



# Advisory Circular

**Subject: Flight Data Monitoring (FDM) Program**

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|--------------------------|---------------------------|-----------------|------------|
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## **1.0 Introduction**

- (1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

### **1.1 Purpose**

- (1) The purpose of this document is to outline the requirements for establishing and maintaining a flight data monitoring (FDM) program.

### **1.2 Applicability**

- (1) This document applies to Transport Canada Civil Aviation (TCCA) personnel, delegates, and the aviation industry.

### **1.3 Description of changes**

- (1) Not applicable.

## **2.0 References and requirements**

### **2.1 Reference documents**

- (1) It is intended that the following reference materials be used in conjunction with this document:
- (a) [Aeronautics Act](#) (R.S.C., 1985, c. A-2)
  - (b) Part I, Subpart 7 of the *Canadian Aviation Regulations* (CARs) — Safety Management System Requirements
  - (c) Part VII, Subpart 5, Division X of the CARs — Safety Management System
  - (d) [Interim Order](#) No. 4 (2026) Respecting Certain ICAO Requirements (Air Navigation Services — Training and Licensing, Standard Operating Procedures, Conflict Zones, Minimum Equipment Lists and Flight Data Monitoring Program)
  - (e) Civil Aviation Directive (CAD) QUA-019 — ICAO Compliance Policy
  - (f) CAD 107-004 — Aviation Enforcement – Safety Management Systems
  - (g) Advisory Circular (AC) 107-001 — Guidance on Safety Management Systems Development
  - (h) Staff Instruction (SI) SI 103-001 — Enforcement Procedures
  - (i) SI SUR-006 — Safety Management Systems – Civil Aviation Non-Compliance Event Review
  - (j) ICAO Annex 6 – Operation of Aircraft, Part I - International Air Transport - Aeroplanes, Chapter 3 – General, 3.3 Safety Management
  - (k) ICAO Annex 6 – Operation of Aircraft, Part III – International Operations – Helicopters, Commercial Air Transport – Helicopters, Section II – International Commercial air Transport, Chapter 1 – General, 1.3 Safety Management

- (l) ICAO Annex 19 – Safety Management, Chapter 5 – Safety Data and Safety information Collection, analysis, Protection, Sharing and Exchange and Appendix 3 – Principles for the Protection of Safety Data, Safety Information and Related Sources
- (m) ICAO Flight Data Analysis Programme Manual (ICAO DOC 10000)
- (n) ICAO Safety Management Manual (ICAO 9859)

## 2.2 Cancelled documents

- (1) As of the effective date of this document, the following document is cancelled:
  - (a) CBAAC No 0193, Original Issue, 2001-11-01 — Flight Data Monitoring (FDM) Programs
- (2) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

## 2.3 Definitions and abbreviations

- (1) The following **definitions** are used in this document:
  - (a) **FDM data:** data captured in an organization's flight data monitoring (FDM) program.
  - (b) **FDM information:** flight data monitoring (FDM) data that has been processed, organized and analyzed to make it useful for safety management purposes.
  - (c) **International air transportation service:** a commercial air service that is operated for the purpose of transporting persons, personal belongings, baggage, goods or cargo in an aircraft between Canada and a point in the territory of another country, between points in the territory of another country, or over the territory or territorial waters of another country
  - (d) **Maximum permissible take-off weight:** means the maximum take-off weight for an aircraft as authorized by the state of registry of the aircraft or as provided for in the aircraft type certificate
  - (e) **Quick access recorder (QAR):** optional non-crash protected devices that record flight data in a low-cost removable medium
  - (f) **Safety data (from ICAO Annex 19):** is a defined set of facts or set of safety values collected from various aviation-related sources, which is used to maintain or improve safety; safety data is collected from proactive or reactive safety-related activities, including but not limited to:
    - (i) accident or incident investigations;
    - (ii) safety reporting
    - (iii) continuing airworthiness reporting
    - (iv) operational performance monitoring;
    - (v) inspections, audits, surveys; or
    - (vi) safety studies and reviews.
  - (g) **Safety information (from ICAO Annex 19):** safety data processed, organized or analysed in a given context so as to make it useful for safety management purposes; safety information may include, but is not limited to:
    - (i) safety data or information captured by an organization's SMS;
    - (ii) safety data or information captured by an organization's FDAP; or

- (iii) safety data or information that includes personal information related to individuals.
- (2) The following **abbreviations** are used in this document:
- (a) **ADRS:** Air data reference system
  - (b) **AIRS:** airborne image recording system
  - (c) **CADORS:** Civil Aviation Daily Occurrence Reporting System
  - (d) **CARs:** *Canadian Aviation Regulations*
  - (e) **CARAC:** Canadian Aviation Regulation Advisory Council
  - (f) **CARS:** cockpit audio recording system
  - (g) **COM:** company operations manual
  - (h) **CTSB:** Canadian Transportation Safety Board
  - (i) **FDA:** flight data analysis
  - (j) **FDAP:** flight data analysis program
  - (k) **FDM:** flight data monitoring
  - (l) **FDR:** flight data recorder
  - (m) **ICAO:** International Civil Aviation Organization
  - (n) **IO:** Interim Order
  - (o) **POI:** principal operating inspector
  - (p) **QAR:** quick access recorder
  - (q) **SARP:** ICAO standards and recommended practices
  - (r) **SMS:** safety management system
  - (s) **SOP:** standard operating procedures
  - (t) **VISPAA:** voluntary information sharing program, agreement or arrangement

### 3.0 Background

- (1) A flight data monitoring (FDM) program, also referred to as a flight data management program (FDM) or flight data analysis program (FDAP) is a proactive safety management tool used by air operators to analyze recorded data in order to identify operational hazards, safety trends, and precursors to incidents or accidents. It may also support continued airworthiness monitoring by identifying abnormal aircraft system behavior, exceedances affecting structural loads, and operational conditions relevant to maintenance programs.
- (2) Recognizing the value of FDAP, ICAO has published SARPs outlining the requirements for establishing and maintaining an FDAP in Annex 6 Part I, Ch 3, 3.3 and in Annex 6, Part III, Section II, Ch 1, 1.3.
- (3) A FDM program functions primarily as an internal operator safety program that involves data governance between the operator and employees. Adequate safeguards should be in place to protect the source(s) of the data.
- (4) The requirement to have an FDM program is independent of any voluntary data-sharing program or agreement made under section 5.31 of the *Aeronautics Act* (AA). An operator's disclosure of FDM data, information derived from FDM data, safety management system (SMS) reports or

information derived from SMS reports to a Transport Canada inspector does not constitute a voluntary data-sharing agreement under AA section 5.31. Requirements and procedures respecting voluntary data-sharing agreements (VISPA) under AA section 5.31 will be set out separately in a Civil Aviation Directive.

- (5) Transport Canada does not formally approve or accept an operator's FDM program. This approach is consistent with the framework described in ICAO Annex 6, Part I, Attachment B. Instead, Transport Canada conducts oversight activities to verify that the program has been established and implemented in accordance with the Interim Order No. 4 (2026).

## **4.0 Flight Data Monitoring (FDM) Program**

### **4.1 Flight Data Monitoring (FDM) program**

- (1) When used to advance flight operations safety, FDM programs contribute to systematic, proactive, safety programs and are intended to be non-punitive mechanisms to collect, analyze and use flight data to improve operational safety. FDM should be implemented in support of the operator's SMS and should be integrated into the SMS in identifying operational hazards, safety trends and precursors to incidents or accidents.
- (2) Data are collected from aircraft systems such as FDR, QAR, CVR, CARS and AIRS or other onboard recording systems and analyzed to detect exceedance criteria, variations from standard operating envelope, trends and other emerging risks.
- (3) Relevant information derived from the FDM program are integrated into the company SMS and are fed back into training, SOP development, operational policies and risk mitigation strategies.

### **4.2 Objectives of an FDM program**

- (1) FDM should enable the identification of gradual changes in operational performance or practices that may indicate practical drift, including trends in procedural compliance, operational variability and deviations from the intended operating envelope.
- (2) The objectives and benefits of an FDM program with respect to improving safety by identifying and preventing the causes of failures may include but are not limited to:
  - (a) providing data to identify hazards, evaluate risk, and implement measures to prevent recurrence of unsafe events;
  - (b) ensuring adherence to SOPs;
  - (c) detecting deviations from expected operational performance and non-standard behaviour;
  - (d) identifying adverse operational trends in any part of the flight;
  - (e) identifying deficiencies in procedures and opportunities for corrective action;
  - (f) identifying weaknesses or limitations in ATC systems;
  - (g) monitoring aircraft performance and airworthiness; and
  - (h) supporting fuel efficiency.
- (3) An FDM program should enable the organization to understand how safe and effective operational performance is routinely achieved, including the operational practices, adaptations and conditions that contribute to consistently successful, efficient and effective outcomes and support continual improvement.

- (4) The objectives and benefits of an FDM program with respect to understanding the conditions that support consistently successful operations and organizational resilience include but are not limited to:
- (a) understanding how flight operations are conducted under normal and varying conditions;
  - (b) identifying the operational practices and adaptations that contribute to consistently safe and efficient outcomes;
  - (c) monitoring operational performance to understand variability and resilience;
  - (d) identifying opportunities to strengthen procedures, training and system design;
  - (e) informing improvements to aircraft operations, air traffic managements and fuel efficiency; and
  - (f) providing data to support continual learning in the enhancement of overall system safety performance.

#### **4.3 Requirement to have an FDM program**

- (1) The Canadian aviation regulatory framework is continuously evolving. Operators are encouraged to monitor the Department of Justice Canada website for current Canadian regulations on requirements to have an FDM program and to monitor CARAC for any future regulatory development.
- (2) Transport Canada's Departmental Plan ([Departmental Plans \[DP\]](#)) includes objectives to align with international standards which may include further alignment with ICAO SARP.
- (3) Under ICAO standards requirements, international air transport operators are required to establish and maintain an FDAP for the following categories of aeroplane:
- (a) aeroplanes with a maximum permissible take-off weight over 27 000 kg (59 500 lbs); and
  - (b) aeroplanes with a maximum permissible take-off weight over 15 000 kg (33 000 lbs) with a passenger seating capacity greater than 19, and with a certificate of airworthiness first issued on or after 1 January 2027. Under the *Canadian Aviation Regulations*, this would apply to aircraft for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers.
- (4) Transport Canada has adopted this ICAO SARP under Interim Order No. 4 (2026) as applicable to Subpart 705 operators conducting international scheduled operations.
- (5) Future consideration may be made to expanding the applicability of the Canadian regulatory framework for FDM to match the ICAO SARP applicability.
- (6) ICAO recommended practices are recognized as desirable in the interest of safety. Under ICAO recommendations international air transport operators should establish and maintain an FDAP for the following categories of aircraft:
- (a) aeroplanes of a certificated take-off mass in excess of 15 000 kg
  - (b) helicopters of a certified take-off mass in excess of 7 000 kg, or having a passenger seating configuration of more than 9, and fitted with a flight data recorder
- (7) Foreign civil aviation authorities may expect operators to fully comply with the ICAO SARP.

#### **4.4 Integration of a FDM program into a Safety Management System (SMS)**

- (1) The FDM program shall be integrated into the operator's SMS. The FDM program should support:
- (a) hazard identification: identification of operational risks through flight data trends

- (b) risk assessment: evaluation of safety significance of identified trends
  - (c) safety assurance: continuous monitoring of operational performance
  - (d) safety promotion: sharing lessons learned with operational personnel
- (2) As part of the SMS, the FDM program may also inform maintenance reliability programs and continued airworthiness.
- (3) The reporting policy for events detected through the FDM program should be non-punitive and developed and implemented with all affected parties. The policy for the internal reporting of a hazard, an incident or an accident, must include the conditions under which immunity from disciplinary action will be granted. A non-punitive approach to safety reporting does not preclude the use of a general approach to discipline in cases where an employee is involved in similar, recurrent events. When considering the application of a safety reporting policy for safety reports generated from data collected through events detected through FDM, the organization should consider whether the event was wilful, deliberate or negligent on the part of the individual(s) involved and the attendant circumstances as indicated in AC 107-001.

#### **4.5 FDM equipment**

- (1) Equipment required to support an FDM program may include but is not limited to FDR, QAR, CVR, ADRS, CARS and AIRS. While traditional recorders such as FDR and QAR are commonly used as the primary means of data capture, other systems may be used to provide alternate or supplementary information.
- (2) Ground based equipment and processes require a means to transfer and secure the data recorded on board the aircraft to a ground-based processing station. This may involve the physical movement of the memory unit from the QAR or may be accomplished via wireless technology.
- (3) A ground-based computer system and software is required to analyze the data. This may be outsourced to a third party provided that adequate data protection policies and processes are in place.

#### **4.6 Processing FDM data**

- (1) Examples of FDM data that may be collected under an FDM program are included in Appendix A and B for aeroplanes. Examples of FDM data that may be collected under an FDM program for helicopters are included in Appendix C.
- (2) Flight data analysis trigger logic may include simple exceedances such as redline values or composites which may be defined by flight mode, aircraft or payload configuration and one or more flight parameters.
- (3) Routine measurements of standard operational data can be taken as part of an FDM program to monitor normal operational performance, determine trends and overall operational quality.
- (4) Events-based measurements focus on predefined safety events, exceedances or variances from company SOP that may occur during a flight.
- (5) FDM data may be used to provide information to verify operational reports from flight crew, ground crew or ATC. Operators may also use FDM data to verify CADORS.

#### **4.7 Protection of FDM data**

- (1) ICAO Annex 19, Appendix 3 indicates that the protection of safety data, safety information and related sources is essential to ensure their continued availability, since the use of safety data and

safety information for purposes other than maintaining or improving safety may inhibit the future availability of such data and information, with a significant adverse effect on safety.

- (2) Data protection policies should be developed jointly with flight crew representatives, employee groups and labour unions.
- (3) Operators should implement a policy and procedure to remove identifying information prior to routine safety analysis.
- (4) Access to FDM data should be limited to authorized personnel such as: FDM analysts, safety managers and maintenance personnel for the purpose of airworthiness analysis.
- (5) Collection of FDM data by Transport Canada is not required for inspection and surveillance related to regulatory requirements to have an FDM program. Transport Canada oversight activities focus on evaluating the requirement to have an FDM program, rather than examining individual operational events. Transport Canada shall not collect FDM data during inspection and surveillance related to regulatory requirements to have an FDM program.
- (6) FDM data is protected and should remain under the control and custody of the operator to ensure there is no risk of disclosure.
- (7) If an operator chooses to share FDM data with Transport Canada under a voluntary agreement established under authority of section 5.31 the *Aeronautics Act*, this data is protected from release under Schedule II of the *Access to Information and Privacy Act*. The sharing of FDM derived safety information under these voluntary arrangements (VISPA) will be described in a separate Civil Aviation Directive.

#### **4.8 Retention of FDM data**

- (1) The organization should have a policy on the retention and archiving of FDM data.

#### **4.9 FDM data lifecycle**

- (1) The management of operational flight data within a FDM program should follow a structured lifecycle designed to support safety analysis while protecting confidential safety information. The lifecycle typically consists of the following stages:
  - (a) aircraft data recording;
  - (b) data extraction and transfer;
  - (c) data processing and event detection;
  - (d) safety analysis;
  - (e) de-identification and aggregation;
  - (f) safety trend monitoring;
  - (g) corrective action and safety improvements; and
  - (h) deletion or archival of raw data.

#### **4.10 Establishing and maintaining a FDM program**

- (1) An effective FDM program should demonstrate that operational flight data is actively used to improve safety and operational performance. This section outlines the key features of an FDM program. Appendix D contains a set of criteria to verify that an operator has established an FDM program.

- (2) An effective FDM program should have clearly defined governance and management structures. Indicators may include:
  - (a) documented FDM policy and procedures;
  - (b) designated FDM manager;
  - (c) defined responsibilities for data analysis and safety reporting;
  - (d) oversight by a safety committee or similar governing body; and
  - (e) governance structure should include participation from operational departments such as flight operations, safety management and continuing airworthiness.
- (3) FDM programs shall be integrated into the operator's SMS. Evidence of integration may include:
  - (a) safety reports are generated from FDM analysis;
  - (b) safety investigations in response to events identified by FDM are carried out by appropriately trained personnel to identify causal and contributing factors;
  - (c) the process identifies how FDM reports are actioned and timescales are specified and addressed;
  - (d) there is a process to identify and evaluate operational risks by highlighting occurrences of non-standard or unsafe circumstances discovered through FDM;
  - (e) a process for the management of risks and hazards identified or monitored through FDM that includes the analysis and assessment of risks associated with hazards expressed in terms of likelihood and severity (or alternative methodology);
  - (f) with respect to data collected by the FDM, there are criteria for the level of risk that the organization is willing to accept and risk assessments and ratings are appropriately justified;
  - (g) corrective actions are tracked through SMS processes;
  - (h) the results of corrective actions are monitored and evaluated with respect to hazards, incidents and accidents with assistance from FDM data;
  - (i) the review of the SMS to determine its effectiveness includes information derived from the FDM program; and
  - (j) there are procedures for making reports as needed for urgent cases involving information derived from the FDM program.
- (4) An FDM program should include well-defined event detection criteria. Event definitions may include:
  - (a) operational precursors such as unstable approaches or excessive decent rates;
  - (b) exceedance of aircraft operational limits; and
  - (c) aircraft system anomalies relevant to continued airworthiness.
- (5) Operational data should be analyzed regularly in order to identify safety trends, hazards and changes to operational risks. Indicators of effective analysis may include:
  - (a) periodic safety analysis reports;
  - (b) identification of recurring operational events; and
  - (c) monitoring of safety performance indicators.
- (6) An effective FDM program should demonstrate the ability to identify safety trends over time. Examples may include trends related to:

- (a) unstable approaches;
  - (b) energy management during approach and landing; and
  - (c) operational deviations associated with specific airports or routes.
- (7) The ultimate measure of an effective FDM program is the implementation of safety improvements based on information derived from the FDM program. Examples may include:
  - (a) changes to operational procedures;
  - (b) targeted pilot training programs;
  - (c) safety bulletins addressing operational risks; and
  - (d) engineering investigations related to aircraft system behaviour.
- (8) FDM may also support aircraft reliability and continued airworthiness monitoring. Indicators may include:
  - (a) identification of structural exceedances;
  - (b) monitoring of engine performance parameters; and
  - (c) identification of abnormal system behaviour.
- (9) Successful FDM programs involve the participation and support of operational personnel. Indicators may include:
  - (a) discussion of observations from the FDM program with flight crews;
  - (b) participation of pilot representatives in FDM governance committees; and
  - (c) training or awareness programs explaining the purpose and protections of the FDM program.
- (10) Operators should demonstrate that appropriate safeguards are in place to protect confidential safety information. Examples include:
  - (a) procedures for de-identification of operational data;
  - (b) restricted access to FDM databases; and
  - (c) clearly identified data retention policies.
- (11) An effective FDM program should evolve over time in response to operational experience and emerging safety risks. Operators should periodically review and update:
  - (a) event detection criteria;
  - (b) analytical methods; and
  - (c) safety performance indicators.

## **5.0 Aviation enforcement - Safety Management Systems and Flight Data Monitoring (FDM) Data**

- (1) The primary purpose of an FDM program is to identify safety trends, operational risks and opportunities for system-wide improvement. The use of FDM should support a non-punitive safety environment between employees and the operator and between Transport Canada and operators. There must be a policy in place that includes the conditions under which immunity from disciplinary action will be granted for safety reports, incidents and accidents detected through FDM data.

- (2) As indicated in CAD 107-004, to encourage employees of SMS enterprises to internally report safety hazards, Transport Canada will not make use of information derived from an internal reporting system or from a flight data monitoring process for any measures or in any proceedings against an enterprise or their employees for a contravention.
- (3) Established Transport Canada policies and procedures for a non-compliance event review for enterprise with a Safety Management System in accordance with SI-SUR-006 shall be followed.
- (4) FDM data shall not be used to initiate, trigger, or form the sole basis of a non-compliance event review.
- (5) FDM data shall not be used to expand the scope of any investigation beyond a non-compliance event identified through the independent source.
- (6) Transport Canada shall not conduct systematic or targeted reviews of FDM data for the purpose of identifying potential non-compliance events.
- (7) FDM safety analysis functions at Transport Canada shall be organizationally separated from compliance verification functions to ensure integrity of this policy.

## **6.0 Information management**

- (1) Not applicable

## **7.0 Document history**

- (1) Not applicable

## **8.0 Contact us**

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## **Appendix A — Flight data monitoring and analysis parameters**

- (1) This comprehensive list covers parameters that can be recorded and monitored as part of a flight data monitoring (FDM) or flight data analysis (FDA) program. Parameters are organized by functional category.
- (2) It is not necessary that an operator records and monitors all these parameters.

### **Aircraft State and Trajectory**

#### **Position and Navigation**

- (a) Latitude and longitude (decimal degrees)
- (b) Geometric altitude (GNSS-derived)
- (c) Pressure altitude (barometric)
- (d) Radio altitude (radar altimeter)
- (e) Altitude rate (vertical speed from air data)
- (f) Inertial vertical speed
- (g) Ground track angle
- (h) True heading
- (i) Magnetic heading
- (j) Drift angle
- (k) Cross-track deviation
- (l) Vertical deviation from glidepath
- (m) Localizer deviation
- (n) Distance to selected waypoint
- (o) Distance measuring equipment (DME) reading
- (p) Ground speed
- (q) Inertial ground speed components (north, east, down)

#### **Attitude and Angular Rates**

- (a) Pitch angle
- (b) Roll (bank) angle
- (c) Yaw angle
- (d) Pitch rate
- (e) Roll rate
- (f) Yaw rate
- (g) Body-axis angular accelerations (pitch, roll, yaw)
- (h) Angle of attack (alpha)
- (i) Sideslip angle (beta)

- (j) Flight path angle
- (k) Angle of attack rate

**Accelerations and Load Factors**

- (a) Longitudinal acceleration (body axis)
- (b) Lateral acceleration (body axis)
- (c) Normal acceleration (body axis)
- (d) Vertical load factor (g)
- (e) Lateral load factor
- (f) Peak g exceedance counts

**Airspeed and Air Data**

- (a) Indicated airspeed
- (b) Calibrated airspeed
- (c) True airspeed
- (d) Mach number
- (e) Maximum operating speed (VMO/MMO) margin
- (f) Airspeed trend
- (g) Stall warning margin (speed above stall)
- (h) Total air temperature
- (i) Static air temperature
- (j) Outside air temperature
- (k) Impact pressure
- (l) Static pressure
- (m) Dynamic pressure
- (n) Pressure altitude rate
- (o) Air data computer validity flags

**Engine Parameters (Per Engine)****Thrust and Power**

- (a) Engine pressure ratio (EPR)
- (b) Fan speed (N1)
- (c) Core speed (N2)
- (d) High-pressure spool speed (N3, if applicable)
- (e) Torque (turboprop/turboshaft)
- (f) Shaft horsepower

- (g) Propeller RPM
- (h) Thrust lever angle
- (i) Thrust lever resolver angle
- (j) Autothrottle commanded thrust
- (k) Thrust asymmetry

**Temperatures**

- (a) Exhaust gas temperature (EGT)
- (b) Turbine inlet temperature (TIT)
- (c) Interstage turbine temperature (ITT)
- (d) Oil inlet temperature
- (e) Oil outlet temperature
- (f) Nacelle temperature

**Pressures and Flows**

- (a) Fuel flow rate
- (b) Cumulative fuel used
- (c) Oil pressure
- (d) Oil quantity
- (e) Fuel pressure
- (f) Bleed air pressure
- (g) Engine inlet pressure

**Engine Health**

- (a) Vibration amplitude (fan, core)
- (b) Vibration frequency spectrum
- (c) Start time duration
- (d) Time above redline parameters
- (e) Surge/stall detection flags
- (f) FADEC fault codes
- (g) Engine trend monitoring deltas (deviation from baseline)

**Flight Control Surfaces and Inputs****Primary Control Positions**

- (a) Elevator position (left, right)
- (b) Aileron position (left, right)

- (c) Rudder position
- (d) Stabilizer (horizontal tail) position
- (e) Flaperon position (if equipped)

**Secondary Control Positions**

- (a) Flap position (actual, commanded)
- (b) Slat position (actual, commanded)
- (c) Spoiler positions (individual panels)
- (d) Speed brake position
- (e) Ground spoiler deployment status

**Control Inputs**

- (a) Control column position (pitch)
- (b) Control wheel position (roll)
- (c) Rudder pedal position
- (d) Sidestick pitch input
- (e) Sidestick roll input
- (f) Trim switch inputs (pitch, roll, yaw)
- (g) Autopilot servo commands
- (h) Control surface rate limits active

**Actuator Data**

- (a) Hydraulic actuator pressures
- (b) Electric actuator current draw
- (c) Surface actuator feedback position
- (d) Control surface load sensing
- (e) Fly-by-wire computer commands

**Landing Gear and Braking**

- (a) Gear handle position
- (b) Gear position (up, down, in transit) per leg
- (c) Weight-on-wheels status (left, right, nose)
- (d) Brake pressure (left, right)
- (e) Parking brake status
- (f) Autobrake setting
- (g) Anti-skid system activation

- (h) Brake temperature (per wheel)
- (i) Tire pressure (if equipped)
- (j) Steering angle
- (k) Nose wheel position
- (l) Gear door position
- (m) Shock strut compression

## **Autopilot and Flight Management**

### **Autopilot Status**

- (a) Autopilot engaged (AP1, AP2, AP3)
- (b) Autopilot mode (altitude hold, heading select, LNAV, VNAV, approach, etc.)
- (c) Flight director engaged
- (d) Autothrottle engaged
- (e) Autothrottle mode
- (f) Autoland status
- (g) Go-around mode activation
- (h) Autopilot disconnect events
- (i) Manual override events

### **Flight Management System**

- (a) Active flight plan waypoints
- (b) Estimated time of arrival
- (c) Required navigation performance (RNP) value
- (d) Actual navigation performance (ANP)
- (e) FMS-computed fuel at destination
- (f) Cost index setting
- (g) Selected altitude
- (h) Selected airspeed/Mach
- (i) Selected vertical speed
- (j) Selected heading
- (k) Lateral deviation from programmed path
- (l) Vertical deviation from programmed path

## Navigation and Communication Systems

### Radio Navigation

- (a) VOR bearing
- (b) VOR radial deviation
- (c) ILS localizer frequency
- (d) ILS glideslope frequency
- (e) Localizer signal strength
- (f) Glideslope signal strength
- (g) Marker beacon passage (outer, middle, inner)
- (h) ADF bearing
- (i) DME distance and ground speed

### Satellite Navigation

- (a) GNSS satellite count in use
- (b) GNSS horizontal dilution of precision (HDOP)
- (c) GNSS vertical dilution of precision (VDOP)
- (d) GNSS position accuracy estimate
- (e) RAIM status
- (f) SBAS/WAAS correction status
- (g) Differential GNSS corrections applied

### Communication

- (a) Active radio frequencies (VHF1, VHF2, HF)
- (b) Transponder code
- (c) Transponder mode (standby, on, altitude reporting)
- (d) TCAS/ACAS resolution advisory active
- (e) TCAS target data
- (f) CPDLC message events
- (g) SELCAL activation
- (h) ELT activation status

## Warning and Alert Systems

- (a) Master caution activation
- (b) Master warning activation
- (c) GPWS/EGPWS mode annunciations

- (d) GPWS terrain alert
- (e) GPWS pull-up warning
- (f) GPWS glideslope alert
- (g) GPWS sink rate alert
- (h) GPWS windshear alert
- (i) Stall warning activation
- (j) Stick shaker activation
- (k) Stick pusher activation
- (l) Overspeed warning
- (m) Configuration warning (takeoff, landing)
- (n) Altitude alert
- (o) Bank angle warning
- (p) Cabin altitude warning
- (q) Fire warning (engine, APU, cargo)
- (r) TCAS traffic advisory
- (s) TCAS resolution advisory
- (t) Windshear warning system activation
- (u) Ice detection alert
- (v) Low fuel warning
- (w) Hydraulic low pressure warning
- (x) Electrical bus fault warning

## **Electrical Systems**

- (a) Generator output (volts, amps) per generator
- (b) Bus voltage (AC, DC)
- (c) Bus current loading
- (d) Battery voltage
- (e) Battery temperature
- (f) Battery charge/discharge rate
- (g) APU generator status
- (h) External power connected
- (i) Electrical bus configuration
- (j) Inverter status
- (k) Transformer rectifier unit output
- (l) Emergency power status

## Hydraulic Systems

- (a) Hydraulic pressure (system A, B, C, etc.)
- (b) Hydraulic quantity
- (c) Hydraulic temperature
- (d) Hydraulic pump status (engine-driven, electric, RAT)
- (e) Accumulator pressure
- (f) Power transfer unit status
- (g) Ram air turbine deployment status

## Pneumatic and Environmental Control

### Bleed Air

- (a) Bleed air source selection
- (b) Bleed air pressure
- (c) Bleed air temperature
- (d) Bleed valve positions
- (e) Precooler outlet temperature
- (f) Wing anti-ice valve position
- (g) Engine anti-ice valve position

### Cabin Environment

- (a) Cabin altitude
- (b) Cabin altitude rate
- (c) Cabin differential pressure
- (d) Outflow valve position
- (e) Pack flow rate
- (f) Pack discharge temperature
- (g) Cabin temperature (zones)
- (h) Cockpit temperature
- (i) Recirculation fan status
- (j) Humidity level (if equipped)

## Fuel System

- (a) Total fuel quantity
- (b) Fuel quantity per tank
- (c) Fuel temperature

- (d) Fuel flow (total, per engine)
- (e) Fuel used since reset
- (f) Fuel imbalance (left/right)
- (g) Crossfeed valve position
- (h) Fuel boost pump status
- (i) Fuel transfer pump status
- (j) Center tank pump status
- (k) Fuel jettison status
- (l) Fuel density

### **Ice Protection**

- (a) Wing anti-ice status
- (b) Engine anti-ice status (per engine)
- (c) Windshield heat status
- (d) Probe heat status (pitot, static, AOA)
- (e) Ice detector status
- (f) Ice accretion rate
- (g) TAT probe heat
- (h) Window heat current draw

### **Auxiliary Power Unit**

- (a) APU running status
- (b) APU N1 or N2 speed
- (c) APU EGT
- (d) APU oil pressure
- (e) APU oil temperature
- (f) APU bleed air available
- (g) APU generator online
- (h) APU fuel flow
- (i) APU start cycle count
- (j) APU fault codes

### **Crew Actions and Inputs**

- (a) Thrust lever movement rate
- (b) Control column force
- (c) Control wheel force

- (d) Rudder pedal force
- (e) Flap lever position changes with timestamp
- (f) Gear lever actuation timestamp
- (g) Speed brake lever position
- (h) Autopilot engage/disengage events
- (i) Autothrottle engage/disengage events
- (j) Go-around initiation
- (k) TOGA button press
- (l) Takeoff configuration button press
- (m) Cockpit voice intercom keying (event marker, not audio)
- (n) Seat occupied sensors (if equipped)

### **Structural and Fatigue Monitoring**

- (a) Wing bending moment
- (b) Vertical tail loads
- (c) Horizontal stabilizer loads
- (d) Landing gear loads (touchdown impact)
- (e) Fuselage cabin pressure cycles
- (f) Hard landing detection (g threshold exceedance)
- (g) Flap/slat load cycles
- (h) Door seal pressure
- (i) Flight hours accumulation
- (j) Flight cycle count
- (k) Pressurization cycle count

### **Weight and Balance**

- (a) Gross weight (computed)
- (b) Zero fuel weight
- (c) Center of gravity position (percent MAC)
- (d) Fuel loading distribution
- (e) Payload weight
- (f) Takeoff weight
- (g) Landing weight
- (h) CG shift during flight

## **Weather and Environmental Sensors**

- (a) Weather radar tilt angle
- (b) Weather radar gain setting
- (c) Weather radar returns (if digital output)
- (d) Turbulence detection
- (e) Lightning strike detection
- (f) Outside air temperature
- (g) SAT/TAT
- (h) Windshear detection
- (i) Wind speed (computed)
- (j) Wind direction (computed)
- (k) Headwind/tailwind component
- (l) Crosswind component

## **Doors and Hatches**

- (a) Passenger door status (open, closed, locked)
- (b) Cargo door status
- (c) Emergency exit status
- (d) Cockpit door locked status
- (e) Overwing exit status
- (f) Service door status
- (g) Avionics bay access status

## **Lighting Systems**

- (a) Navigation light status
- (b) Strobe light status
- (c) Anti-collision beacon status
- (d) Landing light position and status
- (e) Taxi light status
- (f) Wing inspection light status
- (g) Logo light status
- (h) Cockpit dome light status
- (i) Emergency lighting armed

**Oxygen Systems**

- (a) Crew oxygen pressure
- (b) Passenger oxygen pressure (if applicable)
- (c) Oxygen mask deployment status
- (d) Oxygen flow indicator

**Miscellaneous Systems**

- (a) Windshield wiper speed
- (b) Rain repellent system activation
- (c) Lavatory smoke detector activation
- (d) Cargo smoke detector status
- (e) Fire extinguisher discharge status
- (f) Emergency locator transmitter activation
- (g) Cockpit voice recorder status
- (h) Flight data recorder status
- (i) Quick access recorder data link status

**Derived and Computed Parameters**

- (a) Beyond raw sensor outputs, FDM programs often compute derived metrics:
- (b) Energy state (total energy, energy rate)
- (c) Stabilized approach compliance score
- (d) Touchdown point relative to threshold
- (e) Runway remaining at touchdown
- (f) Flare height and duration
- (g) Time in windshear
- (h) Time below glideslope
- (i) Exceedance severity scores
- (j) Approach gate compliance (1000 ft, 500 ft criteria)
- (k) Takeoff rotation rate
- (l) V-speed adherence (V1, VR, V2)
- (m) Standard operating procedure deviation flags
- (n) Fuel efficiency metrics (specific range, fuel burn vs. plan)
- (o) Noise abatement compliance
- (p) CFIT risk index
- (q) Unstabilized approach index

- (r) Hard landing probability estimate

### **Event Markers and Metadata**

- (a) Flight phase (taxi, takeoff, climb, cruise, descent, approach, landing, go-around)
- (b) UTC timestamp
- (c) Flight number
- (d) Aircraft registration
- (e) Departure airport
- (f) Destination airport
- (g) Runway used
- (h) Crew identifier codes
- (i) Maintenance action codes
- (j) Data validity flags per parameter
- (k) Recording frame counter
- (l) Data dropout flags

## **Appendix B — Flight data exceedance detection parameters**

- (1) Exceedance detection identifies instances where recorded flight parameters deviate beyond predefined thresholds, indicating potential safety risks, procedural deviations, or aircraft stress events. The following list covers parameters and conditions typically monitored for exceedance in FDM/FDA programs. Parameters are organized by functional category.
- (2) It is not necessary that an operator records and monitors all these parameters.

### **Airspeed Exceedances**

- (a) Maximum operating speed (VMO) exceeded
- (b) Maximum operating Mach (MMO) exceeded
- (c) Flap limiting speed (VFE) exceeded for each flap setting
- (d) Landing gear extended speed (VLE) exceeded
- (e) Landing gear operating speed (VLO) exceeded
- (f) Minimum control speed (VMC) approach
- (g) Stall speed margin below threshold
- (h) Airspeed below reference speed (VREF) on approach
- (i) Target approach speed deviation (above or below)
- (j) Rotation speed (VR) deviation at takeoff
- (k) V2 not achieved by specified height
- (l) Airspeed decay rate excessive during approach
- (m) Indicated airspeed disagree between sources
- (n) Excessive groundspeed during taxi

### **Altitude and Vertical Path Exceedances**

- (a) Altitude deviation from cleared level (positive or negative)
- (b) Descent below decision altitude without visual contact
- (c) Descent below minimum descent altitude
- (d) Radio altitude below threshold during approach (gates at 1000 ft, 500 ft, 200 ft)
- (e) Terrain clearance below minimum
- (f) Glideslope deviation excessive (above or below)
- (g) GPWS terrain warning activation
- (h) GPWS pull-up warning activation
- (i) GPWS sink rate warning activation
- (j) Altitude capture overshoot
- (k) Level bust (departure from assigned altitude)
- (l) Cabin altitude exceeded threshold
- (m) Cabin altitude rate of change excessive

- (n) Pressurization differential exceeded

### **Attitude and Bank Angle Exceedances**

- (a) Pitch attitude excessive (nose high)
- (b) Pitch attitude excessive (nose low)
- (c) Bank angle exceeded during takeoff roll
- (d) Bank angle exceeded below specified altitude
- (e) Bank angle exceeded in cruise
- (f) Bank angle exceeded on approach
- (g) Bank angle warning activation
- (h) Roll rate excessive
- (i) Pitch rate excessive during rotation
- (j) Pitch rate excessive during flare
- (k) Negative pitch attitude on takeoff

### **Load Factor and Acceleration Exceedances**

- (a) Positive g limit exceeded
- (b) Negative g limit exceeded
- (c) Lateral g threshold exceeded
- (d) Touchdown vertical acceleration excessive (hard landing)
- (e) Longitudinal deceleration excessive on landing
- (f) Peak g during turbulence encounter
- (g) Cumulative g cycles above fatigue threshold
- (h) Asymmetric loading event

### **Angle of Attack Exceedances**

- (a) Angle of attack approach to stall threshold
- (b) Angle of attack exceeded operational limit
- (c) Stall warning activation
- (d) Stick shaker activation
- (e) Stick pusher activation
- (f) Alpha floor protection activation
- (g) AOA disagree between sensors

## Engine Parameter Exceedances

### Speed and Thrust

- (a) N1 exceeded redline
- (b) N2 exceeded redline
- (c) N3 exceeded redline (if applicable)
- (d) Torque limit exceeded
- (e) Engine pressure ratio limit exceeded
- (f) Propeller overspeed
- (g) Thrust asymmetry above threshold during takeoff
- (h) Thrust asymmetry above threshold during go-around
- (i) Reverse thrust deployed above groundspeed limit
- (j) Reverse thrust deployed in flight

### Temperature

- (a) Exhaust gas temperature exceeded takeoff limit
- (b) Exhaust gas temperature exceeded continuous limit
- (c) Turbine inlet temperature exceeded
- (d) Interstage turbine temperature exceeded
- (e) Oil temperature exceeded maximum
- (f) Time at elevated EGT beyond limit

### Pressure and Flow

- (a) Oil pressure below minimum
- (b) Oil pressure above maximum
- (c) Fuel flow imbalance between engines
- (d) Bleed air pressure out of range

### Engine Health Indicators

- (a) Vibration amplitude exceeded threshold
- (b) Engine surge or stall event
- (c) Abnormal start (hot start, hung start)
- (d) Start time exceeded limit
- (e) FADEC fault activation
- (f) Engine trend deviation beyond tolerance

## Flight Control Exceedances

### Surface Positions

- (a) Elevator deflection beyond normal range
- (b) Aileron deflection beyond normal range
- (c) Rudder deflection beyond normal range
- (d) Stabilizer out of trim range for flight phase
- (e) Asymmetric flap position
- (f) Asymmetric slat position
- (g) Flap load relief activation
- (h) Spoiler uncommanded deployment

### Control Inputs

- (a) Control column force exceeded limit
- (b) Control wheel force exceeded limit
- (c) Rudder pedal force exceeded limit
- (d) Excessive control input rate
- (e) Pilot-induced oscillation detection
- (f) Autopilot override force threshold
- (g) Dual control input conflict

### Configuration

- (a) Flap position incorrect for flight phase
- (b) Slat position incorrect for flight phase
- (c) Speed brake extended in unauthorized configuration
- (d) Gear not down at low altitude on approach
- (e) Takeoff configuration warning activation
- (f) Landing configuration warning activation

## Autopilot and Autothrottle Exceedances

- (a) Autopilot disconnect below minimum engagement altitude
- (b) Autopilot disconnect without pilot command
- (c) Autothrottle disconnect without pilot command
- (d) Autopilot in wrong mode for flight phase
- (e) Flight director not followed (deviation threshold)
- (f) Altitude capture deviation excessive

- (g) Heading capture deviation excessive
- (h) Localizer capture deviation excessive
- (i) Glideslope capture deviation excessive
- (j) VNAV path deviation excessive
- (k) LNAV path deviation excessive
- (l) Go-around mode not armed on approach

### **Navigation Exceedances**

- (a) Lateral deviation from flight plan (RNP exceedance)
- (b) Localizer deviation excessive on approach
- (c) Glideslope deviation excessive on approach
- (d) Required navigation performance not met
- (e) Navigation source disagree
- (f) GNSS position error excessive
- (g) Unintended deviation from assigned track

### **Landing and Touchdown Exceedances**

- (a) Touchdown beyond normal zone
- (b) Touchdown short of threshold
- (c) Long landing (excessive distance from threshold)
- (d) Touchdown vertical speed excessive
- (e) Touchdown bank angle excessive
- (f) Touchdown with drift (crab angle at contact)
- (g) Runway remaining below minimum at touchdown
- (h) Approach not stabilized at gate (1000 ft, 500 ft)
- (i) Late stabilization below gate altitude
- (j) Go-around initiated below decision altitude
- (k) Bounce on landing (multiple touchdowns)
- (l) Runway excursion risk parameters
- (m) Asymmetric brake application on rollout
- (n) Directional deviation on rollout

### **Takeoff Exceedances**

- (a) Rotation rate below minimum
- (b) Rotation rate above maximum
- (c) Rotation initiated early (before VR)

- (d) Rotation initiated late (after VR)
- (e) Pitch attitude at rotation excessive
- (f) Tail strike risk (pitch angle plus rate)
- (g) V1 call not followed (rejected takeoff after V1)
- (h) Rejected takeoff at high speed
- (i) Engine failure recognition delay
- (j) Takeoff thrust not set
- (k) Takeoff configuration warning not resolved
- (l) Crosswind component exceeded limit
- (m) Tailwind component exceeded limit
- (n) Runway heading deviation during roll

### **Go-Around Exceedances**

- (a) Go-around initiated below minimum altitude
- (b) Go-around climb gradient insufficient
- (c) Go-around not executed when required
- (d) Thrust application delayed during go-around
- (e) Pitch attitude excessive during go-around
- (f) Flap retraction sequence incorrect
- (g) Gear retraction delayed
- (h) Speed not maintained during go-around

### **Ground Operations Exceedances**

- (a) Taxi speed excessive
- (b) Brake temperature exceeded before takeoff
- (c) Brake temperature exceeded after landing
- (d) Groundspeed excessive during turn
- (e) Runway incursion event marker
- (f) Engine start parameters out of range
- (g) APU start parameters out of range
- (h) Doors not secure at movement initiation
- (i) Parking brake released with wheel chocks absent (if sensed)

### **Weather and Environmental Exceedances**

- (a) Windshear encounter (airspeed or altitude deviation)
- (b) Windshear warning activation

- (c) Severe turbulence encounter (g threshold)
- (d) Crosswind component exceeded for landing
- (e) Tailwind component exceeded for landing
- (f) Icing conditions beyond certified envelope
- (g) Temperature deviation from ISA beyond limit (performance implications)

### **Warning System Activation Events**

- (a) Master caution activation
- (b) Master warning activation
- (c) Fire warning (engine, APU, cargo bay)
- (d) Smoke detection (lavatory, cargo, avionics bay)
- (e) TCAS resolution advisory issued
- (f) TCAS resolution advisory not followed
- (g) GPWS/EGPWS caution
- (h) GPWS/EGPWS warning
- (i) Windshear caution
- (j) Windshear warning
- (k) Overspeed warning
- (l) Stall warning
- (m) Configuration warning
- (n) Altitude alert
- (o) Low fuel warning
- (p) Hydraulic system warning
- (q) Electrical system warning
- (r) Pressurization warning
- (s) Oxygen system warning
- (t) Door warning in flight
- (u) Icing system failure warning

### **System Malfunction Exceedances**

- (a) Dual hydraulic system failure
- (b) Dual electrical bus failure
- (c) Flight control surface jam or restrict
- (d) Engine shutdown in flight
- (e) APU shutdown (uncommanded)
- (f) Pressurization system failure

- (g) Bleed air system failure
- (h) Anti-ice system failure in icing conditions
- (i) Autopilot failure
- (j) Autothrottle failure
- (k) Navigation system degradation
- (l) Communication system failure
- (m) Transponder failure

### **Fuel Exceedances**

- (a) Fuel quantity below planned minimum
- (b) Fuel imbalance above threshold
- (c) Fuel flow deviation from expected
- (d) Fuel leak indication
- (e) Fuel temperature out of range
- (f) Reserve fuel quantity minimum not maintained

### **Structural Load Exceedances**

- (a) Wing bending moment limit approached
- (b) Flap load limit exceeded
- (c) Landing gear load limit exceeded
- (d) Tail load limit exceeded
- (e) Fatigue cycle threshold exceeded
- (f) Cumulative damage index increment significant

### **Time-Based Exceedances**

- (a) Time below glideslope on approach
- (b) Time with configuration warning active
- (c) Time in unstabilized approach condition
- (d) Time with stick shaker active
- (e) Time in windshear
- (f) Time with engine parameter above redline
- (g) Time with overspeed warning active
- (h) Time at excessive bank angle
- (i) Duration of master warning activation

## Derived and Composite Exceedances

These are calculated metrics often combining multiple parameters:

- (a) Unstabilized approach score above threshold
- (b) Energy management index out of range
- (c) Approach risk index exceeded
- (d) CFIT risk score elevated
- (e) Hard landing probability exceeded prior to touchdown
- (f) Braking action required exceeds available
- (g) Stopping distance exceeds runway available
- (h) Rotation energy state deviation
- (i) Thrust-to-weight ratio below minimum at rotation
- (j) Climb gradient below required obstacle clearance

## Threshold Types

Exceedances are typically categorized by severity. The following is an example of how exceedances could be categorized.

| Severity | Description                |                              |
|----------|----------------------------|------------------------------|
| advisory | parameter approached limit | early awareness              |
| caution  | parameter at or near limit | requires review              |
| warning  | parameter exceeded limit   | safety implication           |
| critical | significant exceedance     | immediate attention required |

## Contextual Factors Logged with Exceedances

Each exceedance event typically captures:

- (a) UTC timestamp
- (b) Flight phase
- (c) Aircraft altitude and airspeed at event
- (d) Duration of exceedance
- (e) Peak value recorded
- (f) Threshold value exceeded
- (g) Parameter recovery time
- (h) Associated crew inputs
- (i) Environmental conditions (wind, temperature)
- (j) System status at time of event

## **Appendix C — Helicopter specific flight data monitoring and analysis parameters**

- (1) This comprehensive list covers parameters that can be recorded and monitored as part of a flight data management (FDM) or flight data analysis (FDA) program specific to rotorcraft operations. Parameters are organized by functional category and reflect the unique characteristics of helicopter flight dynamics, rotor systems, and operational profiles.
- (2) It is not necessary that an operator records and monitors all these parameters.

### **Aircraft State and Trajectory**

#### **Position and Navigation**

- (a) Latitude and longitude
- (b) GNSS altitude
- (c) Pressure altitude (barometric)
- (d) Radar altitude (radio altimeter)
- (e) Altitude rate
- (f) Ground track
- (g) True heading
- (h) Magnetic heading
- (i) Drift angle
- (j) Ground speed
- (k) Distance to waypoint
- (l) Cross-track error
- (m) Along-track distance
- (n) Hover position stability (lateral drift rate)
- (o) Hover position stability (longitudinal drift rate)

#### **Attitude and Angular Rates**

- (a) Pitch attitude
- (b) Roll attitude
- (c) Yaw attitude (heading)
- (d) Pitch rate
- (e) Roll rate
- (f) Yaw rate
- (g) Body-axis angular accelerations
- (h) Turn coordination (slip/skid)
- (i) Attitude rate of change

#### **Velocity Components**

- (a) Longitudinal airspeed
- (b) Lateral airspeed (sideward velocity)
- (c) Vertical velocity (climb/descent rate)
- (d) Inertial velocity (north, east, down)
- (e) Groundspeed components

#### **Accelerations and Load Factors**

- (a) Longitudinal acceleration
- (b) Lateral acceleration
- (c) Vertical acceleration
- (d) Normal load factor
- (e) Lateral load factor
- (f) Longitudinal load factor
- (g) Peak g during maneuvers
- (h) Vibration-induced acceleration components

#### **Airspeed and Air Data**

- (a) Indicated airspeed
- (b) True airspeed
- (c) Calibrated airspeed
- (d) Never-exceed speed (VNE) margin
- (e) Maximum structural cruising speed margin
- (f) Airspeed in sideward flight
- (g) Airspeed in rearward flight
- (h) Low airspeed warning threshold proximity
- (i) Airspeed at height-velocity diagram boundaries
- (j) Retreating blade stall speed margin
- (k) Autorotation entry airspeed
- (l) Best rate of climb airspeed deviation
- (m) Best angle of climb airspeed deviation
- (n) Best autorotation airspeed deviation
- (o) Outside air temperature
- (p) Total air temperature
- (q) Static air temperature
- (r) Density altitude
- (s) Pressure altitude

## Main Rotor System

### Rotor Speed

- (a) Main rotor RPM (Nr)
- (b) Main rotor RPM rate of change
- (c) Rotor RPM droop during maneuvers
- (d) Rotor RPM overspeed
- (e) Rotor RPM split (dual tachometer comparison)
- (f) Low rotor RPM warning proximity
- (g) High rotor RPM warning proximity
- (h) Rotor RPM during autorotation
- (i) Rotor RPM at touchdown

### Blade and Hub Dynamics

- (a) Main rotor blade flapping angle (if instrumented)
- (b) Lead-lag motion
- (c) Blade pitch angle (collective component)
- (d) Blade pitch angle (cyclic component)
- (e) Rotor disc tilt (longitudinal)
- (f) Rotor disc tilt (lateral)
- (g) Blade track and balance indicators
- (h) Rotor vibration amplitude (vertical)
- (i) Rotor vibration amplitude (lateral)
- (j) Rotor vibration frequency spectrum
- (k) Blade damper pressure or position
- (l) Elastomeric bearing temperature (if equipped)

### Rotor Loads

- (a) Main rotor shaft torque
- (b) Main rotor thrust estimate
- (c) Rotor mast moment (bending)
- (d) Blade root strain (if instrumented)
- (e) Hub shear loads
- (f) Rotor system fatigue cycles accumulated

## Tail Rotor System

- (a) Tail rotor RPM
- (b) Tail rotor gearbox input RPM
- (c) Tail rotor pitch angle
- (d) Tail rotor pedal position
- (e) Tail rotor thrust estimate
- (f) Tail rotor drive shaft torque
- (g) Tail rotor vibration amplitude
- (h) Tail rotor vibration frequency
- (i) Tail rotor gearbox oil pressure
- (j) Tail rotor gearbox oil temperature
- (k) Tail rotor blade track indicators
- (l) Tail rotor authority remaining
- (m) Loss of tail rotor effectiveness proximity

## **Flight Control System**

### **Pilot Inputs**

- (a) Collective lever position
- (b) Collective lever rate of change
- (c) Cyclic stick longitudinal position
- (d) Cyclic stick lateral position
- (e) Cyclic stick rate of change
- (f) Pedal position (left, right)
- (g) Pedal rate of change
- (h) Trim actuator positions
- (i) Force trim release activation
- (j) Beeper trim inputs

### **Control System Response**

- (a) Swashplate position (collective)
- (b) Swashplate position (longitudinal cyclic)
- (c) Swashplate position (lateral cyclic)
- (d) Servo actuator positions (each servo)
- (e) Servo actuator pressures
- (f) Servo actuator electrical current (fly-by-wire)
- (g) Hydraulic boost pressure
- (h) Control system rigging position

- (i) Artificial feel force
- (j) Control friction setting

**Stability Augmentation**

- (a) Stability augmentation system (SAS) engaged
- (b) SAS channel status (pitch, roll, yaw)
- (c) SAS authority usage
- (d) SAS trim rate
- (e) Autopilot engaged
- (f) Autopilot mode (altitude hold, heading hold, hover hold, coupled approach)
- (g) Flight director guidance commands
- (h) Automatic flight control system (AFCS) status
- (i) AFCS servo commands
- (j) Automatic trim function status
- (k) Hover augmentation system status
- (l) Attitude hold engagement
- (m) Heading hold engagement
- (n) Altitude hold engagement
- (o) Airspeed hold engagement
- (p) Coupled approach mode status

**Engine Parameters (Per Engine)****Power and Speed**

- (a) Gas generator speed (Ng or N1)
- (b) Power turbine speed (Np or N2)
- (c) Engine torque
- (d) Torque share between engines (multi-engine)
- (e) Torque split indication
- (f) Contingency power usage
- (g) Maximum continuous power exceedance
- (h) Takeoff power usage duration
- (i) One engine inoperative power margin
- (j) Torque available versus torque required
- (k) Power assurance check values
- (l) Power margin to transmission limit

**Temperature**

- (a) Turbine outlet temperature (TOT)
- (b) Turbine inlet temperature (TIT)
- (c) Interstage turbine temperature (ITT)
- (d) Exhaust gas temperature (EGT)
- (e) Measured gas temperature (MGT)
- (f) Compressor inlet temperature
- (g) Oil inlet temperature
- (h) Oil outlet temperature
- (i) Engine bay temperature

**Pressure and Flow**

- (a) Compressor discharge pressure
- (b) Fuel flow rate
- (c) Fuel used
- (d) Oil pressure
- (e) Oil filter differential pressure
- (f) Fuel filter differential pressure
- (g) Bleed air pressure
- (h) Anti-ice bleed air flow
- (i) Engine inlet pressure

**Engine Health**

- (a) Engine vibration (gas generator)
- (b) Engine vibration (power turbine)
- (c) Vibration spectrum analysis data
- (d) Start time duration
- (e) Start peak temperature
- (f) Engine trend monitoring parameters (delta Ng, delta TOT, delta fuel flow)
- (g) Compressor health indicators
- (h) FADEC/DECU fault codes
- (i) Engine chip detector activation
- (j) Engine hours accumulated
- (k) Cycles since overhaul

## **Transmission System**

### **Main Transmission**

- (a) Main transmission oil pressure
- (b) Main transmission oil temperature
- (c) Transmission chip detector activation
- (d) Transmission vibration amplitude
- (e) Transmission vibration frequency
- (f) Input shaft torque
- (g) Output shaft torque
- (h) Combining gearbox torque split (multi-engine)
- (i) Freewheel unit engagement status
- (j) Overrunning clutch status
- (k) Rotor brake status
- (l) Transmission oil quantity
- (m) Transmission filter bypass indication

### **Intermediate and Tail Rotor Gearbox**

- (a) Intermediate gearbox oil pressure
- (b) Intermediate gearbox oil temperature
- (c) Intermediate gearbox chip detector
- (d) Tail rotor gearbox oil pressure
- (e) Tail rotor gearbox oil temperature
- (f) Tail rotor gearbox chip detector
- (g) Accessory gearbox parameters

## **Drive System**

- (a) Main drive shaft torque
- (b) Tail rotor drive shaft torque
- (c) Drive shaft vibration
- (d) Hanger bearing temperature
- (e) Drive shaft coupling condition indicators

## **Hydraulic Systems**

- (a) Main hydraulic system pressure
- (b) Auxiliary hydraulic system pressure

- (c) Utility hydraulic system pressure
- (d) Hydraulic fluid temperature
- (e) Hydraulic fluid quantity
- (f) Hydraulic pump status (each pump)
- (g) Servo actuator hydraulic pressure
- (h) Accumulator pre-charge pressure
- (i) Hydraulic filter clogging indicator
- (j) Hydraulic system selector position
- (k) Emergency hydraulic system status

## **Electrical Systems**

- (a) Generator output voltage
- (b) Generator output current
- (c) Generator frequency (AC systems)
- (d) Main bus voltage
- (e) Essential bus voltage
- (f) Battery bus voltage
- (g) Battery temperature
- (h) Battery state of charge
- (i) Inverter output status
- (j) Transformer rectifier unit output
- (k) External power connected
- (l) Starter-generator mode
- (m) Load shedding status
- (n) Bus tie status
- (o) Emergency power status
- (p) Current draw by system

## **Fuel System**

- (a) Total fuel quantity
- (b) Fuel quantity per tank
- (c) Fuel flow rate (total)
- (d) Fuel flow rate (per engine)
- (e) Fuel used since start
- (f) Fuel remaining time at current consumption
- (g) Fuel temperature

- (h) Fuel pressure at engine inlet
- (i) Boost pump status
- (j) Transfer pump status
- (k) Crossfeed valve position
- (l) Fuel selector position
- (m) Fuel filter status
- (n) Fuel imbalance (left/right)
- (o) Low fuel warning status

### **Environmental Control and Bleed Air**

- (a) Cabin heating status
- (b) Cabin ventilation status
- (c) Defog system status
- (d) Bleed air source selection
- (e) Bleed air temperature
- (f) Environmental control unit status
- (g) Cabin temperature
- (h) Cockpit temperature
- (i) Avionics cooling status
- (j) Air conditioning pack status (if equipped)

### **Ice Protection**

- (a) Pitot heat status
- (b) Static port heat status
- (c) Engine inlet anti-ice status
- (d) Engine inlet particle separator status
- (e) Windshield anti-ice or defrost status
- (f) Rotor blade de-ice status (if equipped)
- (g) Ice detector status
- (h) Ice accretion rate
- (i) Outside air temperature relative to icing range
- (j) TAT probe heat status

### **Warning and Caution Systems**

- (a) Master caution activation
- (b) Master warning activation

- (c) Engine fire warning
- (d) Engine out warning
- (e) Transmission warning
- (f) Low rotor RPM warning
- (g) High rotor RPM warning
- (h) Overtorque warning
- (i) Overtemperature warning (engine)
- (j) Chip detector warning (engine, transmission, gearboxes)
- (k) Fuel low warning
- (l) Hydraulic pressure low warning
- (m) Generator failure warning
- (n) Altitude alert
- (o) Airspeed alert (VNE approach)
- (p) Height-velocity warning (if equipped)
- (q) Terrain awareness warning system (HTAWS) alerts
- (r) Obstacle warning system alerts
- (s) TCAS/TAS traffic advisories
- (t) Wire strike protection system alerts (if equipped)
- (u) Vortex ring state warning (if equipped)
- (v) Loss of tail rotor effectiveness warning (if equipped)
- (w) Rotor overspeed warning
- (x) Rotor underspeed warning
- (y) Gearbox overheat warning
- (z) Oil pressure low warning
- (aa) Oil temperature high warning
- (bb) Starter engaged warning
- (cc) Door open warning
- (dd) Cargo hook load warning
- (ee) Hoist overload warning

## **Navigation Systems**

### **Radio Navigation**

- (a) VOR bearing and deviation
- (b) ILS localizer deviation
- (c) ILS glideslope deviation

- (d) ADF bearing
- (e) DME distance
- (f) Marker beacon passage
- (g) NDB identification

**Satellite Navigation**

- (a) GNSS position (latitude, longitude, altitude)
- (b) GNSS ground speed
- (c) GNSS track
- (d) GNSS horizontal accuracy estimate
- (e) GNSS vertical accuracy estimate
- (f) Number of satellites tracked
- (g) RAIM status
- (h) SBAS correction status
- (i) GNSS antenna status

**Area Navigation**

- (a) FMS/RNAV active waypoint
- (b) Cross-track deviation
- (c) Vertical deviation from profile
- (d) Required navigation performance value
- (e) Actual navigation performance
- (f) Estimated time to waypoint
- (g) Estimated fuel at waypoint

**Radar and Sensors**

- (a) Weather radar tilt and gain settings
- (b) Weather radar returns (if recorded)
- (c) Radar altimeter reading
- (d) Radar altimeter rate of change
- (e) Terrain awareness data
- (f) Obstacle database alerts
- (g) Synthetic vision data (if equipped)

**Communication Systems**

- (a) VHF radio frequency selected

- (b) UHF radio frequency selected (military/SAR)
- (c) HF radio frequency selected
- (d) Transponder code
- (e) Transponder mode
- (f) ADS-B out status
- (g) TCAS/TAS mode
- (h) Emergency locator transmitter status
- (i) Intercom status
- (j) Crew communication keying events
- (k) SATCOM status (if equipped)
- (l) Datalink message events

## **External Load and Hoist Operations**

### **Cargo Hook**

- (a) Cargo hook load (tension)
- (b) Cargo hook status (armed, released)
- (c) Manual release activation
- (d) Electrical release activation
- (e) Emergency release activation
- (f) Hook suspension angle
- (g) Load swing detection
- (h) Cable/strap angle
- (i) Cargo mirror or camera status

### **Rescue Hoist**

- (a) Hoist cable tension
- (b) Hoist cable length deployed
- (c) Hoist cable speed (up/down)
- (d) Hoist motor current
- (e) Hoist limit switch status (up, down)
- (f) Hoist brake status
- (g) Hoist mode (manual, automatic)
- (h) Personnel on hoist indicator
- (i) Hoist overload indication
- (j) Dual hoist synchronization (if equipped)

**Sling Load**

- (a) Sling load weight
- (b) Load oscillation frequency
- (c) Load swing amplitude
- (d) Release command

**Landing Gear and Ground Contact**

- (a) Landing gear position (extended, retracted, in transit)
- (b) Gear selector position
- (c) Weight on wheels (each gear)
- (d) Skid/wheel ground contact
- (e) Touchdown vertical velocity
- (f) Touchdown longitudinal velocity
- (g) Touchdown lateral velocity
- (h) Touchdown rotor RPM
- (i) Touchdown collective position
- (j) Touchdown cyclic position
- (k) Ground resonance vibration detection
- (l) Parking brake status
- (m) Wheel brake pressure (wheeled helicopters)
- (n) Tire pressure (if monitored)
- (o) Ski or float status (if equipped)
- (p) Emergency flotation deployment status

**Structural and Fatigue Monitoring**

- (a) Main rotor mast loads
- (b) Tail boom loads
- (c) Cabin frame loads
- (d) Landing gear loads
- (e) Dynamic component life tracking
- (f) Rotor hub fatigue cycles
- (g) Blade retention hardware cycles
- (h) Transmission mount loads
- (i) Vertical fin loads
- (j) Horizontal stabilizer loads

- (k) Sponson or stub wing loads (if applicable)
- (l) Hard landing detection (g threshold)
- (m) Ground resonance cycle accumulation
- (n) Cumulative damage index
- (o) Component hours and cycles since new
- (p) Component hours and cycles since overhaul

## **Vibration Monitoring**

- (a) Main rotor 1-per-rev vibration
- (b) Main rotor n-per-rev vibration (blade passage frequency)
- (c) Tail rotor vibration signature
- (d) Fuselage lateral vibration
- (e) Fuselage vertical vibration
- (f) Cockpit vibration levels
- (g) Cabin vibration levels
- (h) Transmission case vibration
- (i) Engine case vibration
- (j) Drive shaft vibration
- (k) Spectral analysis data (FFT)
- (l) Vibration trend over time
- (m) Abnormal vibration signature detection

## **Health and Usage Monitoring System (HUMS)**

Many modern helicopters incorporate dedicated HUMS that track:

- (a) Component remaining useful life estimates
- (b) Gearbox health indicators
- (c) Bearing wear indicators
- (d) Oil debris monitoring (quantitative)
- (e) Chip detector particle counts
- (f) Mechanical diagnostics codes
- (g) Trend exceedance flags
- (h) Maintenance action recommendations
- (i) Regime recognition (flight phase)
- (j) Severity factor accumulation
- (k) Mission profile characterization

- (l) Exceedance event logs with context

## **Mission-Specific Parameters**

### **Emergency Medical Services (EMS)**

- (a) Patient compartment equipment power status
- (b) Medical equipment interference monitoring
- (c) Cabin altitude for patient care
- (d) Oxygen system status
- (e) Vibration levels in patient compartment
- (f) Landing site approach parameters

### **Search and Rescue (SAR)**

- (a) Searchlight position and status
- (b) FLIR/EO sensor status and pointing angle
- (c) Search pattern track adherence
- (d) Time on station
- (e) Hover endurance remaining
- (f) Hoist operations parameters
- (g) Swimmer deployment status

### **Offshore Operations**

- (a) Helideck approach path adherence
- (b) Deck motion compensation data (if equipped)
- (c) Emergency flotation system armed status
- (d) Passenger manifest tracking
- (e) Fuel uplift records
- (f) Distance from shore
- (g) Weather conditions at destination platform

### **Aerial Work (Firefighting, Construction, Utility)**

- (a) Bucket or tank water load
- (b) Drop command and timing
- (c) Spray system status
- (d) Bucket cable tension
- (e) Longline length and load
- (f) Precision hover position accuracy

- (g) Time in high-power operations
- (h) Repetitive cycle tracking

### **Law Enforcement**

- (a) Searchlight status and aim
- (b) Sensor turret position
- (c) Tactical communication status
- (d) Pursuit tracking parameters
- (e) Loiter time and pattern

### **Weight and Balance**

- (a) Gross weight (computed or entered)
- (b) Empty weight
- (c) Payload weight
- (d) Fuel weight
- (e) External load weight
- (f) Longitudinal center of gravity position
- (g) Lateral center of gravity position
- (h) Vertical center of gravity estimate
- (i) CG envelope compliance
- (j) CG shift during fuel burn
- (k) CG shift during external load release
- (l) Weight at takeoff
- (m) Weight at landing

### **Performance Monitoring**

- (a) Power required versus power available
- (b) Hover ceiling (in ground effect)
- (c) Hover ceiling (out of ground effect)
- (d) Climb rate capability
- (e) Single-engine climb capability
- (f) Takeoff distance required
- (g) Landing distance required
- (h) Fuel consumption rate versus plan
- (i) Range remaining at current consumption
- (j) Endurance remaining

- (k) Height-velocity envelope position
- (l) Autorotation performance parameters
- (m) Category A/B takeoff compliance (if applicable)
- (n) Rejected takeoff decision point data
- (o) Continued takeoff decision point data

## **Autorotation Parameters**

- (a) Autorotation entry altitude
- (b) Autorotation entry airspeed
- (c) Autorotation entry rotor RPM
- (d) Rotor RPM decay rate after power loss
- (e) Rotor RPM management during descent
- (f) Rate of descent in autorotation
- (g) Autorotation airspeed maintenance
- (h) Flare initiation altitude
- (i) Flare pitch attitude
- (j) Collective pull timing
- (k) Touchdown parameters in autorotation
- (l) Time from power loss to collective reduction
- (m) Energy management during autorotation

## **Hover and Low-Speed Flight**

- (a) Hover altitude (radar altimeter)
- (b) Hover groundspeed
- (c) Hover drift rate (lateral)
- (d) Hover drift rate (longitudinal)
- (e) Hover torque required
- (f) Hover in ground effect versus out of ground effect
- (g) Hover ceiling margin
- (h) Hover turns (pedal turn rate)
- (i) Sideward flight speed
- (j) Rearward flight speed
- (k) Taxi groundspeed
- (l) Collective position in hover
- (m) Cyclic position in hover
- (n) Pedal position in hover

- (o) Hover time accumulated

## **Approach and Landing**

- (a) Approach angle
- (b) Approach speed
- (c) Rate of descent on approach
- (d) Deceleration rate
- (e) Flare height
- (f) Flare angle
- (g) Collective timing during flare
- (h) Touchdown point relative to intended spot
- (i) Touchdown speed
- (j) Touchdown vertical velocity
- (k) Touchdown heading alignment
- (l) Touchdown attitude (pitch, roll)
- (m) Rotor RPM at touchdown
- (n) Ground contact parameters
- (o) Slope landing detection
- (p) Pinnacle/confined area parameters
- (q) Running landing parameters (if applicable)

## **Takeoff Parameters**

- (a) Takeoff gross weight
- (b) Takeoff density altitude
- (c) Takeoff wind conditions
- (d) Hover power check values
- (e) Cushion takeoff parameters
- (f) Running takeoff parameters
- (g) Vertical takeoff parameters
- (h) Takeoff decision point compliance
- (i) Initial climb rate
- (j) Initial climb airspeed
- (k) Power application rate
- (l) Torque at liftoff
- (m) Rotor RPM at liftoff
- (n) Obstacle clearance margin

**Environmental and Weather**

- (a) Outside air temperature
- (b) Pressure altitude
- (c) Density altitude
- (d) Wind speed (computed)
- (e) Wind direction (computed)
- (f) Headwind/tailwind component
- (g) Crosswind component
- (h) Turbulence encounter (g deviation)
- (i) Windshear detection
- (j) Visibility (if sensor equipped)
- (k) Cloud base (if sensor equipped)
- (l) Precipitation rate (if sensor equipped)
- (m) Icing conditions indicator
- (n) Temperature deviation from ISA

**Crew Actions and Operational Events**

- (a) Engine start initiation
- (b) Engine start completion
- (c) Rotor engagement
- (d) Rotor brake release
- (e) Liftoff event marker
- (f) Touchdown event marker
- (g) Flight phase transitions
- (h) Autopilot engagement/disengagement
- (i) Stability augmentation changes
- (j) Collective input events
- (k) Cyclic input events
- (l) Pedal input events
- (m) Trim changes
- (n) Go-around initiation
- (o) Emergency procedure initiations
- (p) External load pickup
- (q) External load release
- (r) Hoist deployment

- (s) Hoist retrieval
- (t) Door open/close events
- (u) Passenger embarkation/disembarkation (if sensed)
- (v) Mission equipment activation

## **Recording System and Metadata**

- (a) UTC date and time
- (b) GNSS time
- (c) Flight number or mission identifier
- (d) Aircraft registration
- (e) Aircraft serial number
- (f) Operator identifier
- (g) Crew identifiers
- (h) Departure location
- (i) Destination location
- (j) Intermediate landing locations
- (k) Flight phase marker
- (l) Data validity flags per parameter
- (m) Sample rate per parameter
- (n) Recording frame counter
- (o) Data dropout indicators
- (p) CVFDR operating status
- (q) Quick access recorder status
- (r) HUMS recorder status
- (s) Data download confirmation

## **Derived and Computed Parameters**

Beyond direct sensor measurements, helicopter FDM programs often calculate:

- (a) Power margin (available minus required)
- (b) Torque margin
- (c) Rotor RPM stability index
- (d) Maneuver severity rating
- (e) Vibration health index
- (f) Fuel efficiency metrics
- (g) Mission profile characterization

- (h) Exceedance severity scores
- (i) Fatigue damage accumulation
- (j) Component life consumption rate
- (k) Stabilized approach index
- (l) Hover stability index
- (m) Autorotation readiness index
- (n) Emergency landing site reachability
- (o) Vortex ring state risk indicator
- (p) Loss of tail rotor effectiveness risk indicator
- (q) Settling with power risk indicator
- (r) Dynamic rollover risk margin
- (s) Ground resonance proximity
- (t) Retreating blade stall margin
- (u) Mast bumping risk (teetering rotor)
- (v) Height-velocity envelope margin

## **Exceedance Detection Categories for Helicopters**

Specific thresholds monitored include:

### **Rotor System Exceedances**

- (a) Nr below minimum
- (b) Nr above maximum
- (c) Nr droop beyond limit
- (d) Nr rate of change excessive
- (e) Rotor overspeed
- (f) Rotor underspeed in autorotation
- (g) Tail rotor RPM exceedance

### **Torque and Power Exceedances**

- (a) Torque above maximum continuous
- (b) Torque above takeoff limit
- (c) Contingency power usage time exceeded
- (d) Single-engine torque limit exceeded
- (e) Transient torque spike
- (f) Torque split beyond limit

### **Temperature Exceedances**

- (a) TOT/TIT/ITT above takeoff limit
- (b) TOT/TIT/ITT above maximum continuous limit
- (c) Transmission oil temperature high
- (d) Gearbox temperature high
- (e) Engine oil temperature high

### **Flight Envelope Exceedances**

- (a) VNE exceeded
- (b) Sideward airspeed limit exceeded
- (c) Rearward airspeed limit exceeded
- (d) Bank angle excessive
- (e) Pitch attitude excessive
- (f) Descent rate excessive
- (g) Load factor exceeded
- (h) Height-velocity curve penetration

### **Landing Exceedances**

- (a) Hard landing (vertical g)
- (b) Touchdown drift excessive
- (c) Slope landing limit exceeded
- (d) Rotor RPM low at touchdown
- (e) Ground resonance detection

## Appendix D — Means of demonstrating compliance

- (1) There is currently no requirement for Transport Canada to approve or accept an operator's FDM program. There is a requirement for Transport Canada to verify that applicable operators have an FDM program. Operators who are required to have an FDM program under the CARs or under an IO must submit details of their FDM policies and procedures to their POI. This may be done via e-mail using CR COM 705 which can be obtained from the operator's POI. The POI will then verify the details of the operator's FDM policies and procedures. The following contains criteria for determining that an operator has an FDM program that meets the regulatory requirements.
  - (a) The FDM program must establish standard operating parameters from which deviations from those parameters can be detected and measured.
  - (b) The FDM program must have procedures to determine if a flight deviated from a standard operating parameter defined by the air operator.
  - (c) The FDM program must allow operational risks to be identified by highlighting occurrences of non-standard or unsafe deviations from the standard operating parameters.
  - (d) The FDM program must contain procedures for any corrective actions to be taken after an operational risk is identified.
- (2) A review of FDM program policies and procedures should include verification that:
  - (a) The operator's applicable aircraft should be equipped to have a means to support FDM. This may include, but is not limited to, an on-board device to capture and record data of in-flight parameters and a means to transfer the data to a ground-based processing station.
  - (b) The operator should have access to a ground-based processing station to process the data. This can be outsourced to a third party. The processing station should have software to check the data for abnormal occurrences and exceedances.
  - (c) The FDM program should be non-punitive. The operator must have a policy for the internal reporting of a hazard, incident or accident, including the conditions under which immunity for disciplinary action will be granted. This policy should include reports, hazards, incidents and accidents identified through FDM data. As indicated in AC 107-001, a non-punitive approach to safety reporting does not preclude the use of a general approach to discipline in cases where an employee is involved in similar, recurrent events or where the event was wilful, deliberate or negligent on the part of the individual involved and the attendant circumstances.
  - (d) The FDM program must be integrated into the operator's safety management system. Operators may have some variation in how FDM data is integrated into the safety management system. Examples of preliminary indicators of compliance with the requirement to have an FDM program that is integrated into the company SMS may include:
    - (i) there is a confidential reporting system where FDM data is used to capture errors, incidents and hazards that includes the conditions under which immunity from disciplinary action will be granted;
    - (ii) the process identifies how FDM reports are actioned and timescales are specified and addressed;
    - (iii) there is a process to identify and evaluate operational risks by highlighting occurrences of non-standard or unsafe circumstances discovered through FDM;

- (iv) there is a process in place to analyze FDM data to look for trends and gain useable safety management information;
  - (v) safety investigations in response to events identified by FDM are carried out by appropriately trained personnel to identify causal and contributing factors;
  - (vi) there is a process for the management of risks and hazards identified or monitored through FDM that includes the analysis and assessment of risks associated with hazards expressed in terms of likelihood and severity (or alternative methodology);
  - (vii) with respect to data collected by FDM, there are criteria for the level of risk that the organization is willing to accept and risk assessments and ratings are appropriately justified; and
- (e) An operator should have a written policy for the protection of safety data and safety information that includes FDM data.
- (f) The FDM program should have adequate safeguards to protect the source(s) of the data. This includes but is not limited to:
  - (i) data access and security policy to restrict information access to authorized persons; and
  - (ii) a formal agreement or policy between the management and flight crew should be in place to protect the source of the data
- (g) If integrated into the FDM program, the FDM policy should include description of use of cockpit voice recorder (CVR) and if installed and used cockpit audio recording system (CARS) and airborne image recording system (AIRS). This policy must be in alignment with the *Canadian Transportation Accident Investigation and Safety Board Act*, Section 28 (1) and (2).
- (h) All of the following processes should be included in the operator's FDM program:
  - (i) aircraft data recording
  - (ii) data extraction and transfer
  - (iii) data processing and event detection
  - (iv) safety analysis
  - (v) de-identification and aggregation
  - (vi) safety trend monitoring
  - (vii) corrective action and safety improvements
  - (viii) deletion or archival of raw data