction" provided the following guidance:

> *The PF shall announce all FMA modifications (boxed items) from the beginning of the take-off role to the point of the "landing" call unless specified differently (e.g. CAT II & III task sharing).*
>
> *All FMA calls shall be cross-checked by the PM on the PFD.*

9.2 Open Descent Mode

Air Canada's Aircraft Operating Manual – Volume 2, A319/A320/A321, Section 22-30 "Auto Flight – Flight Guidance" provided the following guidance pertaining to "Open Descent Mode", as it pertains to the incident airplane:

GENERAL

Ident.: 2-22_30-70-60-00010576.0001001 / 23 DEC 15
Applicable to: **ALL**

The OPEN DES mode is a selected mode. It maintains a SPD/MACH (selected or managed) with the AP/FD pitch mode while autothrust (if active) maintains IDLE thrust.

It is not to be used for final approach.

ENGAGEMENT CONDITIONS

Ident.: 2-22_30-70-60-00010577.0001001 / 23 DEC 15
Applicable to: **201-213, 215-222, 225-226, 228, 232, 258, 260-261, 264-271, 274-275, 280, 282, 285, 401-405, 408, 411, 415-416**

The OPEN DES mode can be engaged only if the following conditions are met:
- The aircraft has been in flight for more than 5 s
- LAND mode is not engaged
- The FCU selected altitude is lower than present altitude.

The OPEN DES mode is engaged by one of the following:
- Pulling out the ALT knob
- Selecting a manual speed when EXP mode is engaged
- A reversion activates to prevent the speed from decreasing below VLS. (refer to AOM 2-22_30-75 General for a description of the conditions that cause a reversion).

NOTE: *When OP DES is engaged:*
- *The FMA displays "OP DES"*
- *The managed LVL/CH dot on the FCU goes out*
- *The system arms the ALT mode.*

DISENGAGEMENT CONDITIONS

Ident.: 2-22_30-70-60-00010578.0001001 / 23 DEC 15
Applicable to: **201-213, 215-222, 225-226, 228, 232, 258, 260-261, 264-271, 274-275, 280, 282, 285, 401-405, 408, 411, 415-416**

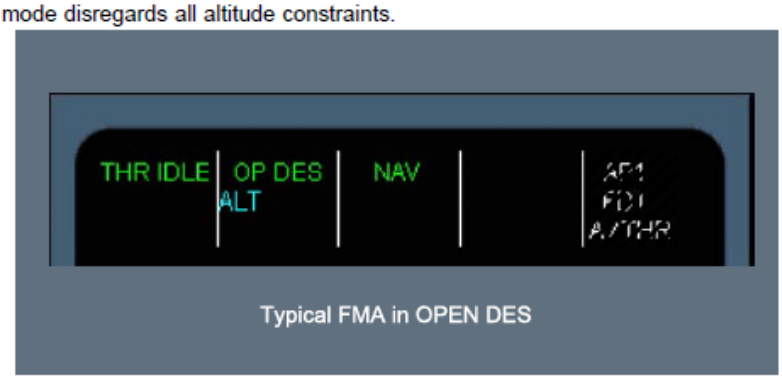
The OPEN DES mode is disengaged by one of the following conditions:
- Manual engagement of another vertical mode
- Reversion to V/S mode (refer to AOM 2-22_30-75 General)
- Selection of an altitude higher than present altitude. V/S (FPA) engages on current V/S (FPA).

GUIDANCE

Ident.: 2-22_30-70-60-00010579.0002001 / 23 DEC 15
Applicable to: **ALL**

When OPEN DES is engaged, pitch control maintains the target speed/Mach number, and autothrust maintains idle thrust (or the flight crew maintains it manually). The speed target may be either selected or managed.

The OPEN DES mode disregards all altitude constraints.



Typical FMA in OPEN DES

9.3 Autopilot and Flight Director

Air Canada's Aircraft Operating Manual – Volume 1, A319/A320/A321, Section "Standard Operating Procedure" provided the following guidance on the use of the autopilot and flight director:

The Autopilot and Flight Director provide assistance to the crew throughout the flight:

- *By freeing the PF from routine handling tasks and thus allowing more time and resources to assess the overall operational situation.*
- *By providing the PF with adequate Attitude or Flight Path orders, with the Flight Director symbol on the Primary Flight display, so as to facilitate the accurate hand flying of the aircraft.*

The AP/FD guide the aircraft along the intended flight path or at the intended speed, according to the guidance modes as engaged by the pilot on the Flight Control Unit (FCU). (e.g., NAV-HDG-V/S...)

The FCU is the short term interface between the pilot and the FMGS, used to select guidance targets and arm/ engage guidance modes. There are 2 types of modes and associated targets:

- *Managed modes and targets: the aircraft is guided along the FMS lateral and vertical Flight Plan and speed profile. These modes and targets are armed or engaged by pressing the FCU knobs.*
- *Selected modes and targets: the aircraft is guided by selected targets according to the modes selected on the FCU. These modes and targets are engaged by the pilot by turning and pulling the FCU knobs.*

The PF selects the desired modes and targets to fly the aircraft.

- *If the Autopilot is used, the PF normally selects the modes on the FCU.*
- *If the Autopilot is OFF, the PF normally commands the PM to make changes to the FCU using the following*

standard format: "Switch (knob), Action" (e.g., "Heading Pull", "Speed Push", "Altitude 8,000"). The armed and engaged modes are indicated on the Flight Mode Annunciator (FMA) on top of the PFD; the targets

(SPD, ALT, HDG) are indicated on the associated scales on the PFD.

- *The crew must check the FCU selected targets on the PFD.*
- *The crew must monitor the engaged/armed modes on the FMA.*

If the Autopilot and/or Flight Director do not guide the aircraft where the crew is expecting:

- *The PF should disengage the Autopilot using the Sidestick Priority Pushbutton or both pilots should select FD's off and the PF should fly the aircraft manually.*
- *The PF should not disengage the Autopilot by Sidestick or Rudder Pedal override except by instinctive reaction.*

The Autopilot may be used from after take-off down to a late stage of the approach (including autoland when permitted). The Autopilot may also be used in most failure cases, when available.

When the PF hand flies the aircraft using the Flight Director, the Flight Director orders must be obeyed; in other words, the crossbars must be centered or the FPV must be on the Flight Path Director symbol so as to fly according to the Selected modes and targets.

- *If the PF does not wish to fly the Flight Director orders, the Flight Director symbol must be removed from both PFDs. (i.e. turn off the Flight Directors).*
- *When flying a visual approach, the Flight Directors (or Flight Path Directors) should be deselected. However, the*

FPV may be used to assist with the approach.

9.4 Flight Control Unit

The Air Canada A319/A320/A321 Airplane Operating Manual – Volume 2, Section 2.22_10.40.20 provided the following information on the Flight Control Unit:

The Flight Control Unit (FCU) is located on the glareshield and is constituted of three control panels. One for the automatic flight controls and two for the Electronic Flight Instrument System (EFIS). The FCU has two channels, each of which can independently command the central control panel. If one channel fails, the other channel can control all the functions.

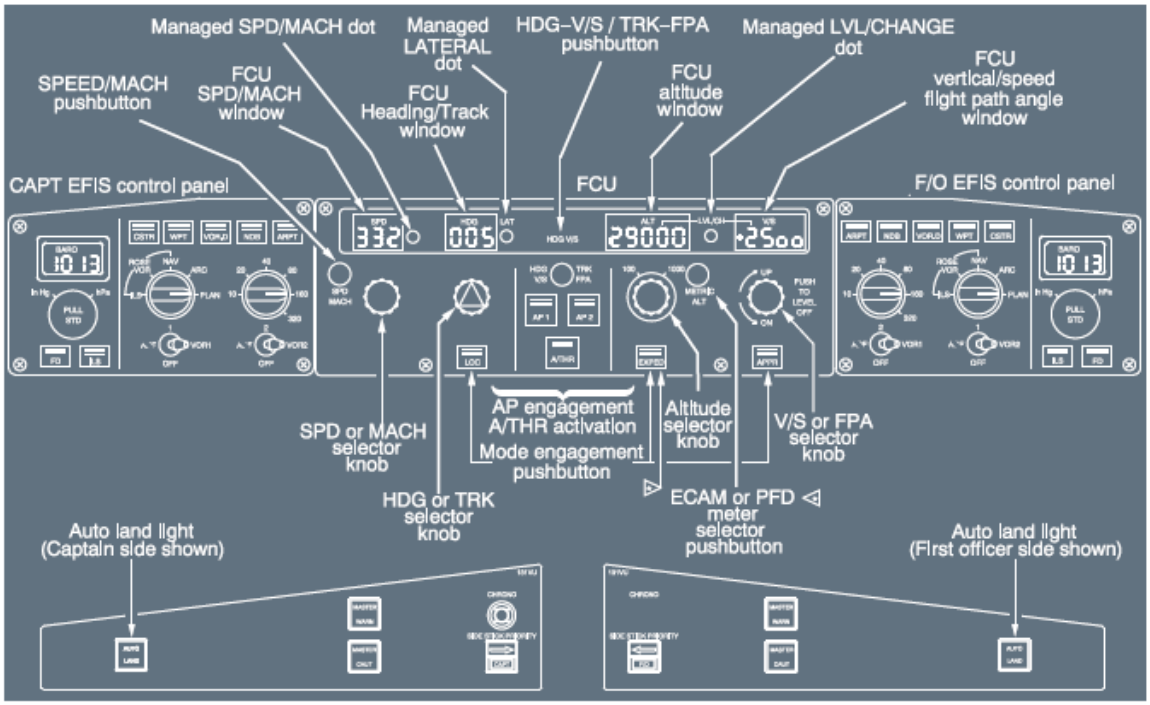


Figure 16: FCU Diagram from the Aircraft Operating Manual - Volume 2

The flight crew can use two types of guidance to control the aircraft in auto flight. One type is managed by the Flight Management Guidance System (FMGS). The other uses target quantities which are manually entered by the flight crew.

When the aircraft uses target quantities from the FMGS (managed guidance), the FCU windows display dashes and the white dotes next to those windows light up. When the

aircraft uses target quantities, entered by the flight crew (selected guidance), the windows display the selected numbers and the white dots do not light up.

Note 1: *The altitude window always displays an altitude selected by the flight crew (never dashes).*

The FCU has four knobs:

- *SPD-MACH*
- *HDG-TRK*
- *ALT*
- *VIS-FPA*

The knobs can be rotated, pushed in, and pulled out:

- *In order to arm or engage managed guidance for a given mode, the flight crew pushed in the associated knob. If, for example, they push in the HDG knob, they engage or arms [sic] the NAV mode.*
- *In order to engage a selected guidance mode, the flight crew turns the knob to set the desired value, then pulls the knob out to engage the mode with a target value equal to the selected value.*

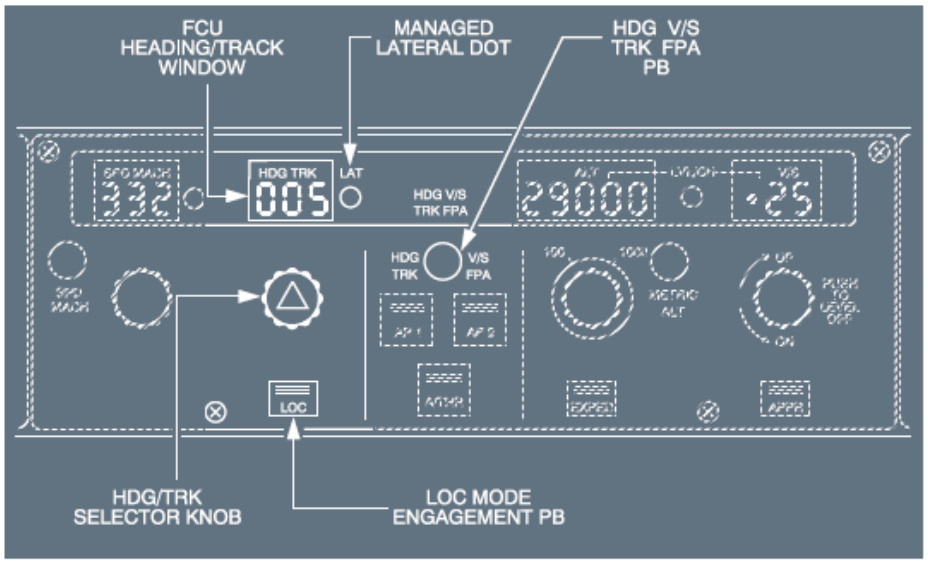
Note 2: *In managed guidance (lateral, vertical guidance or managed speed), the corresponding window is dashed. Turning a knob without pulling it, displays a value that is the sum of the current target and the turn action value. The display remains 45 s on the HDG/TRK and V/S windows and 10 s on the SPD/MACH window before the dashes reappear. This rule does not apply to the ALT knob/window.*

9.4.1 Lateral Control Area

The Air Canada Flight Operations A319/A320/A321, Aircraft Operating Manual – Volume 2, provided the following guidance on the lateral control portion of the FCU:

LATERAL CONTROL AREA

Ident.: 2-22_10-40-20-00010115.0007001 / 23 DEC 15
Applicable to: ALL



HDG/TRK KNOB

Display range: between 0 ° and 359 °.

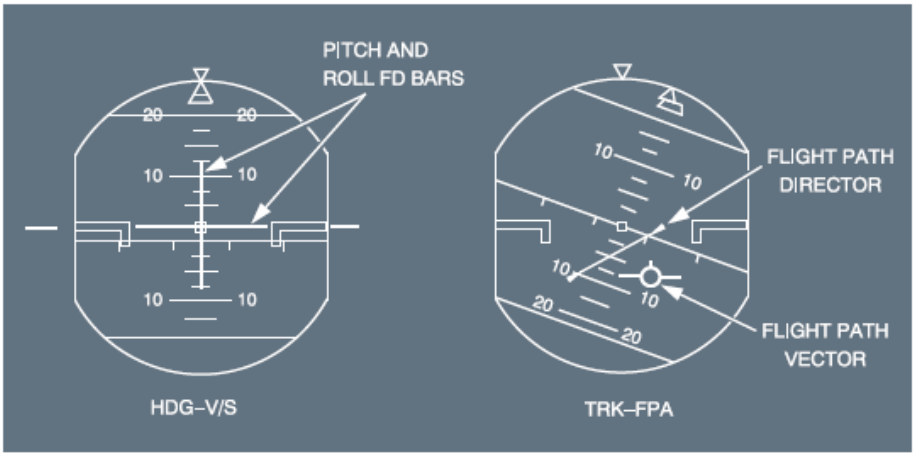
One rotation of the knob corresponds to 32 ° (1 ° per click).

LOC PB

Pushing this pushbutton arms, engages, or disengages the LOC mode.

HDG V/S – TRK FPA PB

The flight crew uses this pushbutton to select HDG (associated with V/S) or TRK (associated with FPA). Pushing it:
- Displays the Flight Path Vector (FPV) on the Primary Flight Display (PFD) or deletes it.
- On the PFD, changes the FD crossbar display (with the aircraft attitude as its reference) to the aircraft Flight Path Director (with the flight path vector as its reference) and vice versa.
- Changes heading reference into track reference in the HDG/TRK window and vice versa.
- Changes vertical speed reference target into flight path angle reference target in the V/S-FPA window and vice versa.



9.4.2 Primary Flight Display (PFD)

The following figure (Figure 17) was provided by the Air Canada Flight Operations A319/A320/A321, Aircraft Operating Manual – Volume 2 and showed the information available on the PFD during the approach phase:

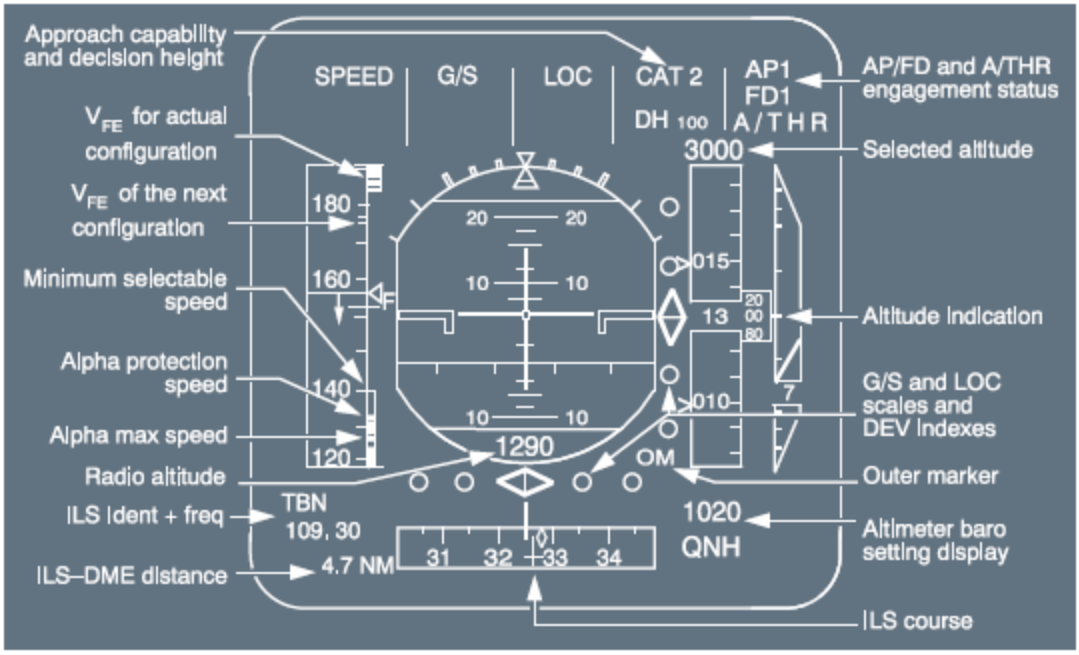


Figure 17: PFD During Approach Phase

9.4.3 Navigation Display (ND)

The Air Canada Flight Operations A319/A320/A321, Aircraft Operating Manual – Volume 2, provided the following information about the ND:

The FMGS generates the following information, displayed on the EFIS Navigation Displays:

- *Flight plan (active secondary, temporary, dashed)*
- *Aircraft position and lateral deviation from the flight plan*
- *Pseudo-waypoints along the flight plan*
- *Raw date from tuned Navaids and type of selected approach*
- *Various display options (waypoints, Navaids, NDBs, airports, constraints)*
- *Wind information and various messages.*

The following figures were pictorial descriptions of various modes available on the ND:

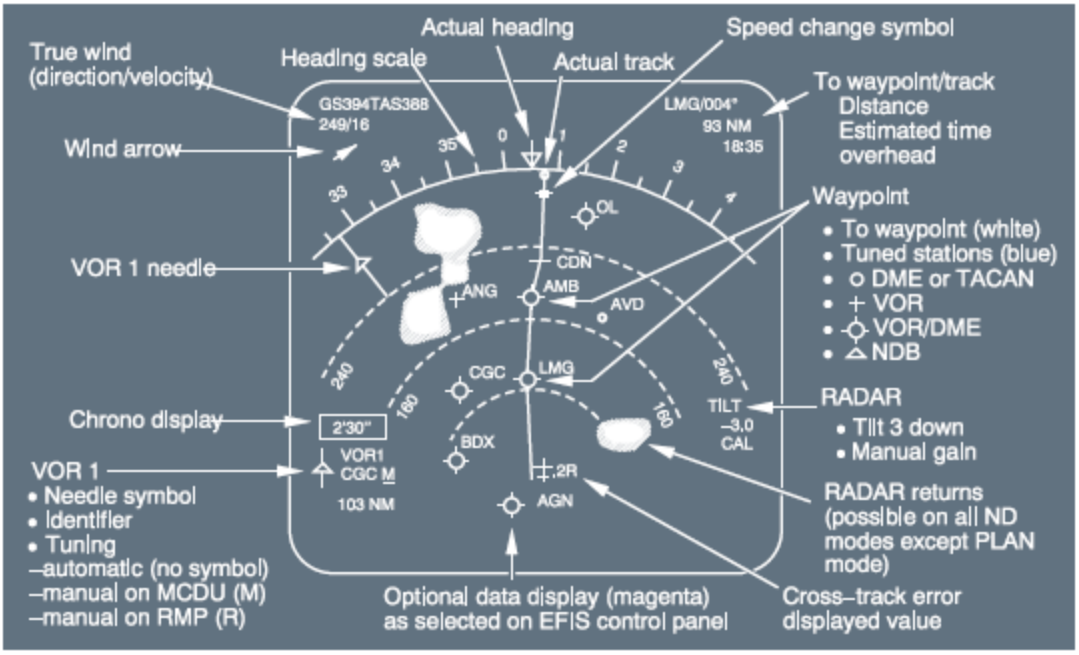


Figure 18: ND in ARC Mode

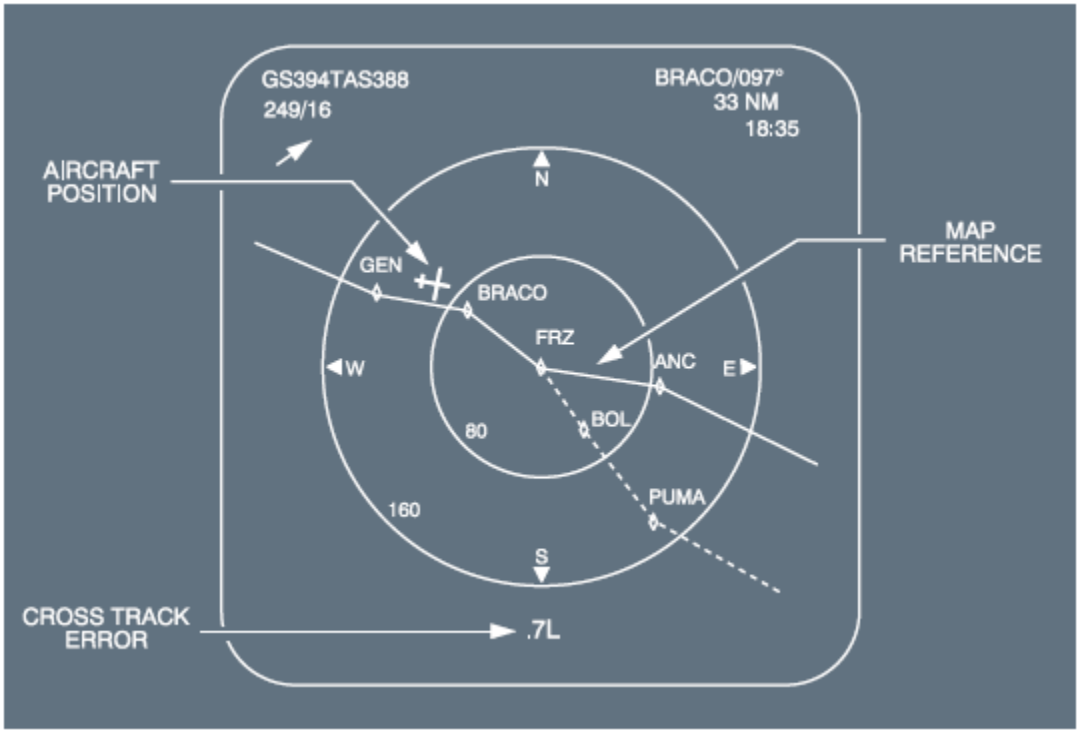


Figure 19: ND in PLAN Mode

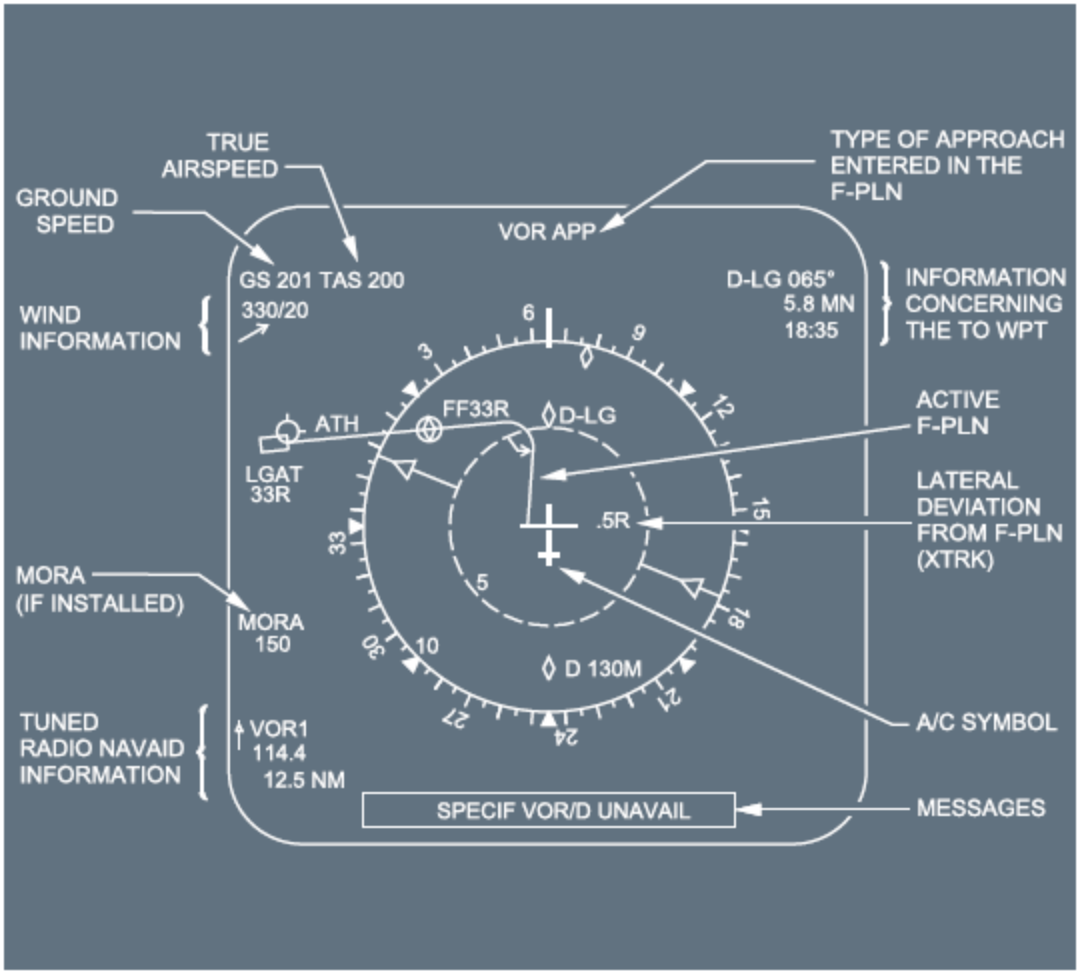


Figure 20: ND in ROSE Mode

10.0 Manuals and Guidance

10.1 Radio Navigation Tuning

The FMGC was the basic means for tuning navaids. Three modes of tuning were available.

10.1.1 Automatic Tuning

According to the Air Canada Airbus A319/A320/A321 Airplane Operations Manual, "Navigation":

> *In normal operation, the FMGC tunes navaids automatically, with each FMGC controlling its own receivers.*
>
> *If one FMGC fails, the remaining one controls both sides receivers.*

10.1.2 Manual Tuning

According to the Air Canada Airbus A319/A320/A321 Airplane Operations Manual, "Navigation":

The crew can use the MCDU to override the FMGC's automatic selection and tuning of navaids and select a specific navaid for visual display.

This does not affect the automatic function of the FMGC. Any entry on one MCDU is sent to both FMGC in dual mode, or the remaining FMGC in single.

10.1.3 Back Up Tuning

According to the Air Canada Airbus A319/A320/A321 Airplane Operations Manual, "Navigation":

If both FMGC's fail, the flight crew can use the RMPs (Radio Management Panels 1 and 2) on the pedestal for back up tuning.

The CAPT RMP controls VOR 1 and ADF 1

The F/O RMP controls VOR 2 and ADF 2

Either RMP controls both ILSs (provided NAV back up is selected on RMP 1 and RMP 2). RMP 3 is not used for navaids tuning.

10.1.4 Radio Management Panel (RMP)

According to the Air Canada Airbus A319/A320/A321 Airplane Operations Manual, "Navigation", the following excerpts provided clarifying guidance about the RMP:

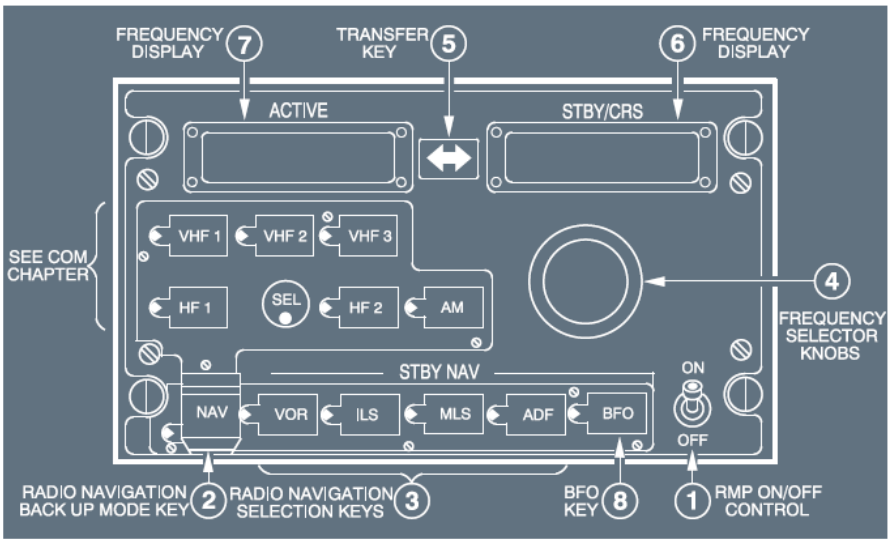


Figure 21: Radio Management Panel[70]

[70] SRCE: Air Canada Flight Operations Manual – Volume 2 A319/A320/A321 "Navigation – Radio Nav Controls and Indicators" P4

(2) NAV key (transparent switchguard)

– *Pressing this key engages the radio navigation backup mode. It takes control of the VOR, ILS, and ADF receivers away from the FMGC and gives it to the RMP.*

NOTE: – *Pressing the MLS key has no effect.*

– *The green monitor light comes on.*
– *Pressing the NAV key a second time returns control of the navigation radios to the FMGC.*

NOTE: – *The flight crew must select this backup tuning mode on both RMP1 and RMP2 if both FMGCs or both MCDUs fail. In the emergency electrical configuration, only RMP1 receives power*

a) *Pressing the NAV key on RMP3 has no effect*
b) *In the NAV backup mode, the flight crew can select radio communication systems as it would in the normal mode.*

Setting one RMP to NAV backup mode removes navaids tuning from both FMGCs.

to tune an ILS/DME, the PFDs do not display the DME distance (applicable to FMS1 Honeywell Legacy only).

(4) Frequency selector knob

Two concentric knobs allow the flight crew to preselect frequencies for communication radios and stand-by navigation systems and select courses for VOR and ILS.

The desired frequency or course is set in the STBY/CRS window.

Setting frequency:

The outer knob controls the most significant digits, the inner knob controls the least significant digits. A rate multiplier speeds up the tuning when the knob is rotated rapidly.

Setting course:

Selected by inner knob only.

(5) Transfer key

The flight crew presses this key to interchange ACTIVE and STBY frequencies. This action tunes the selected receiver to the new ACTIVE frequency.

(6) STBY/CRS window

The flight crew can make the frequency displayed in this window become the active frequency by pressing the transfer key, or change it by rotating the tuning knob.

If this window displays a course, then the ACTIVE window displays the associated frequency.

NOTE: *If the STBY/CRS window is displaying a course, then pressing the transfer key displays the active frequency in both windows.*

10.2 Approach Modes

10.2.1 Non-Precision Approach

According to the Air Canada Airbus A319/A320/A321 Aircraft Operating Manual – Volume 2, "AUTO FLIGHT – FLIGHT GUIDANCE," provided the following:

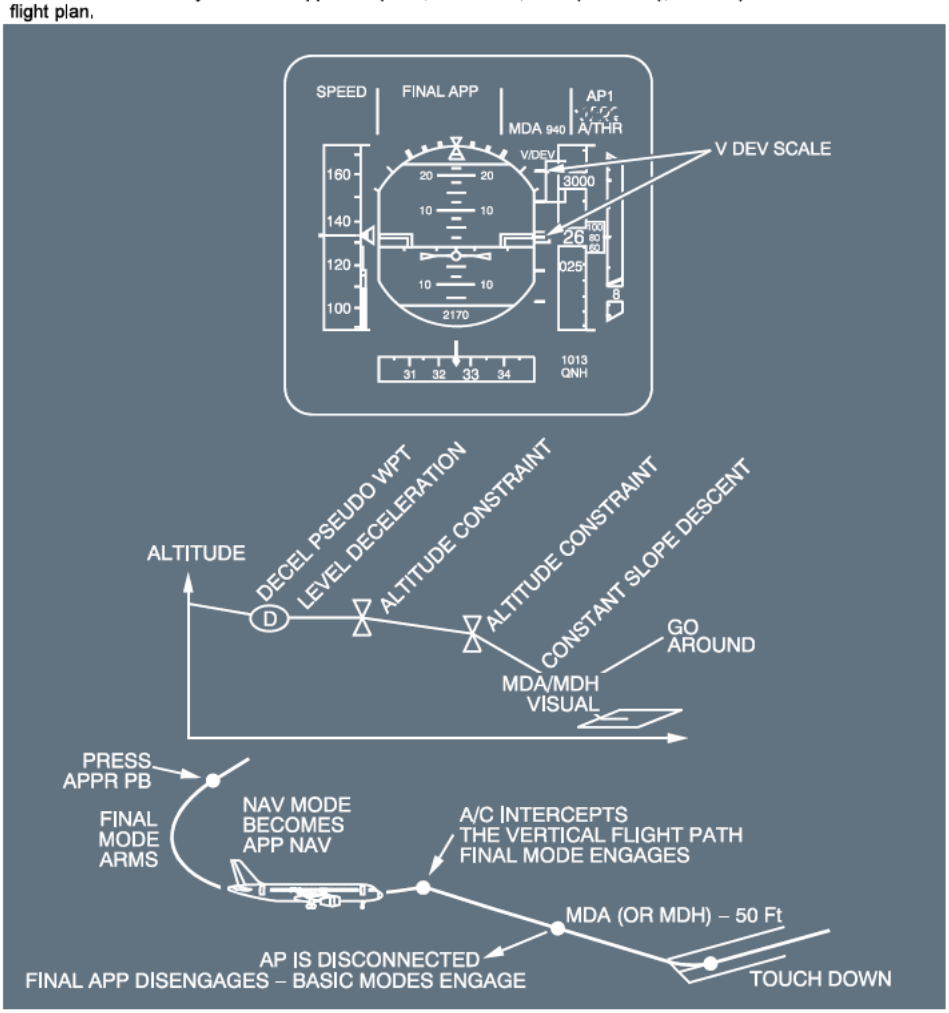
GENERAL

Ident.: 2-22_30-60-30-20-00012388.0005001 / 24 MAR 16

Applicable to: **201-213, 215-222, 235-240, 258, 260-261, 264-271, 274-275, 280, 282, 285, 401-405, 408, 411, 415-416, 451-460**

This mode guides the aircraft laterally and vertically down to the Minimum Descent Altitude (MDA) or Minimum Descent Height (MDH) along the final descent profile computed by the FMGS.

This mode is used to fly a non-ILS approach (VOR, VOR/DME, NDB (if ADF), RNAV...) as inserted into the flight plan.



The non-ILS approach includes the following managed modes:
- APP NAV mode for lateral guidance
- FINAL mode for vertical guidance.

SELECTION

Ident.: 2-22_30-80-30-20-00012389.0001001 / 23 DEC 15

Applicable to: **ALL**

A non-ILS approach (VOR, VOR/DME, NDB (if ADF), RNAV) is selected if the active flight plan calls for it (and it has been inserted in that flight plan).

ARMING CONDITIONS

Ident.: 2-22_30-80-30-20-00012390.0001001 / 23 DEC 15

Applicable to: **ALL**

The flight crew arms the APP NAV and FINAL modes by pressing the APPR pb on the FCU, if all of the following conditions are met:
- The aircraft is above 400 ftAGL
- The flight plan is valid (lateral and vertical profile)
- The active flight plan has selected a non-ILS approach
- GA mode is not engaged.

The FMA displays "FINAL" and "APP NAV" in blue.

If NAV mode was already engaged, APP NAV engages immediately.

DISARMING CONDITIONS

Ident.: 2-22_30-80-30-20-00012391.0001001 / 27 JUL 16

Applicable to: **201-213, 215-222, 225-226, 228, 232, 235-242, 258, 260-261, 264-271, 274-275, 280, 282, 285-287, 401-405, 408, 411, 415-416, 451-463, 473**

FINAL and APP NAV modes are disarmed if the flight crew:
- Presses the APPR pb , or
- Presses the LOC pb arming the LOC mode, or
- Engages the GO AROUND mode.

10.3 Crew Briefing Guidance

10.3.1 Route Briefing the Americas

4.3.26 SAN FRANCISCO, CA KSFO / SFO* (12/5/17)**

*San Francisco is a FAA Special Airport Qualification. Refer to FOM (5.4.5) and Jeppesen Route Manual / Air Canada tab – 'Airport Qualification' page 1, and 19-xx pages.

4.3.26.4 Arrival Information

SFO Tower has received a FAA waiver to operate at higher than standard crosswind and tailwind limitations.

SFO is authorized to operate on Rwys 28R/L and 1R/L with up to a 25 knot crosswind component on dry runways, and up to a 10 knot tailwind component on wet runways.

This waiver will not be used for Rwys 10/19.

When using provisions of the waiver on Rwy 1, the runway must be departure only.

The main benefits of this waiver are the airport can remain on the more efficient Rwys 28/1 configurations, rather than the Rwys 28/28 configurations.

Terrain rises rapidly to the south, west and northwest of the airport.

Because of traffic volumes, ATC frequently assigns and closely monitors descent speeds.

Arrivals from the north will typically be held very high until over the airport. Flap overspeeds are reported as a high occurrence into SFO.

Weather permitting, arrivals from the east can anticipate the FMS Bridge Visual Rwy 28R. If no aircraft are on approach to Rwy 28L, pilots may be issued a side-step manoeuvre to 28L.

Visual approaches may place approaching aircraft in very close proximity during final.

Caution: Heavy aircraft and B757's will not be authorized to overtake another aircraft on the adjacent final approach course due to wake turbulence. Some airlines are not aware of this restriction and have overtaken aircraft on approach.

Pilots are authorized to conduct the ILS PRM Rwy 28L and LDA PRM Rwy 28R approach provided the following conditions are met:

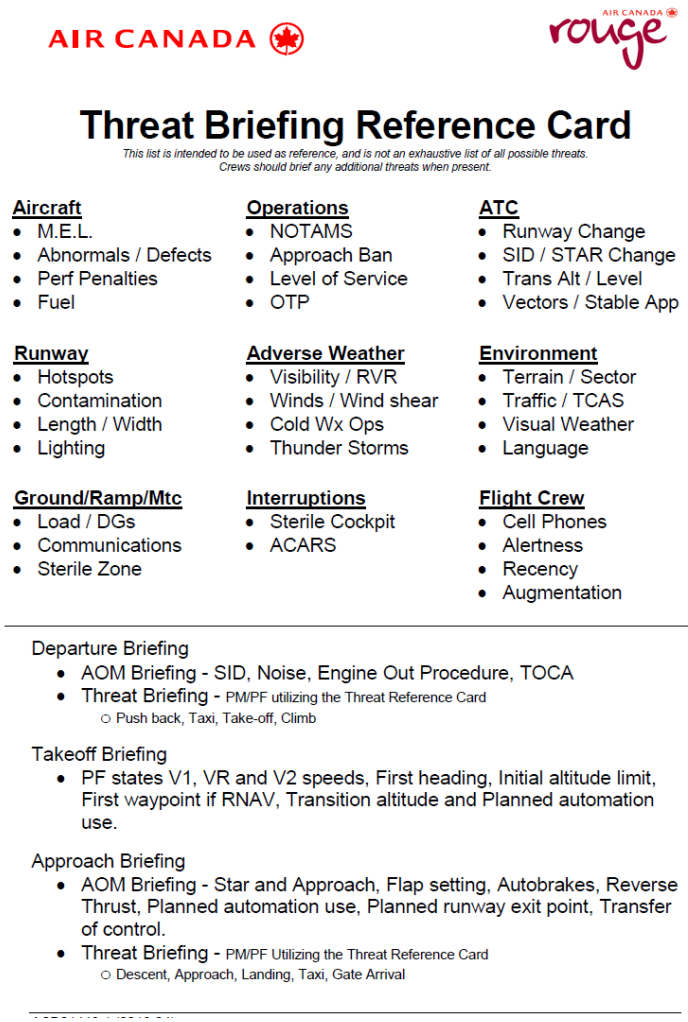
- the AOM has SOPs for PRM approaches,
- have completed the required initial/QC ground and simulator training,
- viewed the video "Simultaneous Offset Instrument Approaches at San Francisco International Airport" located on the FAA website;

  http://www.faa.gov/training_testing/training/prm/
- thoroughly review the appropriate 11-3 or 11-6 page.

In addition to the above, and just to keep things interesting, San Francisco has a "Fly Quiet Program" for late night and early morning arrivals and departures. Its purpose is to encourage individual airlines to operate as quietly as possible at SFO. The program promotes a participatory approach in complying with noise abatement procedures and objectives by grading an airline's performance and by making the scores available to the public via newsletters, publications, and public meetings. For arrivals landing on Runways 28L/R, under Visual Meteorological Conditions, they ask flight crews to request the Quiet Bridge Visual or FMS Bridge Approach for Runway 28R. This approach keeps aircraft over the bay and away from Foster City, a noise sensitive community located adjacent to the San Mateo Bridge. Once the aircraft is inside the bridge you can request with SFO Tower for a side-step to Runway 28L (traffic permitting). During Instrument Meteorological Conditions where ILS is required, flight crews should request an ILS or LDA approach to Runway 28R. Utilizing these approaches especially during the late night hours will help reduce the aircraft noise climate in Foster City on final approach.

Figure 22: Air Canada Route Briefing Guidance - SFO

10.3.2 Threat Briefing Card



AIR CANADA

rouge

Threat Briefing Reference Card

This list is intended to be used as reference, and is not an exhaustive list of all possible threats. Crews should brief any additional threats when present.

Aircraft
- M.E.L.
- Abnormals / Defects
- Perf Penalties
- Fuel

Operations
- NOTAMS
- Approach Ban
- Level of Service
- OTP

ATC
- Runway Change
- SID / STAR Change
- Trans Alt / Level
- Vectors / Stable App

Runway
- Hotspots
- Contamination
- Length / Width
- Lighting

Adverse Weather
- Visibility / RVR
- Winds / Wind shear
- Cold Wx Ops
- Thunder Storms

Environment
- Terrain / Sector
- Traffic / TCAS
- Visual Weather
- Language

Ground/Ramp/Mtc
- Load / DGs
- Communications
- Sterile Zone

Interruptions
- Sterile Cockpit
- ACARS

Flight Crew
- Cell Phones
- Alertness
- Recency
- Augmentation

Departure Briefing
- AOM Briefing - SID, Noise, Engine Out Procedure, TOCA
- Threat Briefing - PM/PF utilizing the Threat Reference Card
  - Push back, Taxi, Take-off, Climb

Takeoff Briefing
- PF states V1, VR and V2 speeds, First heading, Initial altitude limit, First waypoint if RNAV, Transition altitude and Planned automation use.

Approach Briefing
- AOM Briefing - Star and Approach, Flap setting, Autobrakes, Reverse Thrust, Planned automation use, Planned runway exit point, Transfer of control.
- Threat Briefing - PM/PF Utilizing the Threat Reference Card
  - Descent, Approach, Landing, Taxi, Gate Arrival

Figure 23: Air Canada Threat Briefing Card

10.3.3 Arrival Preparation

Air Canada Flight Operations Manual, Section 8.9.10.1 "Arrival Preparation," dated May 16, 2017, provided flight crews with information on preparing for an arrival into an airport. The guidance stated the following:

> *The Flight Crew shall prepare for descent and arrival prior to briefing the arrival and approach as follows:*
>
> *1. Obtain the current ATIS; and*
>
> *2. Verify approaches that are available (ATIS). Prepare for advertised approach or be prepared to request the pilot desired approach when checking-in with the terminal controller. When arriving from a downwind or base leg, consider the following priority when selecting the approach:*
>
> *a) RNP AR APCH*
> *b) RNP APCH*
> *c) ILS/GLS with GNSS Hybrid T-transition*

d) ILS via vectors
e) Other

NOTE: *Carefully consider the visibility when selecting the best approach. An ILS approach (CAT 1, 2, or 3) may be the best choice under certain conditions.*

3. Review the aircraft technical status (if applicable), fuel status, and applicable NOTAMs; and

4. Program the FMS/FMGS with the required data and crosscheck the entries against the appropriate charts. When multiple approaches are in use, a different approach may be loaded in the secondary flight plan of the FMS/FMGS (if available).

For downwind/base leg arrivals confirm the common STAR/APPROACH transition waypoint and select that transition. Once input is complete, confirm that there is a discontinuity after the last STAR waypoint and the Approach Transition waypoint (common STAR/Approach waypoint) is listed immediately after the discontinuity.

Caution: Connecting the STAR/Approach transition (removing the discontinuity at the end of the STAR) without ATC clearance could result in a loss of separation and a risk of collision.

Refer to FOM 14.1.10 PBN STAR/Approach Transitions for more detailed guidance; and

5. Cold temperature corrections should be applied per aircraft AOM when the airport's OAT is less than or equal to zero degrees Celsius; and

6. Determine appropriate autobrake, autoland and flap setting for landing; and

7. Set performance speeds (if required); and

8. Ensure adequate landing distance is available for the aircraft weight and configuration for the actual meteorological conditions and runway surface conditions that exist at the time of arrival. Landing runway analysis is completed using dry, wet, or contaminated runway conditions or Runway Condition Codes. Specific procedures for calculating landing performance is contained in aircraft AOMs. Braking action PIREPs may only be used to downgrade a runway analysis. Runway friction reports may only be used to downgrade a landing runway analysis except for the following exception: When ICE has been treated with sand and/or chemical, and the CRFI is greater than 0.40, then COMPACTED SNOW may be used to compute landing performance instead of ICE. This is the only case when CRFI can be used to assist in upgrading the condition of the landing surface. Runway slope can be calculated by reference to the Jeppesen Route Manual Airport Information page.

9. When planning to use missed approach climb gradient minima, the crew must verify the aircraft is capable of meeting the one engine inoperative missed approach climb gradient at the expected landing weight (refer to FOM 8.1.3.5 Missed Approach Performance Requirements). One of two methods is used to calculate the missed approach climb:

a) Missed Approach Performance Assessment

The Air Canada Aircraft Performance group conducts an obstacle clearance and one engine inoperative performance assessment in accordance with Transport Canada guidance. The assessment may allow the use of the published missed approach procedure or may necessitate a special engine out navigation procedure. The assessment information is contained in the Route Manual 10-10 Arrival section.

b) Missed Approach Climb Gradient Performance Tables

The AOM and/or QRH one engine inoperative missed approach climb gradient tables are used to verify that the landing weight does not exceed that needed to meet the published gradient.
***NOTE:** ACARS WAT, EFB and PERF can alternatively be used to calculate climb gradients if available.*

Crews are prohibited from using missed approach climb gradient minima when the aircraft exceeds the landing weight needed to meet the one engine inoperative gradient. The following guidance also applies:

• The Route Manual missed approach performance assessment is controlling when it is published for the intended approach, and
• When there is no published Route Manual missed approach performance assessment, the AOM or QRH one engine inoperative missed approach climb gradient performance tables are controlling.
• Crews are not required to verify standard missed approach minima.

10. Review the FMS/FMGS ETA and update the ETA via ACARS if the estimated gate arrival time varies from the DFM ETA by more than four minutes; and

11. Advise MOC via the ACARS SNAG function of any aircraft defects entered into the Aircraft Defect Log; and

12. Advise MOC via the ACARS Messenger function (Maintenance) of any cabin defects entered into the Cabin Defect Log; and

13. Review, as required, with the In-Charge Flight Attendant the TOD time and ETA, expected weather conditions, anticipated use of the seatbelt sign, cabin defects, and any additional items deemed to affect the safety or comfort of the passengers and Cabin Crew; and

14. Obtain DFR from participating stations to determine gate assignment. The DFR information should be used as part of the arrival briefing to discuss concerns or threats for taxi and gate arrival.

General operating procedures applicable to RNAV procedures are located in FOM 14.1.9 PBN General Operating Policy.

10.3.4 Arrival and Approach Briefing

Air Canada Flight Operations Manual, Section 8.9.10.3 "Arrival and Approach Briefing," dated May 16, 2017, provided flight crews with information on briefing the approach and arrival into an airport. The guidance stated the following:

The purpose of the arrival and approach briefing is to enhance situational awareness and clarify expectations. Arrival and approach briefings are required for all approaches including visual approaches.

The Aircraft AOMs contain sample approach briefings which shall be used by Flight Crews to conduct arrival and approach briefings.

The PF shall normally conduct the arrival and approach briefing during the cruise phase of flight prior to planned top of descent. The PF and PM shall be in their appropriate seats to address the Arrival and Approach briefing and Threat briefing preparations. In a multicrew flight deck the RP and/or Augment pilot should be briefed at an appropriate time.

If the P-EFB is being used to display arrival charts, flight crew members shall ensure that their P-EFB is placed in a mode which will allow it to remain unlocked and available for viewing throughout the arrival process. These modes are described in the P-EFB Users Guide.

Where both an instrument and a visual approach is in use for the same runway, the briefing shall be of the instrument approach with the addition of any pertinent considerations associated with the visual procedure.

Following the first approach briefing of each crew cycle the Flight Crew shall review shall review the go-around procedure from the point where the PF calls "Go-around, flaps" to the point where climb thrust would be selected.

When a Flight Crew has planned for and briefed an IFR approach and subsequently accepts a visual approach, all calls shall remain as per the IFR briefing conducted. All flight crew members shall remain aware of, and communicate to the other flight crew

members, any remaining visual approach restrictions, pertinent information including noise restrictions, and missed approach intentions.

Crews should remain vigilant, identify and communicate any additional threats that may arise.

Threat Briefing

Beginning with the Pilot Monitoring (PM), followed by the Relief Pilot and/or Augment Pilot and ending with the Pilot Flying (PF), each crew member should identify any relevant threats that are anticipated during descent, arrival, approach, landing and taxi-in that pertain to their role, as well as strategies to mitigate them.

Additional Required Briefing Items:

In addition to the AOM approach briefing, the PF shall discuss the following:

a) The use of automation; and (Specific procedures for Non Precision App and when Auto Pilot/Throttle will be disconnected)
b) Flap setting; and
c) Autobrake selection; and
d) Level of reverse thrust for landing; and
e) The planned runway exit point; and
f) Transfer of Control

10.3.4.1 Descent Preparation

Air Canada Aircraft Operating Manual- Volume 1, A319/A320/A321, Section 4 "Standard Operating Procedures," dated April 13, 2017 provided flight crews with information on preparing for the descent into the destination airport, briefing the approach, and arrival into an airport. The guidance stated the following:

DESCENT PREPARATION

Applicable to: **ALL**

Ident.: 1-04-09-K20141117-0955555555.0002001 / 13 APR 17

The PRE-DESCENT preparation or flow, should be completed at any time when cockpit workload permits prior to Top of Descent.

For descent planning purposes, the use of Engine/Wing Anti-ice increases the idle schedule commanded by FADEC, resulting in a decreased V/S. This reduction in V/S is not accounted for in the FMGC calculated T/D point.

ECAM STATUS ..... PF ..... CHECK

- *Check on Upper ECAM MEMO display for configuration and/or status reminders. If the STS reminder is displayed, check the ECAM STATUS page prior to descent to review any operational aspects affecting the approach and landing.*
- *Check on Lower ECAM CRUISE page that the LDG ELEV AUTO is displayed with the correct landing elevation.*

NOTE: *1. Review the aircraft status prior to directing the PM to set up the approach.*
2. Advise maintenance if engine oil quantities are less than 13.0 quarts in cruise.

WEATHER AND LANDING INFORMATION ..... PM ..... OBTAIN

Check weather reports at ALTERNATE and DESTINATION airports. Airfield data should include runway in use for arrival.

NOTE: *Consider cold weather corrections, as per FOM policy.*

LANDING PERFORMANCE ..... PM ..... CONFIRM

- *Perform an in-flight landing performance assessment if arrival conditions change significantly since time of dispatch.*
- *The Captain and First Officer will ensure runway distance available is adequate for landing. Check or modify landing configuration:*

NOTE: *Landing Distances should be calculated anytime when:*
- *The Aircraft is over MLW; or*
- *Landing with a tail wind; or*
- *The landing runway is shorter than 7 000 ft; or*
- *The pressure altitude at destination is 6 700 ft or higher; or*
- *The landing runway is contaminated; or*
- *There is an abnormality affecting the Landing Performance of the aircraft; or*
- *Land and Hold Short Operations (LAHSO) are in effect.*

NOTE: *To accept LAHSO, the available landing distance (ALD) must exceed the calculated landing distance by a minimum of 1000 ft.*

Even if the documentation, QRH or ECAM, does not clearly state landing distance corrections, it is the Flight Crews' responsibility to assess the circumstances and apply necessary corrections prior to landing.

MISSED APPROACH CLIMB GRADIENT ..... PM ..... CONFIRM (IF REQ'D)

For minima requiring a Missed Approach Climb Gradient , use the QRH Missed Approach Climb Gradient Tables to confirm the aircraft approach weight is within limits.

F-PLN page ARRIVAL ..... PM ..... COMPLETE/CHECK

Insert APPR, STAR, APPR VIA and TRANS if applicable.

NOTE: *Changing RWY or type of arrival (VOR, NDB, or ILS) automatically deletes the previous MDA or DH entered in the PERF APPR page.*

CAUTION	*When there is a common waypoint used in both a STAR and RNAV (GNSS) approach with altitude restrictions the RNAV (GNSS) approach altitude will overwrite the STAR altitude when the discontinuity is deleted. If required, re-enter the STAR altitude restriction.*

F-PLN page A ..... PM ..... CHECK

Check speeds and altitude constraints and modify as required.

For Non-Precision Approaches flown Managed-Managed (FINAL APP mode):
- *Insert VAPP as a Speed Constraint at the FAF.*
- *0.1 degree of difference between the MCDU and the charted final vertical path is acceptable.*
- *3 degree of difference between the MCDU and the charted final lateral track is acceptable.*

For Non-Precision Approaches flown Managed-Selected (NAV-FPA mode):
- *3 degree of difference between the MCDU and the charted final lateral track is acceptable.*

RAD NAV page ..... PM ..... CHECK

Set navaids as required and check idents on NDs (VOR-ADF) and PFDs (ILS). If a VOR/DME exists close to the airfield, it may be selected and its ident set on the PROG page in the BRG/DIST field, for navigation accuracy monitoring during descent.

FUEL PRED page ..... PM ..... CHECK

Confirm fuel requirements and check GW.

DES WIND ..... PM ..... CHECK
- *Enter descent winds from the OFP prior to commencing the descent.*
- *For certain fins, descent winds are accessed via DES FORECAST on the PERF CRUISE page.*

PERF CRUISE page ..... PM ..... CHECK

Modify the CAB RATE if a different pressurization rate is required.

PERF DES page ..... PM ..... CHECK
- *Prior to descent, access PERF DES page and check ECON MACH/SPD. If a different speed from ECON is required, insert the desired MACH or SPD into the ECON field. This new MACH and/or SPD is now the Managed Descent Speed that is used for the top of descent computation and the Managed descent profile (instead of ECON).*
- *Below 10 000 ft, a 250 KIAS default is calculated in the Managed descent profile; it may be deleted or modified as necessary on VERT REV at DEST.*

PERF APPR page ..... PM ..... COMPLETE/CHECK
- *Enter QNH, TEMP and MAG WIND at destination.*
- *If the wind includes a gust (e.g. 150/20 gusting 25) insert 150/20. GS mini guidance will cope with the gusts. Calm winds may be entered with runway heading and 0 (e.g. 150/00).*
- *In gusty conditions, if landing distance permits, Vapp may be modified in the MCDU by the crew up to a maximum of VLS +15 kt. The new inserted value will be taken into account for GS mini guidance.*
- *Check/Modify TRANS ALT as required. Enter MDA or DH. For approach with CAT I limits or higher enter the published minima in the MDA field (allowing for temperature corrections). For CAT II or CAT III SINGLE, enter the published RA value in the DH field. For CAT III DUAL, enter 'NO' in the DH field.*
- *CONF 3 and CONF FULL are normal landing configurations. CONF 3 should be planned unless operational circumstances indicate CONF FULL would be more appropriate (e.g. short or contaminated). CONF 3 landings enhance go-around performance and are recommended when windshear is suspected.*
- *If landing CONF 3, select LDG FLAP 3 pushbutton on the overhead GPWS panel to ON.*

PERF GO AROUND page ..... PM ..... CHECK/MODIFY

Check/modify THR RED ALT and ACC ALT

PROG page ..... PM ..... CHECK

Perform NAVIGATION ACCURACY CHECK, if required (e.g. GPS PRIMARY LOST).

For RNAV(GPS) approaches ensure that 'P-RAIM CHECK COMPLETED - NO OUTAGES' is shown in the OFP REMARKS section; otherwise check RAIM availability by selecting the PREDICTIVE GPS key [5L] on the PROG page.

NOTE: *A predictive outage is for awareness only and does not prevent the ability to conduct an approach.*

SEC F-PLN page ..... PM ..... AS RQRD

SEC F-PLN may be used for programming another possible approach and/or runway as a back up at the destination airport.

NOTE: *If the SEC F-PLN is activated, check the VAPP, minimums and navaids. Modify if necessary.*

APPROACH SET UP ..... PF ..... REVIEW

The PF, will review MCDU programming, as programmed by the PM. Check for any unusual or specific procedures making use of MCDU data and ND displayed constraints.

Ensure the following items are reviewed as a minimum:

F-PLN page	:	STAR, VIA, Transition, Approach, Missed Approach and associated crossing altitudes and speeds.
RAD NAV page	:	ILS, VOR, ADF as required.
FUEL PRED page	:	Confirm fuel requirements and check GW.
PERF APPR page	:	Transition Altitude and Landing Configuration.

PROG page ..... PF ..... CHECK

Perform a NAVIGATION ACCURACY CHECK, if required (e.g., GPS PRIMARY LOST).

AUTOBRAKE selector ..... PF ..... AS RQRD

For recommended autobrake usage refer to AOM 1-04-10 In Range Checklist - Initial Flow .

GPWS LDG FLAP 3 pb-sw ..... PF ..... CHECK

If a Flaps 3 landing is planned, select the GPWS LDG FLAP 3 pushbutton to ON.

TERR ON ND pb ..... AS RQRD

- *In mountainous areas, terrain shall be displayed on the ND.*
- *If use of radar is required, consider selecting the radar display on the PF side, and TERR ON ND on the PM side only.*
- *If NAV ACCURACY is LOW, do not use TERR on ND.*

ARRIVAL BRIEFING ..... PF ..... COMPLETE

The arrival briefing will include:

1. *Procedure Ident, Runway, Airport and Chart Number; and*
2. *General Information Box:*
   - *Any relevant threats;*
   - *Brief transition altitude if other than 18 000 ft; and*
3. *Route and constraints as published.*

The following is an example of an arrival briefing:

Air

PF	*"This will be the RAGID TWO ARRIVAL, RWY 05, Toronto. Chart 10- 2E3, route and constraints as published."*
PM	*"Roger".*

APPROACH BRIEFING ..... PF ..... COMPLETE

The approach briefing will include:

1. *Procedure Ident, Runway, Airport and Chart Number; and*
2. *Primary Approach aid identifier and frequency, Final Approach Course, Step Altitudes (if pertinent) and FAF crossing altitude; and*
3. *DA on the Barometric Altimeter or DH on the Radio Altimeter;and*
4. *Missed approach as published or per ATC instructions, MAP ALT is XXXXfeet.*

The following is an example of an approach briefing:

PF	*"This will be the ILS RWY 05, Toronto, Chart 11-1. Localizer ITX 109.7, Final approach Course 057, Meadowvale 1930, DA 764 on the barometric altimeter, missed approach as published or per ATC Instructions, missed approach altitude is 5000 feet."*
PM	*"Roger"*

THREAT BASED BRIEFING ..... PF-PM ..... COMPLETE

Beginning with the Pilot Monitoring (PM) and ending with the Pilot Flying (PF), each crew member should identify any relevant threats that are anticipated during descent, arrival, approach, landing and taxi-in that pertain to their role, as well as strategies to mitigate them.

P-EFB SECURING DEVICE ..... ATTACHED AND SECURED

P-EFB ..... SECURED

Figure 24: Air Canada's Descent Preparation Guidance

10.3.4.2 In-Range Checklist

Air Canada Aircraft Operating Manual – Volume 1, A319/A320/A321, Section 4 "Standard Operating Procedures," dated April 13, 2017, provided flight crews with an "IN RANGE" checklist. The guidance stated the following:

IN RANGE CHECKLIST

Applicable to: **ALL**

Ident.: 1-04-10-K20141117-1826262626.0001001 / 23 DEC 15

The IN RANGE flow and CHECKLIST are routinely done at 10 000 ft or when approximately 30 track miles to touchdown.

Flight Attendants must be given enough time to prepare the cabin for landing.

..... **PF** ..... **"IN RANGE CHECKLIST"**

The PF calls for the "IN RANGE CHECKLIST". The PM completes the following items as a flow, then reads the In-Range Checklist:

LAND LIGHTS ..... **ON**

LAND L and R will be selected ON by the PM.

SEAT BELTS sw ..... **ON**

If the SEAT BELT sign is ON, cycle the seat belt switch OFF then ON

LANDING DATA ..... **CHECK**

If there has been any significant change to the landing runway, STAR, VIA, or Transition the PF will give a new Approach Briefing including all items in the format of the Pre-descent Briefing.

Both Flight Crew review the applicable items as listed and confirm the required settings.

On the MCDUs	:	PF set PERF, PM set F-PLN
On the Lower ECAM	:	Check GW
On the Upper ECAM:	:	FUEL ON BOARD

..... **PM** ..... **"FCU"**

On the FCU including EFIS Control Panels (both pilots check):
- *SPEED, HDG, ALT, ILS/LS, ND Display modes, ADF/VOR, Range Select, Optional Data Display, as required.*

..... **PM** ..... **"FMA"**

On the FMA (both pilots check):
- *MDA or DH set.*
- *Annunciations in agreement with FCU selections.*

..... **PM** ..... **"PFD"**

On the PFD (both pilots check):
- *ILS Frequency, ASI Targets, ALT Targets set.*

..... **PM** ..... **"ND"**

On the ND (both pilots check):
- *VOR, ADF, DME, Active Waypoint, WX RADAR, TERR ON ND, displayed as required.*

AUTOBRAKE ..... **AS RQRD**

Use of AUTOBRAKE is preferable.
- *MAX autobrake is prohibited for landing.*

MED mode is recommended when:
- *landing on a short (less than 7 000 ft) runway, or*

– *contaminated runway, or*
– *when operating in low visibility weather (equal or less than 1200 RVR).*

LO mode is recommended when:
– *landing on a long runway (but not in low visibility conditions)*

Check ON light illuminated on selected mode pushbutton.

NAV ACCURACY ..... CHECK

The NAVIGATION ACCURACY CHECK determines the use of Autopilot modes, the type of ND displays to be used as well as the use of EGPWS. For more information refer to AOM 1-04-09 Navigation Accuracy Check - Methods for Navigation Accuracy Comparison Check .

See individual approach procedures for ND selection recommendations.

Applicable to: **ALL**

Ident.: 1-04-10-K20141117-1826372637.0001001 / 23 DEC 15

IN RANGE CHECKLIST

'LIGHTS"	**PM**	**"ON"**
"SEAT BELTS"	**PM**	**"ON"**
"LANDING DATA"	**PM**	**"SET"**
	PF	**"REVIEWED AND SET"**
"AUTOBRAKE"	**PM**	**"OFF" or "LOW" or "MED"**
"NAV ACCURACY"	**PM**	**"CHECKED"**
	PM	**"IN RANGE CHECKLIST COMPLETE"**

Figure 25: In Range Checklist

10.3.5 Approach

Air Canada Flight Operations Manual, Section 8.11.2 "General," dated May 16, 2017, provided flight crews with information on the general policy regarding approaches. The guidance stated the following:

The following outlines general policy regarding approaches:

(7) Each specific AOM will detail the authorized approaches for that fleet type. Fuel efficiency is an important consideration in the conduct of an approach, however priority shall be given to meeting the stable approach parameters.

(8) Air Canada is not authorized for PAR, ASR, and SRE approaches.

(9) Air Canada is authorized for Land and Hold Short Operations (LAHSO) in Canada and the U.S.

(10) When below 1,000 feet AAE:

a. The PF shall have one hand on the flight controls and one hand on the thrust levers, regardless of whether or not the autopilot and/or autothrust is engaged; and

b. If the Pilot-in-Command takes control from the PF, then the Pilot-in-Command shall retain control and complete the landing or go-around.

(11) The In-Charge Flight Attendant shall advise the Flight Crew immediately if the safety checks have not been completed for landing (i.e. cabin not secured) and the approach shall be delayed or a go-around shall be initiated.

(12) Flight Crews are never obligated to land following an approach, even when weather is at or above minima if other factors indicate that the operation cannot be conducted with the desired standard of safety.

10.3.5.1 Approach Terminology

Air Canada's, Aircraft Operating Manual – Volume 1, A319/A320/A321, Section 4 "Standard Operating Procedures" Chapter 11 "Approach," defined the terminology used with regard to approaches. The definitions were as follows:

> ***Coupled Approach –*** *Autopilot or Flight Director systems directed by ground based aids. (i.e. Glideslope and/or Localizer)*
> ***Managed Approach –*** *Autopilot or Flight Director systems directed by FMGS capabilities. (i.e. FMGS Non-Precision data based approaches)*
> ***Selected Approach -*** *Autopilot or Flight Director systems directed by pilot selected commands.*

10.3.6 Crew Coordination

Air Canada's, Aircraft Operating Manual – Volume 1, A319/A320/A321, Section 4 "Standard Operating Procedures," Chapter 11 "Approach," provided the crew with guidance about crew coordination. The guidance provided the following:

> *The PM must maintain a high level of vigilance in monitoring aircraft position, attitude and configuration and pay close attention to instrument indications. The PF must monitor position through both external references and by reference to NAV systems, including DME and NAV Display. Use automation functions to the greatest extent possible. Good crew communication is important.*
>
> *Beware of both pilots focusing on external references at the expense of monitoring instrument indications.*

10.3.7 Monitoring and Announcing Deviations During Approach

Air Canada Flight Operations Manual, Section 8.11.6 "Monitoring and Announcing Deviations During Approach," dated May 16, 2017, provided flight crews with information on pilot monitoring duties (PM) and stabilized approach criteria. The guidance stated the following:

> *Monitoring and feedback are the key to a stable approach and the role of the PM is crucial. The PF may be too task saturated during an unstable approach and fail to recognize that tolerances are being exceeded.*
>
> *The PM shall monitor approach tolerances as defined by the AOM and alert the PF when a significant deviation is observed during an approach (e.g., "Localizer" or "Airspeed") or when a flag or warning is observed (e.g., "Glideslope Flag").*

Throughout the approach, the PM should make informative callouts to assist the PF to achieve stabilized approach conditions (e.g., "Airspeed, target plus 15"). Momentary deviations of glidepath, course, airspeed, and sink rate do not require an immediate go-around. The PM shall make required deviation callouts and monitor for corrections. The PF shall acknowledge any deviation callouts and correct as appropriate.

For the purposes of stable approach requirements, flightpath deviations are defined as deviations from tolerances described in the AOM for:

- *Instrument approaches - Localizer and Glideslope tracking; NPA tracking of lateral and vertical path; or*
- *Deviations from the intended visual approach path when 1,000 feet AAE and below.*

10.3.8 Stabilized Approach

10.3.8.1 Stabilized Approach Policy

Air Canada Flight Operations Manual, Section 8.11.7 "Stabilized Approach Policy," dated May 16, 2017, provided flight crews with the requirements of an approach to be considered "stable". The guidance stated the following:

Air Canada's Stable Approach Policy is built around two Arrival Gates with specific requirements for each gate. These requirements apply at all times to all approaches in all weather conditions, including visual approaches. A Go-around shall be conducted if the requirements for each Arrival Gate are not met, or at any time on approach if conditions warrant. This will be initiated when either pilot calls "unstabilized".

Tolerances for the flightpath, speed, and rate of descent during approach are as established in the aircraft AOM.

1. *There are two Arrival Gates for every approach:*
    a) *1,000 feet AAE[71]; and*
    b) *500 feet AAE.*

        ***NOTE**: The radar altimeter is an acceptable means to determine height over relatively level terrain.*

2. *There are five requirements that shall be established and maintained within tolerance at specific gates during the approach:*
    a) *Flightpath; and*
    b) *Configuration; and*
    c) *Airspeed; and*
    d) *Thrust; and*
    e) *Rate of Descent.*

10.3.8.2 1,000 Foot Arrival Gate

No flight shall continue an approach and landing past the 1,000 foot AAE Arrival Gate

[71] Above Airport Elevation

unless the following requirements are met:
1. The aircraft is on the correct lateral and vertical flightpath in accordance with the AOM; and
2. Final landing configuration (gear and flap) has been selected.

10.3.8.3 500 Foot Arrival Gate

No flight shall continue an approach and landing past the 500 foot AAE Arrival Gate unless the 1,000 foot gate requirements continue to be met, and;
1. Airspeed is stabilized on target (+10/-5 knots); and
2. Thrust stabilized, usually above idle, to maintain the target airspeed; and
3. Rate of descent is stabilized not in excess of 1,000 fpm; and
4. Final landing checks completed.

10.3.8.4 Stable Approach Requirements Below 500 Feet AAE

The aircraft shall continue to meet the Stable Approach requirements below 500 feet

and be in a position over the runway threshold to make a normal landing within the Touchdown Zone. The PM shall monitor flight instrument indications for Stable Approach compliance throughout the approach.

If these requirements are not maintained below 500 feet AAE, a verbal call of "Unstabilized" shall be made, even if a "Stable" call had been made earlier. A Go-around

shall be carried out anytime an "Unstabilized" call is made.

10.3.8.5 Other Considerations

1. Unique Approach Procedures: Approaches which require visual maneuvering, including sidestep, have steeper than normal final approach segments or abnormal conditions that require a deviation from the elements of a stabilized approach, shall be briefed prior to commencing the approach.

For approach procedures that require lateral maneuvering below minimums, (e.g., LGA Expressway Visual Rwy 31, or SFO ILS 28R Sidestep minima to 28L) the aircraft shall be established on the extended runway centerline by 300 feet AAE.

Published sidestep approaches must be carefully planned and briefed including additional considerations such as:
- *use of flight directors after initiating the sidestep;*
- *possible GPWS glideslope alerts;*
- *use of VASI or PAPI;*
- *the effect of staggered thresholds on the flight profile.*

2. Airspeed and Descent Fluctuations: An approach may be continued where airspeed or descent rate fluctuations exceed the normal stabilized approach policy due to certain factors (e.g., gusty conditions, slow auto-throttle response, etc.) if the excursions are brief in duration, can be corrected with normal control or power inputs, and do not jeopardize the safety of the approach and landing.

3. Ground Speed Mini: For Airbus aircraft, Flight Crews shall use the Ground Speed Mini airspeed as Target when active.

10.3.8.6 Stable Approach Tolerances

Air Canada's Aircraft Operating Manual – Volume 1, A319/A320/A321, Section 11 "Approach," Chapter 50 "Final Approach Phase," provided pilots with the tolerances allowed for a stable approach for various approaches, including a visual approach. The guidance stated the following:

Flight parameters are closely monitored by both pilots. The PF announces any FMA changes. Throughout the final approach the PM shall call out any deviation which exceeds the parameters established below. Policy defining whether to continue an approach or to go around based on these parameters is contained in the FOM.

■**Tracking**

		Deviation:
• LOC/VOR approaches	– Lateral deviation within	1 dot
	– Vertical deviation (if available) within	½ scale deflection
• CAT I approaches	– LOC and G/S within	1 dot
• CAT II/III approaches	– LOC within	1/4 dot
	– G/S within	1 dot
• RNAV approaches	– Lateral tracking within	the RNP requirement
	– Vertical deviation (if available) within	½ scale deflection
• NDB approaches	– Bearings within	± 5 °
	– Vertical deviation (if available) within	½ scale deflection

• Visual approaches and approaches without vertical path guidance:
– Lateral tracking as close as possible to the extended runway centerline or published inbound course;
– Vertical tracking on approximately a 3 degree glide path and using visual approach slope indicators (i.e. PAPI, VASIS) if available.

■ Vertical Speed not exceeding 1000 fpm
■ Airspeed within +10/ -5 knots of Target.

Unusual circumstances or conditions may require allowances for momentary variations due to weather and turbulence.

Figure 26: Stable Approach Guidance

10.3.9 Go-Around

Air Canada Flight Operations Manual, Section 8.11.9.3 "Go-Around," dated May 16, 2017, provided flight crews with the requirements of when a go-around shall be initiated. The guidance stated the following:

A Go-Around shall be initiated when it is apparent that:
1. *Stable approach parameters cannot be met and maintained inside the appropriate gates; or*
2. *The aircraft has reached the DH/DA or MDA and required visual reference is not established or is lost after descending below DH, DA, or MDA; or*
3. *Landing will not be accomplished within the touchdown zone; or*

4. *Landing will be within the touchdown zone, but not within stable approach speed parameters; or*
5. *Landing will not be accomplished on the runway centerline and the Pilot-in-Command cannot be assured of safe clearance between main landing gear and the runway edge. This distance will vary with fleet type.*

When a go-around is initiated the PF shall call "Go-Around" as specified in the specific aircraft AOM and comply with the go-around procedure as specified in the specific aircraft AOM and fly the published missed approach routing or modified routing as required.

If a Missed Approach procedure contains an "At" or "Below" crossing restriction prior to permitting climb to the final Missed Approach altitude, the PM shall monitor or set the constraint altitude until assured of meeting the crossing restriction.

10.3.10 Visual Approaches

Air Canada Flight Operations Manual, Section 8.11.12 "Arrivals in VMC," dated May 16, 2017, provided flight crews with the requirements of conducting a visual approach in both day and night visual conditions. The guidance, in part, stated the following:

IFR Arrival to a Visual Approach

1. *Flight Crew Responsibilities during a Visual Approach*

Flight Crews may conduct both charted and non-charted daytime visual approaches. When accepting a visual approach the Pilot-in-Command assumes additional responsibilities not normally associated with other phases of IFR flight. These are:

a) *At controlled aerodromes, maintaining separation from traffic that the Flight Crew is instructed to follow; and*

b) *Maintaining adequate wake turbulence separation; and*

c) *Navigation to the final approach; and*

d) *Adherence to published noise abatement procedures and compliance with any restrictions that may apply to Class F airspace; and*

e) *At uncontrolled aerodromes, maintaining appropriate separation from VFR traffic that, in many cases, will not be known to ATC.*

2. *Visual Approach Requirements*

A visual approach to a runway with no navaids shall be carried out only when a missed approach due to weather is not a possibility.

a) *Canadian Destinations*

At Canadian destinations in a radar environment, to gain operational advantages, the Flight Crew or ATC may request a radar-vectored flight to conduct a visual approach clearance, provided that:

- *The reported ceiling is at least 500 feet above the established minimum IFR altitude and the ground visibility is at least three statute miles; and*
- *The Flight Crew reports sighting the airport, controlled or uncontrolled, or*
- *At a controlled aerodrome, the identified preceding aircraft from which visual separation shall be maintained.*

b) *U.S. Destinations*

In the U.S. the reported weather at the airport must have a ceiling at or above 1,000 feet and visibility of three statute miles or greater.

3. *Altitude Selector Requirements during a Visual Approach*

During a visual approach, the altitude selector shall be set in accordance with any altitude restrictions associated with the charted approach procedure in use or any other restriction assigned by ATC (recommended altitudes do not need to be set, only monitored). Once all crossing restrictions are met, and just prior to commencing the final uninterrupted descent to the runway, the altitude selector shall be set to the visual missed approach altitude or where none exists to the IFR missed approach altitude or as assigned by ATC.

Night Visual Approaches

Night visual approaches may be conducted in accordance with the daytime criteria above. The following visual approaches are prohibited except when specified in the Jeppesen Route Manual 10-10 pages:

1. *Night visual approaches at mountainous airports[72]; and*
2. *Night contact approaches at mountainous airports.*

For night visual approaches, Flight Crews shall not deviate from published IFR routing and altitudes until within 10 nautical miles of the airport, and only in accordance with any applicable restrictions in the Jeppesen Route Manual 10-10 Mountainous Airport section.

[72] An airport is considered to be a mountainous airport if the terrain rises 2,000 feet or greater within a radius of 12 NM centered on the airport's Aerodrome Reference Point (ARP). SRCE: Flight Operations Manual 8.11.1 "Definitions" dated May 16, 2017.

Flight Operations A319/A320/A321	STANDARD OPERATING PROCEDURES APPROACH	P1 13 APR 17

VISUAL MANEUVERING

VISUAL APPROACHES

Applicable to: ALL

Ident.: 1-04-11-40-K20141119-101200120.0001001 / 23 DEC 15

CONDITIONS

Visual approach policy is described in the FOM.

Visual Approaches are planned to be referenced on a nominal 3 ° glideslope, to be stabilized on the correct approach path, in the landing configuration at Vapp.

RECOMMEND METHOD

- AP/FDs are OFF (FDs both OFF)
- Use the FPV (Bird)
- Use A/THR
- Use Managed Speed

VISUAL CIRCUIT

The flight plan selected on the MCDU should include the selection of the planned landing runway.

The downwind leg may also be a part of the F-PLN. This may be a useful indication of the aircraft position in the circuit on the ND, however visual references are to be used.

At the beginning of the downwind leg:

- Ensure the FMGS APPROACH phase has been activated so as to be at or below the Green Dot speed prior to a point abeam the threshold
- Select FDs to OFF
- Select TRK-FPA to have FPV (Bird) displayed
- Check A/THR active

NOTE: *It is the pilot's responsibility to meet the noise abatement requirements for the approach.*

FMS BRIDGE VISUAL19-3-1A

At or before F101D, disengage autopilot and continue as per Visual Approaches (SOP).

10.3.11 Post-Flight

Air Canada Flight Operations Manual, Section 8.16 "Post Flight," dated May 16, 2017, provided flight crews with guidance on post-flight activities, including guidance on when Air Canada's dispatch department should be briefed. The guidance, in part, stated the following:

Flight Crews should brief Flight Dispatch about significant operational factors including:

1. *Turbulence or windshear on approach and landing; or*
2. *Changing weather conditions on approach and landing; or*
3. *Runway conditions and braking action; or*

4. *Volcanic activity; or*

5. *Other significant issues.*

10.4 Rest and Fatigue Policy

10.4.1 Rest Requirements

6.5.3 Flight Time Limitations

A flight crew member's total flight time in all flights conducted by the flight crew member shall not exceed:

1. 1200 hours in any 365 consecutive days; or
2. 300 hours in any 90 consecutive days; or
3. 120 hours in any 30 consecutive days; or
4. 40 hours in any seven consecutive days.

Flight Time is the time from the moment an aircraft first moves under its own power for the purpose of taking off until the moment it comes to rest at the end of the flight.

6.5.4 Flight Duty Time Limitations and Rest Periods

A flight crew member's flight duty time shall not exceed 14 consecutive hours in any 24 consecutive hours, including 15 minutes for post-flight duties, unless as detailed below:

1. Augmentation without a Flight Relief Facility

   Where the Flight Crew is augmented by the addition of at least one fully qualified flight crew member and the division of duty and rest is balanced between the flight crew members, flight duty time may be extended to 15 consecutive hours if:

   a) The additional flight crew member occupies a flight deck observer seat during take-offs and landings unless the observer seat is required by a ACI in which case a passenger seat must be available for the flight crew member; and

   b) The maximum flight deck duty time for any flight crew member is 12 hours; and

   c) The subsequent minimum rest period is increased by at least two hours.

2. Where a Flight Crew is augmented by the addition of at least one flight crew member, the division of duty and rest is balanced between the flight crew members and a flight relief facility is provided, flight duty time may be extended if:

   a) Where a flight relief seat is provided, the flight duty time may be extended to 17 consecutive hours in which case the maximum flight deck time for any flight crew member shall be 12 hours; or

   b) Where a flight relief bunk is provided, the flight duty time may be extended to 20 consecutive hours in which the maximum flight deck duty time for any flight crew member shall be 14 hours; and

   c) The subsequent minimum rest period shall be at least equal to the length of the preceding flight duty time; and

   d) A maximum of three sectors may be completed.

Flight Duty Time means the total time that starts when a flight crew member first reports for duty (i.e., flight standby, deadheading, training periods, management duties, or supervisory duties), and finishes at the last engines off plus 15 minutes for post-flight duties.

The Pilot-in-Command may request an additional flight crew member to be activated for duty. However, only Crew Scheduling has the authority to assign an additional flight crew member for duty.

A flight crew member shall receive at least 24 consecutive hours free from flight duty following three consecutive flight duty time assignments that exceed 12 consecutive hours unless the flight crew member has received at least 24 consecutive hours free from flight duty between each flight duty time assignment.

Following a flight duty assignment, Air Canada provides a flight crew members with the minimum rest period and any additional rest period required.

A flight crew member shall use a rest period to obtain the necessary rest and shall be adequately rested prior to reporting for duty.

Deadheads or other assignments conducted after operating do not count towards Flight Duty Time.

When flying is assigned to Management or Supervisory Pilots, they must inform Crew Scheduling when their flight duty time commenced.

10.4.1.1 Reserve Rest

6.5.8 Flight Crew Members on Reserve

Each flight crew member shall be given the opportunity to obtain at least eight consecutive hours sleep in any 24 consecutive hours of reserve duty. Air Canada does this by providing at least 24 hours notice of the commencement and duration of the rest period through the assignment of a reserve block. This rest period shall normally be 21:00 to 05:00 local home base time unless otherwise advised by crew scheduling.

The designated rest period cannot shift more than three hours earlier or later than the preceding rest period, nor more than a total of eight hours in any seven consecutive days.

Where Air Canada is unable to provide a flight crew member with the rest period required above and the flight crew member is notified to report for duty, or the reporting time occurs between 21:00 and 05:00 local home base time, the maximum flight duty time shall be 10 consecutive hours and the subsequent minimum rest period shall be increased by at least one-half of the length of the preceding flight duty time.

10.4.2 Fatigue Program

The following is described in the company's FOM regarding fatigue management.

4.11 FATIGUE Last Update: 30 JUN 2015

All flight crew members are expected to report for duty sufficiently rested in order to comply with CARs and to meet Air Canada's safety, security, and service standards.

The prime objective of flight time limitations set in the Collective Agreement is to ensure that flight crew members are adequately rested at the beginning of each flying duty period and while flying, and are sufficiently free of fatigue so that they can operate to a satisfactory level of efficiency and safety in all normal and abnormal situations.

All flight crew members shall make optimum use of the opportunities and facilities provided for rest.

Before considering additional employment or commuting, flight crew members must recognize that the responsibility for being sufficiently rested before undertaking a duty period remains with the individual.

4.12 ALERTNESS MANAGEMENT Last Update: 30 JUN 2015

The following information has been excerpted from the ATA Alertness Management Guide. The guide was completed with the scientific collaboration of Alertness Solutions.

4.12.1 Introduction

Flight operations can lead to fatigue, disruption of sleep and circadian rhythms, and degradation of alertness and performance. Clearly, these factors could affect operational safety. Acknowledging and managing these physiological challenges promotes safety and performance in flight operations, while ignoring them can increase the potential for errors, incidents and accidents. Fortunately, a wide range of strategies is currently available to effectively manage fatigue in flight operations.

There is no single approach or countermeasure that will eliminate fatigue from flight operations. Operational demands, human physiology and individual differences are too complex for a simple mechanistic approach. Since there is no simple answer, the challenge is to effectively manage alertness. Education is crucial in any effort to manage fatigue.

Section 1 below provides basic information on the physiological factors that underlie fatigue. Section 2 presents information on personal alertness strategies, including both preventive and operational fatigue countermeasures. By learning about the issues involved and using personal strategies to maximize alertness and performance during operations, flight crew can contribute to safer flight operations.

4.12.2 Basic Human Physiology: Sleep and the Circadian Clock

4.12.2.1 Sleep Basics

Sleep is a Vital Physical Need

Like food, water and air, sleep is required by the body for survival. Further, sleep is a critical requirement for alertness and performance. Data collected during actual flight operations demonstrate that alertness and performance degrade with sleep loss. Conversely, with sleep, alertness and performance can be optimized.

Sleep is a Complex Physiological Process

Sleep is comprised of two distinct components: NREM (non-REM) sleep generally involves restoring the body, while REM (rapid eye movement) sleep generally involves restoring the mind. NREM sleep is divided into four stages, with Stages 3 and 4 providing the deepest sleep.

Average Sleep Requirement is Eight Hours

An individual requires the amount of sleep necessary to achieve full alertness and an effortless level of functioning during waking hours. Most adults require about eight hours of sleep, though there is a range of individual sleep-needs (e.g., about six to 10 hours). Despite many claims to the contrary, only a very small percentage of people can function optimally with less than 6 hours sleep.

4.12.2.2 Sleep Debt

Lost Sleep Accumulates

An individual who requires eight hours of sleep and obtains only six hours is sleep-deprived by two hours. If that individual sleeps only six hours each night over four nights, then the sleep loss accumulates into an eight-hour sleep debt. Estimates suggest that most adults obtain one to one and a half hours less sleep per night than they actually need. Generally, recovery from a sleep debt involves obtaining deeper sleep and sufficient amounts over one to two nights. Given that almost all flight crew members accumulate some sleep debt while at work, and that sleep is the only long term method of reversing fatigue, it is accurate to say that rest periods are the most important element in managing flight crew member alertness.

Sleep Changes with Age, Alcohol and Disorders

Some of the most significant changes to sleep occur as a natural function of age. While younger people sleep more and deeper, as people age, they get less sleep during the night (although they still need the same amount), get less deep sleep, and have more awakenings. Sleep also changes with alcohol consumption. Although many people use alcohol to "wind down" and foster sleep, it can actually reduce sleep quality and quantity overall. Alcohol can reduce REM sleep in the first half of night, and then disturb sleep in the second half of night.

Sleep Disorders

A range of physiological sleep disorders also can disturb the quantity and quality of sleep, and subsequently can degrade waking performance and alertness. Although about one-third of adults report a sleep disturbance, this figure is conservative considering that sleepers often are unaware of these disturbances. One example of a common disorder is sleep apnea, characterized by breathing pauses during sleep that cause the sleeper to awaken repeatedly to resume breathing. A cardinal symptom of sleep apnea is snoring (although there are other causes for snoring besides sleep apnea). Sleep apnea is an example of a sleep disorder that is a well-documented health risk and can significantly reduce waking alertness and performance. Evaluation and treatment for sleep disorder is available at accredited sleep disorders clinics.

Physiological vs. Subjective Sleepiness

Two aspects of sleepiness can be considered: physiological and subjective. Physiological sleepiness is the result of sleep loss: lose sleep, get sleepy. Sleep loss will be accompanied by increased physiological sleepiness that will drive an individual to sleep in order to meet the physiological need for sleep. Subjective sleepiness is an individual's introspective self-report of how sleepy they feel. Subjective reports of sleepiness can be affected by many factors, such as physical activity or a particularly

stimulating environment (e.g., an interesting conversation), which tend to mask or conceal physiological sleepiness and lead people to overestimate their own level of alertness. Subjective reports of sleepiness often differ significantly from physiological measurements; individuals will generally report greater alertness than indicated by physiological state. Applying this fact to operations means that a flight crew member who reports being alert, in fact, may be close to falling asleep.

Daily Maximum Sleepiness

Humans are hard-wired to experience two periods of physiological sleepiness each day. These are at about 3-5 a.m. and 3-5 p.m., and are dictated by the circadian system controlled by the brain.

4.12.3 Circadian Basics

The Circadian Clock

Humans, like other mammals, have an internal circadian clock that regulates physiological and behavioural functions on a 24-hour basis. Located in the brain, this body clock is set by external time cues, especially bright light.

Control of 24-Hour Rhythms

The clock coordinates daily cycles of sleep/wake, performance, physiology, mood and other functions. It programs us to sleep at night, to be awake during the day, and to have daily peaks and troughs in different functions at specific times. Between 3-5 a.m., physiological sleepiness peaks, and virtually all aspects of alertness and performance slow and can be reduced. Less dramatically, an afternoon dip between 3-5 p.m. also affects sleepiness, alertness and performance.

Circadian Disruption

The circadian clock cannot adjust immediately when a person suddenly changes schedule (e.g., by flying to a new time zone or changing to a new work/rest schedule). This is the basis for the circadian disruption associated with jet lag and shift work patterns.

To shift schedules (e.g., from day to night shift), the body must override the circadian signals to sleep at night and be awake during the day. Also, the clock will receive conflicting time cues from the environment.

Jet lag, resulting from flying to a new time zone, produces a different challenge to the circadian clock. The time cues in the new time zone provide consistent information to the clock, but it can take several days or weeks for the clock to get into step with the new local time. In addition, circadian rhythms in different body functions do not all adjust at the same rate, and therefore may be out of step with each other for an extended period of time.

4.12.4 Alertness Management: Personal Strategies

For the individual facing the challenges of managing alertness in flight operations, a variety of well-tested countermeasure strategies can help maintain alertness and on-the-job performance. However, there is no simple, universal solution to fatigue in the workplace. Both operational requirements and human physiology are complex, and each individual is different. It is important to use multiple strategies, and tailor the strategies to individual needs.

Fatigue countermeasures can be divided into two categories:

1. Preventive strategies are those used before work and during rest periods, and
2. Operational strategies are those used on-the-job.

Preventive strategies are designed to minimize the sleep loss and circadian disruption caused by work demands. They are aimed at the physiological causes of fatigue. Operational countermeasures are designed to minimize the impact of sleep loss and circadian disruption on alertness and on-the-job performance. They can temporarily relieve the symptoms of fatigue, to help get the job done as safely and efficiently as possible.

4.12.5 Preventive Strategies

Minimizing Sleep Loss

A number of preventive strategies can be used to minimize sleep loss. The effective use of days off and rest periods to catch up on sleep is critical. Field studies in flight operations indicate that sleep loss is common. Since the effects of sleep loss are cumulative, it is important not to begin a new work schedule or pairing with an existing sleep debt. Therefore, try to get at least two nights of sufficient sleep before a pairing.

On nights before or between duty days, try to get at least as much sleep as you get on normal off-duty nights. If your duty schedule prevents you from getting that much sleep in a single sleep period, try to sleep more than once (e.g., morning and evening) or to take naps. Take advantage of times in the circadian cycle when it is easy to fall asleep. Conversely, because it is impossible to force sleep, don't depend on getting sleep during peaks in the circadian cycle when you would usually be awake.

Naps

Naps can acutely improve alertness and performance, and even short naps can provide benefits. However, the duration of a nap is important because if you enter deep NREM sleep you may experience sleep inertia, a feeling of grogginess, sleepiness and disorientation that can last for 10 to 15 minutes. Therefore, if you have a short nap opportunity just before work, or if you are likely to be interrupted by a duty call, then limit the nap to about 45 minutes or less. At other times, longer naps can be beneficial, and two hours will normally allow for a complete cycle through the different states and stages of sleep. Generally, performance improves, even when people do not report feeling refreshed on awakening. With due regard for the effects of sleep inertia a flight crew member who has been sleeping in-flight (e.g., practicing Controlled Rest) must be awake for a minimum of 15 minutes prior to assuming flight deck duties.

A nap reduces the duration of continuous wakefulness before a work period, and can be particularly beneficial before a period of night work, when the challenge of working through the circadian low point is also a factor. Getting some sleep is always better than none. Simply stated any and all sleep is beneficial in reducing levels of fatigue.

Good Sleep Habits

Good sleep habits can help improve sleep quality on a regular basis, at home and while away on layovers. By practicing a regular pre-sleep routine, you can teach your body and mind that certain activities mean that it is time to sleep. It separates the psychological stressors of the day from the sleep period. Once this pattern of cues is established, it can

be used anywhere and anytime. It may include such things as checking door locks and turning off lights, or reading something relaxing and entertaining (not work-related). Also, various physical and mental relaxation techniques can be learned and used in this way, such as meditation, autogenic training, yoga and progressive muscle relaxation. These skills must be developed and practiced before they can be expected to provide benefit. It is also important that the bedroom remain an environment conducive to relaxation and sleep, and does not become associated with stressful activities, such as work or worry. Sleep time needs to be given priority and kept as free as possible from other commitments and activities.

Sleep Environment

Physical aspects of the environment can also affect sleep. A dark, quiet room is preferable. Eye shades are a simple and portable solution to the problem of intrusive light. Earplugs can help by reducing noise, but they must be used such that they do not interfere with a required wake-up signal (such as an alarm clock or call for duty). Sudden sounds can disturb sleep, and continuous background "white" noise can help mask such noises. One suggestion is to set the radio between two stations for this purpose. In general, sleep quality is better if the environment is cooler rather than warmer. A comfortable sleep surface also can be important. Random noise is the most common reason aircraft sleep is interrupted. Non-resting flight crew members should make every effort to eliminate noise in the vicinity of the rest facilities. (e.g., loud or excessive conversation, closing the flight deck door with more force than is required etc.)

Effects of Food, Alcohol and Exercise

Food, alcohol and exercise shortly before sleep can affect the quantity and quality of the sleep that you obtain.

The discomfort associated with being hungry or, conversely, with having eaten too much may interfere with falling asleep. If you are hungry or thirsty at bedtime, have a light snack or a small drink. In general, evidence that common foods significantly affect sleep is not yet conclusive. However, both caffeine and alcohol have well-documented disruptive effects on sleep.

Caffeine stimulates the nervous system, generally taking effect 15-30 minutes after ingestion and remaining active for 3-4 hours (up to 10 hours in some individuals). The effects of caffeine depend on a number of factors, including habitual usage, body mass and previous food intake. However, regardless of how much caffeine someone habitually takes, caffeine before sleep can lead to lighter sleep with more awakenings and reduced total sleep time. Consider eliminating or minimizing caffeine intake at least three hours before bedtime. Individuals sensitive to caffeine effects should consider avoiding caffeine as much as six hours before bedtime. Nicotine has much the same effects as caffeine on nocturnal sleep and subsequent daytime sleepiness and performance. As with caffeine, avoid nicotine (e.g., tobacco, gum or patch) for several hours before the time you want to fall asleep.

Alcohol is reported as the most commonly used sleep aid. It can promote relaxation and thereby help a person to fall asleep. However, with moderate to excessive alcohol intake, sleep is easily disrupted. Alcohol suppresses REM sleep in the first half of the night, leading to REM rebound and withdrawal effects in the second half. Therefore, avoid drinking even

moderate amounts of alcohol 2-3 hours before sleeping. Also, individuals with breathing disorders during sleep, for example apnea, should keep in mind that alcohol worsens these conditions and reduces oxygen levels during sleep.

There is evidence that regular exercise may enhance deep sleep, which has been shown to be physically restorative. However, strenuous exercise results in physiological activation, which may interfere with sleep. Therefore, avoid strenuous exercise within several hours of going to bed.

Circadian Strategies

Currently, there are more practical, well-tested preventive strategies for minimizing sleep loss than there are for speeding circadian adaptation to different schedules. Resetting the circadian clock in an operational setting is complex for several reasons. First, unless a technique is applied correctly, interventions that reset the circadian clock can shift the clock in the wrong direction. (i.e., an intervention intended to move the circadian clock "eastward" may end up sending it "westward.") Further, for such a treatment to be successful, it is necessary to control exposure to the natural time cues in the environment, such as sunlight and darkness. In practice, this can be very difficult to achieve, especially during a pairing.

In some situations, it may not be possible or even desirable to adapt the clock fully to rapidly changing schedules. For example, during long-haul flight operations, crewmembers usually spend each consecutive rest period (layover) in a different time zone, so it may not be preferable to adapt to the destination time zone. The known clock-shifting interventions (e.g., melatonin and bright light) need more testing to determine their feasibility and effectiveness in improving alertness and performance in operational settings.

4.12.6 Operational Countermeasures

Once on the job, the range of available strategies to combat fatigue is more restricted since flight crew members must remain in their cockpit seats from take-off through landing, except for physiological needs. In general, operational countermeasures do not address the underlying physiological causes of fatigue. Instead, they are meant to temporarily enhance alertness and performance by masking fatigue, so that operational safety and efficiency are maintained.

Social Interaction and Conversation

Interacting with others can be a useful operational strategy. To maintain alertness, it is necessary to be actively involved in the conversation, not just listening and nodding. In fact, a lack of conversation can be associated with declining physiological alertness.

Physical Activity

Physical activity is one of the most effective ways of combating sleepiness. Some stretching and isometric exercises can be done in the cockpit seat. Even writing or chewing gum may help. Almost any physical activity is preferable to passivity.

Caffeine

Use the alerting effects of caffeine to help you stay awake during circadian low points or other times during operations when you struggle to maintain wakefulness (remember: on average, about 15-30 minutes to take effect, lasting three to four hours). To optimize caffeine as an operational strategy, avoid or minimize its use when you are already alert,

such as at the beginning of a daytime work period or just after a nap. Start consuming caffeine about an hour before expected times of decreased alertness (e.g., 3-5 a.m.). However, consider your planned bedtime, and try to stop caffeine consumption at least three hours before to avoid its disruptive effects on sleep. In some situations, these requirements may be conflicting. For example, using caffeine to help work through the circadian low point at the end of a night flight could result in problems trying to fall asleep after coming off duty in the morning. In that case, consider the benefits and drawbacks in light of overall operational demands.

Caffeine is a diuretic, which can cause further dehydration for flight crews, who are already vulnerable due to low humidity in the cockpit. Another consideration when using caffeine is that, in high doses, caffeine can lead to anxiety, irritability, "shakiness" and insomnia.

Diet

Currently, there is no compelling evidence that specific types of food directly affect alertness and performance. Candy or other "energy boosters" can produce a transient increase in alertness (e.g., "sugar highs"), but this is frequently followed by a decrease in alertness (sometimes suddenly) as blood glucose levels fall. Stomach (gastrointestinal) upsets can be disruptive to sleep, and maintaining a balanced diet is important. Duty schedules can make it difficult to maintain a regular pattern of well-balanced meals, so plan ahead and bring nutritious snack foods with you on long flights.

Naps

The goal of all operational countermeasures is to improve on-the-job performance and alertness when compared to the no-countermeasure condition. Napping is one countermeasure that has been tested in a real-world operational setting. A NASA/FAA study examined the effectiveness of a planned cockpit rest period to improve subsequent performance and alertness in commercial long-haul flight operations. Crewmembers who were allowed to take planned naps showed better performance (34 percent) and higher physiological alertness (100 percent) during the last 90 minutes of flight than the control group crewmembers who had not napped.

The significant results of this NASA/FAA study and other scientific research have demonstrated that naps can be extremely beneficial. Strategic naps should be used as a high-priority countermeasure in appropriate circumstances. For example, there are many opportunities outside the cockpit environment when a short strategic nap can be an effective countermeasure, such as between flight legs when other duties are completed. Napping is the only operational countermeasure that addresses one of the major physiological causes of fatigue - the need for sleep - and reverses it. While other operational countermeasures primarily mask fatigue, naps actually reduce it.

Even if flight crew members do not feel sleepy during a rest period they should always attempt sleep. External stimuli may mask fatigue which may lead flight crew members to believe they are not able to sleep when, in fact, sleep may come quite easily.

Due to the inconsistent nature of rest obtained on an aircraft, flight crew members should not intentionally deprive themselves of pre-flight rest with the intent of making efficient use of aircraft rest periods.

To minimize sleep debt and maintain alertness use controlled rest when necessary.

10.4.2.1 Fatigue Training

Air Canada provided crew fatigue risk management training to all pilots. A 7-slide presentation was reviewed during recurrent training and pilots were required to conduct online training. The online training course consisted of 52 slides consisting of topics relating to fatigue causes, fundamentals of sleep, consequences, mitigations, fatigue risk management program, and reporting fatigue. There was a quiz at the end of the online training consisting of 10 multiple choice questions on the material presented. The company required 100% on the quiz and quiz could be retaken until 100% was earned.

10.4.2.2 Fatigue Report Form

Fatigue reports could be filed online via the following form (Figure 27):

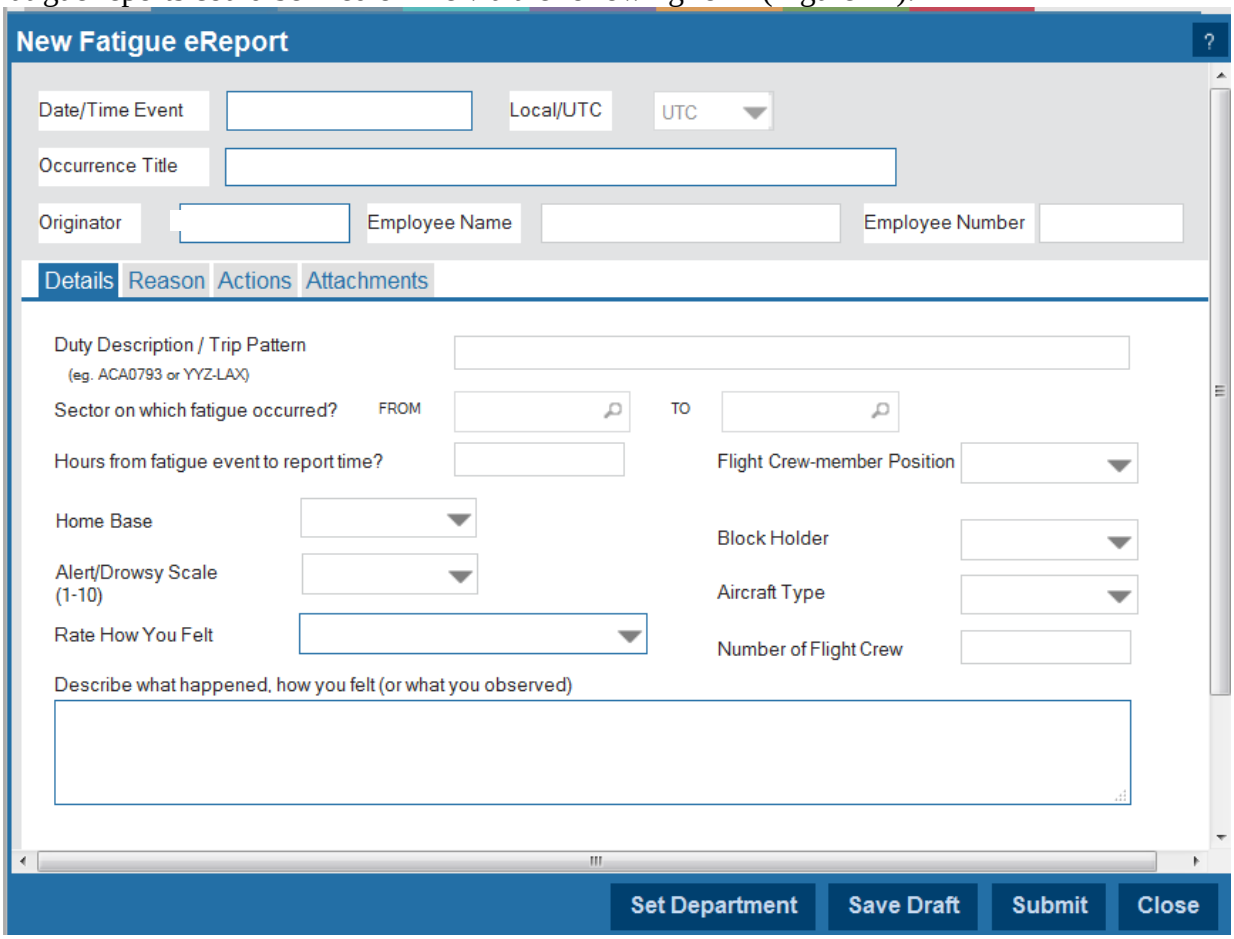


Figure 27: Fatigue eReport – Details Tab (Courtesy of Air Canada)

The form provided an alert/drowsy scale in 0.5 increments with anchors of alert for level 1 and drowsy for level 10. In the "Rate How You Felt" section, reporters could choose from the following options:

- "Fully Alert – wide awake
- Very Lively – responsive, but not at peak
- OK – somewhat fresh
- A Little Tired – less than fresh

- Moderately Tired – let down
- Extremely Tired – very difficult to concentrate
- Completely Exhausted
- Not Applicable”

The “Reason” tab of the form is shown below (Figure 28):

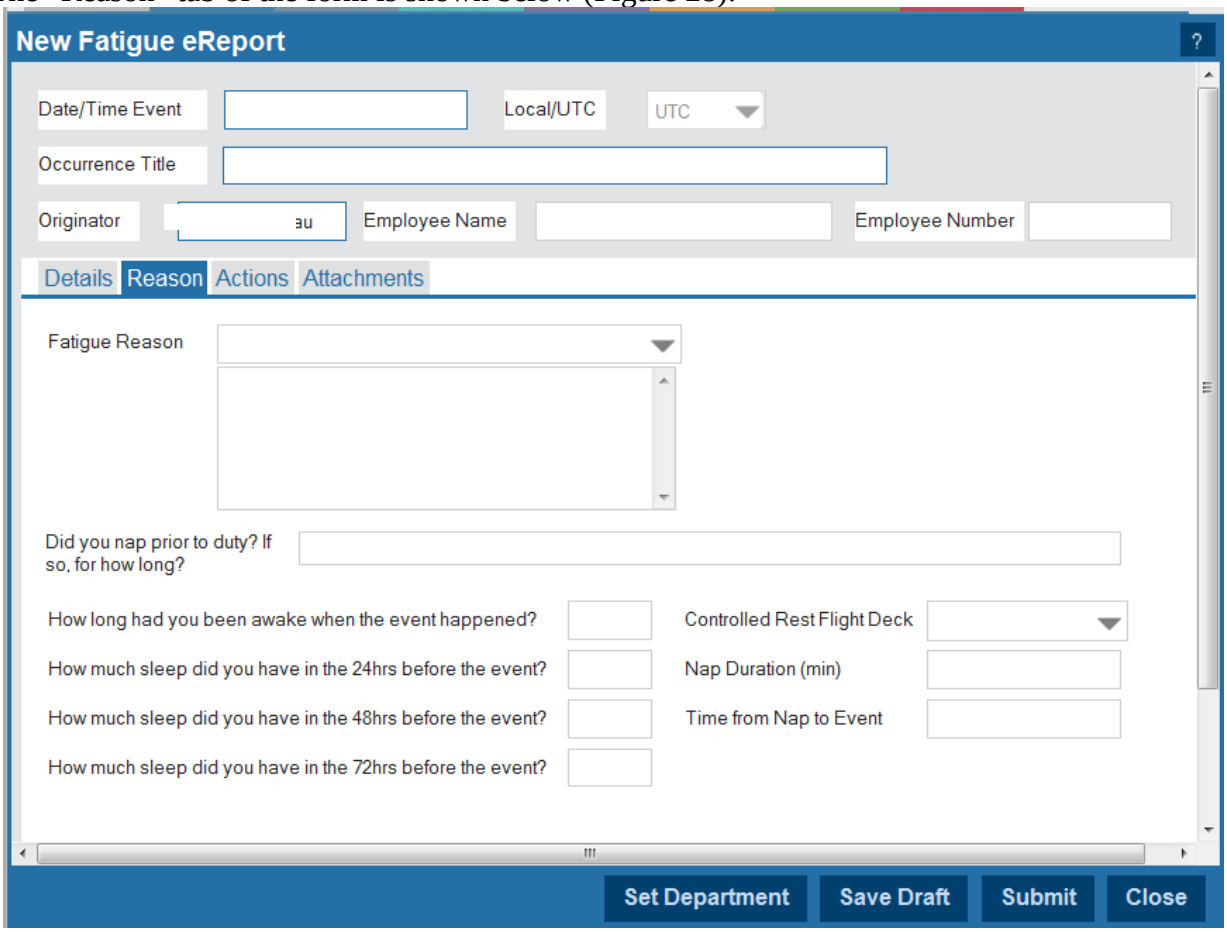


Figure 28: Fatigue eReport - Reasons Tab (Courtesy of Air Canada)

The “Fatigue Reason” section of the form included the following options to choose from:

- “Block
- Fatigued prior to duty
- Hotel
- Home
- Duty itself
- In-Flight Rest
- Sleep Pattern
- Pairing
- Personal”

The “Action” tab of the form is shown below (Figure 29):

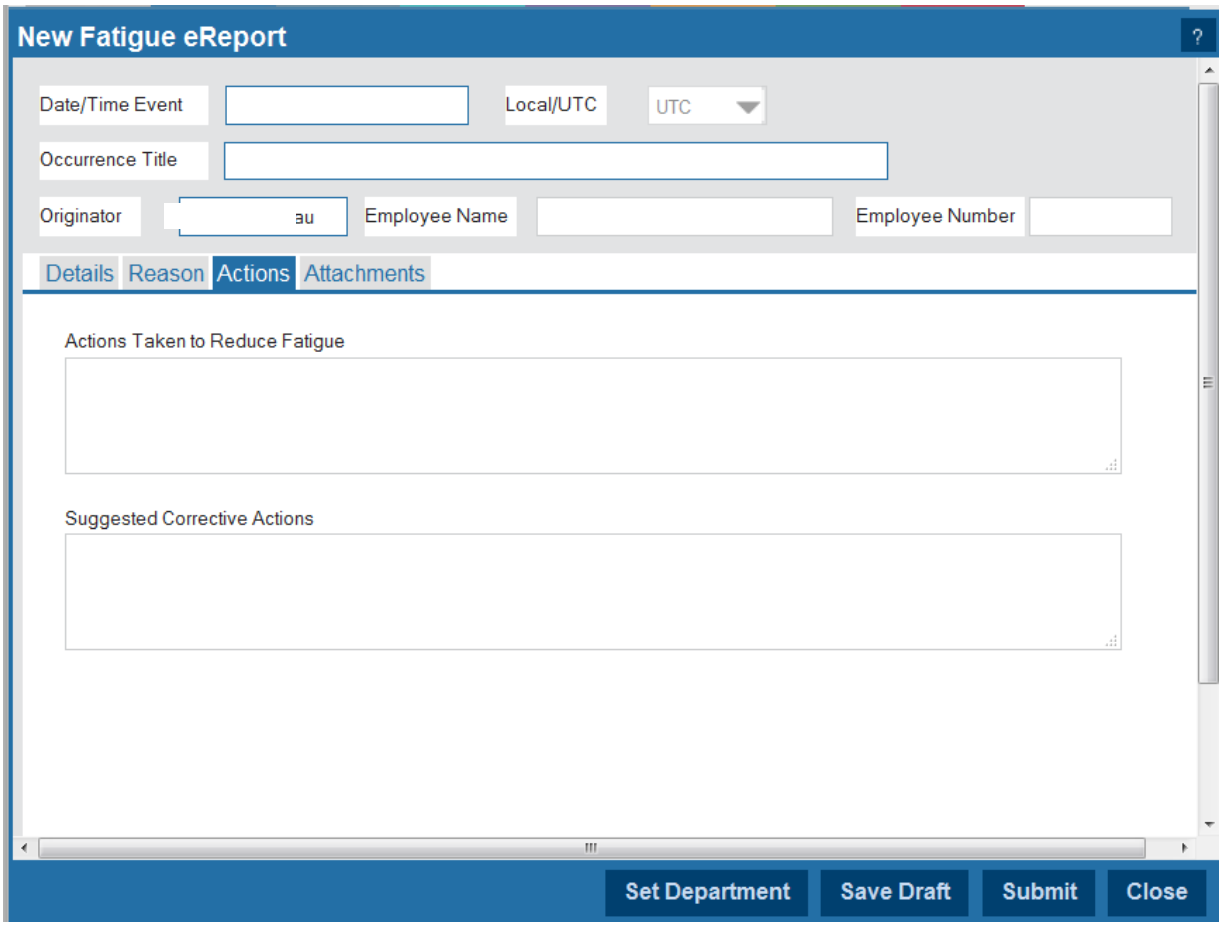


Figure 29: Fatigue eReport - Actions Tab (Courtesy of Air Canada)

10.4.3 Controlled Rest In-Flight

7.8 CONTROLLED REST ON THE FLIGHT DECK Last Update: 30 SEP 2016

Prior to conducting controlled rest on the flight deck the Pilot-in-Command shall ensure that all flight crew members have read and understand the contents of this section of the FOM.

Controlled rest uses strategic napping on the flight deck to improve flight crew member alertness during critical phases of flight. Controlled rest periods are a maximum of 40 minutes in length and shall be completed at least 30 minutes before the planned top of descent. The In-Charge Flight Attendant shall be advised that controlled rest is taking place and shall be instructed to call the flight deck at a specified time.

Flight crew members are to keep the other flight crew members informed of their need for controlled rest. Activities such as reading do not provide the benefits of controlled rest.

7.8.1 Pre-Flight Activities

Controlled rest should be planned and briefed as part of the pre-flight activities. The Pilot-in-Command shall determine if operational considerations allow or preclude the use of controlled rest on the flight deck. Examples of operational considerations that may preclude the use of controlled rest are weather, MEL relief in effect, ATC communications, the fuel situation, and anticipated high workloads.

The pre-flight briefings shall include:

1. Flight crew members' requirement for controlled rest and choice of rest period sequence; and
2. Advising the In-Charge Flight Attendant that controlled rest may take place during the flight.
3. If required, these briefings can be conducted during flight.

7.8.2 Pre-Controlled Rest Period

The applicable flight attendant shall be made aware that controlled rest will be taking place and the flight deck shall be called at a specific time no later than 45 minutes from the time of briefing.

7.8.2.1 Pre-Controlled Rest Operational Briefing

A pre-controlled rest operational briefing between the flight crew members shall be conducted which includes:

1. A fuel check; and
2. A review of fuel system status; and
3. Aircraft deviations; and
4. Anticipated conditions; and
5. Fatigue level of the non-resting flight crew member; and
6. Time of planned awakening.

7.8.2.2 Criteria for Interrupting Controlled Rest

A review shall be completed of the criteria for waking-up the resting flight crew member prior to the end of the rest period which includes but is not limited to:

1. Any abnormal or emergency situation; or
2. Any circumstances not characterized as low workload; or
3. Thunderstorm activity; or
4. Oceanic re-clearance or re-clearance in a non-radar environment.

7.8.3 Requirements during the Controlled Rest Period

During the controlled rest period the following requirements shall be adhered to:

1. Only one flight crew member shall rest on the flight deck at a time; and
2. The non-resting flight crew member shall remain alert; and
3. The resting flight crew member's duties shall be completed by the non-resting flight crew member; and
4. At least two flight crew members shall remain on the flight deck throughout the rest period; and
5. Each rest period shall be limited to a maximum of 40 minutes to avoid sleep inertia (the grogginess sometimes experienced upon awakening); and
6. Rest periods shall only be taken when workload is low during the cruise phase of the flight and shall be completed at least 30 minutes prior to the planned top of descent; and
7. The non-resting flight crew member shall wake up the resting flight crew member when required or at the predetermined time (calling the person's name in a normal tone is usually sufficient).

Particular attention shall be made by the non-resting flight crew member to the radio setup (e.g., for domestic operations VHF 1 should be selected to ATC with appropriate volume adjustment and VHF 2 should be set to 121.5 with the appropriate volume adjustment). The volume of the ATC frequency shall not be turned down unless requesting to go off frequency from ATC.

Time should be allowed for the resting flight crew member to prepare for rest. Aids to rest such as eye shades, ear plugs, and neck supports are permitted.

The resting flight crew member shall remain in their operating seat, which shall be moved to the full aft position to prevent inadvertent contact with the flight controls.

As an additional safeguard it is recommended that alarm devices be used to ensure rest periods do not extend beyond the planned time.

7.8.4 Post Controlled Rest Period Requirements

Unless required due to an abnormal or emergency situation the awakened flight crew member should be provided at least 15 minutes without any flight duties to allow sufficient time to become fully awake before resuming normal duties.

Upon assuming flight deck duties the awakened flight crew member shall:

1. Receive a briefing from the non-resting flight crew member regarding aircraft present position, the waypoint ahead, the next waypoint, ATC communication, and any other factors affecting the flight; and
2. Complete a fuel check; and
3. Complete a full cockpit scan to verify aircraft condition.

If required, flight crew members may take more than one controlled rest opportunity.

10.5 Crew Resource Management

10.5.1 CRM Training

Air Canada provided their pilots with a CRM Manual detailing CRM skills training, communication, situational awareness, planning, decision making, workload management,

professional management, active monitoring, threat and error management, errors, and practical use of TEM.

In 2016, Air Canada upgraded their CRM training to reflect a Threat and Error Management model. Four courses were provided on CRM including new hire, recurrent, command upgrade, and in the AQP 101 course for instructors. Classes were taught using PowerPoint slides, interactive discussion, and videos created by a contracted organization. The new hire indoctrination included a 12-hour CRM course consisting of 192 slides on the topics of CRM history, background, concepts, skills, criteria, communication, professional management, hazardous attitudes, fatigue, stress, briefings, leadership, decision making and problem solving, risk management, active monitoring and threat and error management procedures, workload management and situational awareness.

CRM training during recurrent training lasted 6 hours and consisted of 42 slides reviewing CRM concepts, criteria, skills, communication, situational awareness, workload management, decision making and problem-solving procedures, professional management procedures, active monitoring and threat and error management procedures, and errors.

Twelve hours of CRM was included in the introduction to command training.

CRM was reviewed for 4-hours in the AQP 101 course. The training was lecture based where each instructor would have to observe training and then be observed conducting the training.

A company check airman stated that the company provides CRM briefings and training every 8 months during LOE and they stress CRM during line checks. It is also a debriefing point during checks. The director of training stated that half of the AQP grading was based on CRM in the simulator sessions and in training. He stated that CRM was also half of the grade for the transition courses as well.

The first officer stated that he felt comfortable bringing any concerns he may have had with the incident captain, and any captain he flew with. The captain stated that he felt CRM between himself and the first officer during the event was "good" and they worked "very well" together. Two captains who had flown with the incident first officer during upgrade training classified his CRM as "good;" however, one captain was concerned about his situational awareness during the flight.[73]

10.5.2 CRM Competency Guide

[73] The captain concerned about the incident first officer's situation awareness during a previous flight described CRM as one box and SA as another. CRM was "good" and SA was "a disaster". He stated the incident first officer did not ask questions that indicated SA or question instructions like why ATC kept asking for intentions or why ATC kept offering radar vectors. He stated further that during a potential flap overspeed event, the incident first officer did not anticipate the condition nor respond to the increase in thrust that would have caused a flap overspeed. The instructor stated that he thought if he [the instructor] hadn't intervened, there would have been a flap overspeed as he was unsure about how long the incident first officer would have let the condition go.

CRM Competency	All Pilots Will	Captains Will	First Officers and Cruise Relief Pilots will
Situational Awareness	- Analyze the state of the aircraft and its systems. - Maintain an accurate awareness of the aircraft's energy state, and its anticipated flight path - Identify and manage Threats and Errors to the flight - Identify and rectify all unresolved discrepancies	- Anticipate future requirements, staying ahead of the situation - Recognize and effectively respond to indications of reduced situational awareness from other crew members - Ensure that all crew members are kept informed of all operationally relevant information	- Recognize and effectively respond to indications of reduced situational awareness amongst the crew - Probe/Alert/Challenge errors and assumptions made by the Captain
Decision Making and Problem Solving	- As time permits, review all information (even contradictory information) for accuracy prior to making a decision	- Monitor, review, and adapt decisions as required - Solicit other crewmembers input, and information.	- Provide input and information to enhance Captain's decision-making
Workload Management	- Plan, prioritize and execute tasks efficiently while managing time available - Manage interruptions, and distractions.	- Recognize and mitigate when you or other crew members are task saturated - Verify task completion and outcome	- Complete tasks as delegated by the Captain - Recognize when you or other crew members are task saturated
Professional Management	- Create an atmosphere of open communication that encourages crew participation, and constructive feedback - Demonstrate an adherence to dress code, SOP's and FOM polices - Project self-control and professionalism in all situations.	- Address and resolve conflicts and disagreements in a constructive manner - Ensure all crew members and passengers are briefed accordingly - Encourage crew to ask questions about actions and decisions	- Carry out instructions when directed - Communicate relevant concerns and intentions
Active Monitoring & Threat and Error Management Procedures	- Utilize the Air Canada TEM, to identify, manage and mitigate operational threats and recover from errors. - Detect deviations from the desired aircraft trajectory and take appropriate action - Review, monitor and cross-check all actions - Recover from all errors	**Pilot Flying (PF)will:** - Will issue commands and instructions to the PM as Appropriate - Actively "Fly" the aircraft when managed by the Auto Flight System - Set targets for aircraft performance (configuration, airspeed etc.)	**Pilot Monitoring (PM) will:** - Communicate all errors, omissions, differences in situational awareness and ambiguities to the PF assertively - Challenge or clarify any deviations from SOP.

THREAT AND ERROR
MANAGEMENT MODEL (TEM)

To use the Air Canada TEM model, begin with the highest level of Threat Management at the top of the diamond and move downwards towards Undesired Aircraft State at bottom of diamond.

Proactive Threat Management
When the crew briefs and mitigate threats prior to encountering them. This is the highest level of Threat Management.

Reactive Threat Management
At this level an **Unexpected Threat** has occurred that the crew must recognize and respond to. If the crew manages this threat, there is no error made. If the crew does not manage the threat, we move down towards the bottom of the diamond. (Error Management, UAS)

Errors and Error Management
At this level the crew has mismanaged a threat and an error has occurred. This can be in the form of a Procedural Error, Communication Error or Handling Error. If the crew traps the error with appropriate Error Management Skills safety margins will be maintained. If the crew does not trap the error an Undesired Aircraft State may result.

Undesired Aircraft State (UAS)
A flight-crew-induced aircraft state that clearly reduces safety margins (i.e., a safety-compromised situation resulting from ineffective Threat and Error Management).

REACTIVE THREAT
MANAGEMENT MODEL

Aviate and Navigate. The first priority is maintaining aircraft control. Stabilize the situation and ensure safety margins are maintained.

Manage workload by clearly assigning PF and PM duties. Unless operationally required the Captain should manage the flight deck and the FO should fly. At any time at the discretion of the Captain, they can resume the Pilot Flying (PF) duties:

PF - Fly the aircraft, respond and comply with ATC clearances, maintain SA.

PM - (Normally the Captain) Prioritize threats, expand team, maintain SA.

Determine criticality of highest threat (No-Time / Time).

No-Time Available

1. Captain will choose a course of action (Plan)
2. Communicate Intentions

Fire	Land ASAP
Smoke*	Crew will evaluate a smoke threat before determining the criticality (e.g., galley smoke may be a Time Threat).
Security	Refer to appropriate QRH Section or FOM appropriate to the Security Threat.

Time Available

1. Create more time to make a plan. (hold, vectors etc)
2. Utilize all resources to make a plan.

10.5.3 CRM Grading Guideline

AQP CRM GRADING GUIDELINES	4	3	2 Undesired Aircraft State (UAS) with no consequence, or	1 Undesired Aircraft state (UAS) with consequence, or
Situational Awareness	➢ Consistently ahead of the aircraft's energy state and flight path. ➢ All TEM resources used effectively. ➢ Accurate and timely perceptions of factors affecting aircraft and crew. ➢ Identified and resolved all discrepancies.	➢ Usually ahead of the aircraft's energy state and flight path. ➢ Most TEM resources used effectively. ➢ Fairly accurate and timely perception of factors affecting aircraft and crew. ➢ Most discrepancies identified and resolved.	➢ Momentarily behind the aircraft's energy state and flight path. ➢ Some TEM resources used effectively. ➢ Slow to perceive factors affecting aircraft and crew. ➢ Situational Awareness momentarily lost.	➢ Consistently behind the aircraft's energy state and flight path. ➢ TEM resources were ineffective. ➢ Factors affecting aircraft and crew not recognized unless prompted. ➢ Situational Awareness lost.
Decision Making and Problem Solving	➢ Considered all information including contradictory. ➢ Chose best possible solution. ➢ Always reviewed assumptions and decisions. ➢ Decision/plan changed when necessary.	➢ Considered most information including contradictory. ➢ Chose a good solution. ➢ Usually reviewed assumptions and decisions. ➢ Decision/plan usually changed when necessary.	➢ Considered some information. ➢ Chose an acceptable solution. ➢ Slow to review assumptions and decisions. ➢ Decision/plan not changed when better option available.	➢ Critical information not considered. ➢ Chose an unsafe solution. ➢ Problem incorrectly identified. ➢ Decision/plan not acceptable.
Workload Management	➢ All tasks prioritized and executed appropriately given time available. ➢ All Interruptions and distractions managed. ➢ Recognized when crew members overloaded.	➢ Most tasks prioritized and executed appropriately given time available. ➢ Most interruptions and distractions managed. ➢ Usually recognized when crew members overloaded.	➢ Some tasks not prioritized and executed appropriately given time available. ➢ Some interruptions and distractions not managed. Errors occur as a result. ➢ Slow to recognize when crew members overloaded.	➢ Tasks not prioritized or executed appropriately given time available. ➢ Interruptions and distractions are not managed resulting in errors with consequence. ➢ Task saturation lead to violations or unsafe operation.
Professional Management	➢ Above standard communication and listening skills with proper feedback. ➢ Briefings clear, concise, and per SOPs. ➢ Disparities in interpretation, priority, and technique resolved. ➢ All conflicts and disagreements resolved effectively. ➢ SOPs followed with no error.	➢ Good communication and listening skills with some feedback. ➢ Briefings usually clear and concise with minor deviations from SOPs. ➢ Most disparities in interpretation, priority, and technique resolved. ➢ Most conflicts and disagreements resolved effectively. ➢ SOPs followed with minor errors.	➢ Communication was non-standard and confusing. ➢ Briefings acceptable with some deviations from SOPs. ➢ Some disparities in interpretation, priority, and technique not resolved. ➢ Some conflicts and disagreements unresolved. ➢ SOPs demonstrated, contained several errors.	➢ Communication not clear. Information and commands not actioned. ➢ Briefings incomplete, not given, or misunderstood. Not per SOP. ➢ Disparities in interpretation, priority, and technique not resolved. ➢ Some conflicts and disagreements ignored resulting in confusion and ambiguity on flight deck. ➢ SOPs not followed.
Active Monitoring and TEM Procedures	➢ All actions monitored, reviewed, and cross-checked. Backed up other crew members. ➢ All deviations from planned operation are corrected.	➢ Most actions monitored, reviewed, and cross-checked. Usually backed up other crew members. ➢ Most deviations from planned operation are corrected.	➢ Some actions monitored, reviewed, and cross-checked. Sometimes backed up other crew members. ➢ Some deviations from planned operation are corrected.	➢ Actions rarely monitored, reviewed, and cross-checked. Failed to back up other crew members. ➢ Deviations from planned operation are not corrected.

	➢ All threats and errors identified, managed, and mitigated.	➢ Most threats and errors identified, managed, and mitigated.	➢ Some threats and errors identified, managed, and mitigated.	➢ Threats and errors are not identified, managed, and mitigated.
Technical Grading	• The pilot performed a task or maneuver with no errors. • Aircraft handling was smooth and precise. • Technical knowledge demonstrated with no errors.	• The pilot performed a task or maneuver with minor errors that were managed. • Aircraft handling was performed within limits. • Technical knowledge demonstrated with minor errors.	• The pilot performed the task or maneuver with errors that went unmanaged with no consequence. • Aircraft handling was performed with momentary deviations from specified limits. • Technical knowledge was limited. • Undesired Aircraft State (UAS) with no consequence.	• The pilot performed the task or maneuver with errors that went unmanaged and affected safety of flight. • Aircraft handling included uncorrected or excessive deviations from specified limits. • Technical knowledge is unacceptable. • Undesired Aircraft State (UAS) with consequence.
CRM Grading	See Reverse	See Reverse	See Reverse	See Reverse

AIR Canada AQP Grading Guideline	4	3	2	1
LOE Event Set Grading IOE / OE Grading	• Safety of flight was assured and all threats were managed. • Aircraft handling was smooth and precise. • Technical knowledge demonstrated with no errors. • CRM skills were highly effective. • Errors were minor and all were trapped and mitigated.	• Safety of flight was maintained and most threats were managed. • Aircraft handling was performed within limits. • Technical knowledge demonstrated with minor errors. • CRM skills were effective. • Errors were minor and most were trapped and mitigated.	• Safety of flight was not jeopardized, but threats were poorly managed. • Aircraft handling was performed with momentary deviations from specified limits. • Technical knowledge was limited. • CRM skills were effective, but some items were only addressed when prompted by other crewmembers. • Some errors were major, but were eventually recognized, trapped, and mitigated. • Undesired Aircraft State (UAS) with no consequence.	• Safety of flight was jeopardized and threat management was unacceptable. • Aircraft handling included uncorrected or excessive deviations from specified limits. • Technical knowledge was unacceptable. • CRM skills were ineffective unless continuously prompted by other crew members. • Major errors were not recognized. • Undesired Aircraft State (UAS) with consequence.

10.6 Altitude Selector Settings

7.1.10 Altitude Selector Settings and Descent Below Prescribed Minimum Altitudes

Whether operating with or without managed vertical guidance, Flight Crews are responsible for actively monitoring the flight to ensure that cleared altitude or constraints are met. Flight Crews shall advise ATC if it appears the cleared altitude or constraint may not be met.

The altitude selector shall be set during climb, cruise, or descent so that the aircraft's vertical direction is protected.

7.1.10.1 Altitude Selector Settings

1. Altitude Selector Procedures

   The altitude selector is normally set to the ATC cleared altitude. If a crossing altitude restriction must be met prior to reaching the final cleared altitude, the Flight Crew may elect to set either:

   a) The crossing restriction altitude until such time as they are assured that the restriction will be met and then select a subsequent crossing restriction; or

   b) The final cleared altitude and use a Vertical Guidance Mode that will ensure the intermediate crossing restriction is met.

   [Content deleted - See SRH]

2. Altitude Selector Setting Example

   A flights is inbound and is cleared to 6,000 feet via the DESCENT 1 arrival and has a restriction of at or above 10,000 feet at waypoint STAVE and a further restriction of to cross GONIR at 7000 feet; with this clearance the Flight Crew could do either of the following:

   a) Set the altitude selector to 10,000 feet prior to STAVE. Once assured the STAVE restriction will be met, the next restriction of 7000 feet would be set for GONIR; or

   b) Set the altitude selector to 6,000 feet using VNAV mode or "Managed Descent" mode as appropriate, and actively monitor descent to ensure that the 10,000 feet or above crossing restriction at STAVE, and the restriction to cross GONIR at 7,000 feet, will be met during the descent to the cleared altitude.

   In cases where an altitude other than the final cleared altitude is selected on the altitude selector, Flight Crews should include both the final cleared altitude and the selected altitude in the verbal crosscheck (e.g., "FL350 for 10,000, cleared altitude 6,000" or "10,000 set, cleared altitude 6,000"). Flight Crews shall ensure that the correct cleared altitude is selected once intermediate restrictions have been met.

   If there is any doubt as to the final cleared altitude, Flight Crews shall confirm with ATC.

   If, during a climb, ATC issues a clearance for a descent at "Pilot Discretion" to an altitude lower than the altitude to which the aircraft is climbing, the altitude selector must remain set to the original cleared higher altitude until the level off is complete. Once the higher altitude is reached, the altitude selector may be set to the discretionary descent altitude.

10.7 Flight Deck Duties

Section 9.3 of the CRM manual details responsibilities of the PF and PM:

9.3 ACTIVE MONITORING: PROCEDURES Last Update: 30 MAR 2017

All Pilots Will:

- Perform Duties and callouts according to the phase of flight
- Aircraft will be monitored according to FOM, AOM, and any applicable bulletins
- Demonstrate AFS mode awareness
- Intervene if AFS is not performing as expected
- Cross check all entries into the FMS
- Crosscheck charts as required
- Crosscheck instruments

Pilot Flying (PF) will:

- Demonstrate AFS mode awareness
- Intervene if AFS is not performing as expected
- Issue commands and instructions to the PM as Appropriate
- Actively "Fly" the aircraft (including when managed by the Auto flight system)
- Set targets for aircraft performance (configuration, airspeed etc.)

Pilot Monitoring (PM) will:

- Acknowledge and carry out PF commands
- Ensure adequate safety margin exists at all times
- Acknowledge all ATC clearances and challenge PF if necessary
- Acknowledge all targets and challenge the PF as necessary
- Communicate all errors, omissions, and ambiguities to the PF assertively
- Challenge any deviations from SOP, (unless agreed upon prior for the interest of safety)
- Maintain awareness of aircrafts flight path, and communicate with PF when this deviates from intended

The FOM states the following regarding PF and PM duties:

7.1.4 Pilot-in-Control

The Pilot-in-Command shall determine who shall be the Pilot-in-Control referred to as the Pilot Flying (PF). The other flight crew member at a seat with controls will be the Pilot Monitoring (PM). At all times there shall be a clear understanding of who is the Pilot-in-Control of the aircraft. The acceptable method of transferring control is by stating, "You have control / I have control."

The flight crew members may switch PF and PM duties at any time as long as there is a clear understanding of duties and a clear understanding of which flight crew member is the Pilot-In-Control.

One flight crew member, normally the PF, shall maintain situational awareness and be prepared at all times to assume control of the aircraft in the event of unexpected turbulence, autoflight or autopilot malfunction, or in-flight emergency. The seat and rudder positions shall be such that the thrust levers and flight controls are always within reach of at least one flight crew member.

During abnormal or emergency troubleshooting, or at any time those flight deck activities are likely to involve more than one flight crew member, one flight crew member shall be designated to control the aircraft and maintain ATC listening watch.

7.1.11 Monitoring Duties

7.1.11.1 Flight Deck Monitoring

The PM shall monitor the PF completing the Cockpit Check. After the Cockpit Check is completed, one flight crew member shall remain in the flight deck to prevent changes to checked items. The CRP may conduct the Cockpit Check at the Pilot-in-Command's discretion.

During all phases of flight, the PF and PM shall monitor each other's actions. Flight crew members occupying a flight deck observer seat (e.g., CRP) shall monitor the actions of the PF and PM.

10.8 Automation Use Policy

7.1.9 Auto-Flight Systems (AFS) Policy

The AFS includes autopilots, flight directors, flight management and guidance systems, and the autothrust.

In addition to preventing over-reliance on automation, the AFS policy is intended to ensure good situational and positional awareness, correct interaction with automation, and effective Flight Crew cross-check.

Use of AFS in no way relieves the Flight Crew of the responsibility of ensuring the aircraft is flown safely and efficiently.

Flight crew members shall be knowledgeable and proficient in the selection and use of all automation.

The level of automation used shall permit flight crew members to maintain a comfortable workload distribution and a high level of situational awareness. In some cases the most appropriate level of automation is to have no automation (manual flying).

Flight crew members shall apply the following principles to AFS use:

1. Carefully monitor AFS status, AFS guidance, and aircraft performance; and
2. Intervene if AFS status, AFS guidance, or aircraft performance is not as desired; and
3. Cross-check the result of all selections, settings, and changes; and
4. Announce changes to AFS status as per AOMs; and
5. Routinely crosscheck raw data versus computed data; and
6. Flight Crews should maintain one head up at all times; and
7. Brief special automation duties and responsibilities where applicable.

Manual flying for the purpose of maintaining proficiency should only be considered when flight conditions and workload permit.

F. LIST OF ATTACHMENTS

Attachment 1: Flight Crew Interview Summaries
Attachment 2: Air Canada Personnel Interview Summaries
Attachment 3: Airplane Crew on Taxiway C Statements
Attachment 4: Preceding Flight Crew Statement
Attachment 5: Incident Flight Plan
Attachment 6: ACARS Traffic Log
Attachment 7: FAA NOTAMS
Attachment 8: Air Canada Ramp Reconciliation Report
Attachment 9: Canadian ATP Requirements
Attachment 10: Air Canada Pilots Contractual Pairing and Rest Requirement
Attachment 11: SFO Approach Charts – Runway 28R
Attachment 12: Air Canada's Route Briefing – The Americas [Excerpt]
Attachment 13: Air Canada's Threat Briefing Reference Card
Attachment 14: Air Canada's Nav Tuning Guidance
Attachment 15: Air Canada's Non-Precision Approach Procedures
Attachment 16: Simulator Evaluation
Attachment 17: Controlled Rest on the Flight Deck Procedure
Attachment 18: Canadian Aviation Regulation Advisory Council Flight Crew Fatigue Management
Attachment 19: Incident Flight Crew Schedules – Preceding 90 days
Attachment 20: Incident Flight Crew Training Records
Attachment 21: Email Correspondence with Air Canada Regarding ACARS, CRM Training, and Fatigue Policies

Submitted by:

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