AEROSPACE INDUSTRIES ASSOCIATION

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Best Practices Guide

Inspection Processes following High Load Events

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1.0 Purpose

This document provides recommended practices that may be used by airplane manufacturers when developing maintenance manuals, or by operators when adapting those manuals for their operation. Specifically, this document outlines recommended inspection processes following certain high load events. These particular high load events are those for which the subsequent inspection process might benefit from the use of flight data. Listed below are the conditions deemed most significant, however, this guidance material might also be useful for other events at the OEM's discretion.

Flight

- A severe turbulence encounter
- Extreme maneuvering
- Exceedance of speed limitations
- Heavy stall buffet

Ground

- Hard landings
- Over-weight landings
- Drift landings resulting in excessive side/drag load

These high load events are a subset of events for which instructions are typically specified in maintenance manuals. The objective of these instructions is to detect aircraft damage following an in-service flight or ground event. These instructions are typically referred to as Unscheduled Maintenance or Special Inspections, and are included in Chapter 5 of the maintenance manual. While there are many conditions that can result in high loads on the airframe and subsequent structural damage, the use of flight data in the inspection process is considered particularly beneficial for the events identified above.

The inspection processes recommended herein should be reflected in the maintenance manual instructions developed by the manufacturer. These processes address 1) appropriate indication that an event has occurred, 2) evaluation of the severity of the event, and 3) coordination with the manufacturer, as appropriate.

2.0 Applicability

This document applies to transport category airplanes, regardless of their type of operation, that are required to have flight data recorders. The recommendations provided in this document are intended for use in the development of maintenance manuals on future airplane programs. Current airplanes may not have the proper technology to take advantage of this document as a whole, but portions of this document may be used by manufacturers and operators to enhance their existing maintenance manuals.

Composite materials have different inspection processes than metallic materials. In particular, some types of damage to composite materials may not be discernable by visual inspection. This guide does not address how to inspect composite or metallic materials, but it does provide an overall process that is appropriate regardless of whether the structure is metallic or composite.

3.0 Related Documents

Industry Publications

- Air Transport Association iSpec 2200 (or later revision): Information Standards for Aviation Maintenance.

U.S Civil Certification Requirements

- 14 CFR Part 25
  - Section 25.1529 and Appendix H - Instructions for Continued Airworthiness.
  - Subpart C - Structural Design Load Requirements.
- 14 CFR Part 21
  - Section 21.3 - Reporting of failures, malfunctions, and defects.

U. S. Civil Operating Requirements

- 14 CFR Part 121 (similar requirements in Parts 91, 125, 129 and 135)
  - Section 121.135 - Contents of operations and maintenance manuals.
  - Sections 121.343, 121.344, and related appendices - Flight data recorders.
  - Section 121.703 - Mechanical reliability reports.
  - Section 121.705 - Mechanical interruption summary report.
  - Section 121.707 - Alteration and repair reports.

FAA Guidance Material

- Advisory Circular 120-16D, Air Carrier Maintenance Programs.

4.0 Table of Contents

5.0 List of Acronyms

AIA	Aerospace Industries Association
AMM	Aircraft Maintenance Manual
ATA	Air Transport Association
CFR	Code of Federal Regulations
CG or cg	Center of Gravity
DFDR	Digital Flight Data Recorder
DFDAU	Digital Flight Data Acquisition Units
FAA	Federal Aviation Administration
FDR	Flight Data Recorder
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer

6.0 Background

This guide was developed in response to National Transportation Safety Board (NTSB) Safety Recommendations A-00-103, A-03-41, A-03-42, A-03-43, & A-03-44. The recommendations address NTSB concerns that aircraft may encounter high load events during which structural damage occurs and the damage may not be found before returning the aircraft to service.

At the request of the FAA, a joint industry and FAA committee was formed under the auspices of the Aerospace Industries Association (AIA) and the Air Transport Association (ATA). The committee included industry representatives from airframe manufacturers and aircraft operators. The FAA team members included representatives from Aircraft Certification and Flight Standards.

The committee evaluated existing special inspection procedures for high load events. Emphasis was placed upon whether the process was robust enough to:

1. Identify that a high load event had occurred.
2. Assure that indications of structural damage would be found in an initial inspection.
3. Adequately involve the OEM if necessary.
4. Provide a process for additional inspections that would identify all of the structural damage.
5. Provide a process for aircraft return to service.

As a result of its work, the committee has concluded that, for the most part, the procedures that are currently in place do meet the above five criteria. However, there are areas where improvements can be implemented, in particular for future aircraft. This guide contains the committee recommendations for such improvements.

7.0 Evaluation of Current Procedures for High Load Events

The committee has reviewed the current AMM Chapter 5 Special Inspection Procedures for several aircraft models. The models include business jets, and narrow and widebody commercial jet aircraft. Table 7.1 provides a summary of the high load events that were included in those procedures. For the majority of these events, the committee believes that current practice is adequate.

The committee has also reviewed the overall procedures used at each of the OEMs and operators represented on the committee. In addition, the perspectives of FAA Aircraft Certification and Flight Standards were considered.

While accomplishing its evaluation, the committee made observations in two significant areas as follows:

1. <u>Determination that a high load event has occurred</u>

Currently, the pilot is relied upon to report that a high load event has occurred. However, it is often difficult for the pilot to evaluate the severity of the event. Some events are straight forward, but other events involve a large number of parameters. As such, if the pilot must often rely upon a "seat of the pants" feel or visual observation, they may either overestimate or underestimate the severity of event. As a result, an aircraft may be inspected unnecessarily or the need for an inspection may not be identified.

The committee found that, particularly in the future, aircraft flight data could be used to increase the crew's situational awareness and lead to more accurate reporting. It is also a valuable tool for use by the operator and OEM in evaluating a potential high load event.

There are many issues involved with flight data such as:

- prompt availability and communication to the pilot and other stakeholders
- measurement of the proper parameters
- measurement of those parameters with sufficient resolution to adequately quantify the magnitude of the event.

Inadequate resolution in the data can result in two different problems as follows:

- The need for an inspection may not be identified because the maximum recorded value of the measured parameter(s) may be significantly less than the actual peak values.
- When there is uncertainty regarding actual peak values, conservatism is necessary in order to envelop the upper boundary of what may have occurred. The resulting conservatism can lead to unnecessary inspections. In addition, it can lead to assumptions that may direct the investigation away from areas where damage has actually occurred.

Another issue with flight data is the setting of appropriate thresholds for the various types of high loading events. Where a large number of parameters are necessary to define the magnitude of the load event, the algorithm for setting thresholds becomes complicated, but such algorithms can play an important part in the process.

The above issues and findings are addressed in this guide.

2. <u>Process subsequent to determination that a high load event has occurred</u>

Current AMM special inspection processes typically include a phased inspection. The first inspection is based upon the type of high load event that has occurred. It is aimed at a limited inspection of areas that are indicators that a high load event has occurred and that damage in other areas may be present.

The committee determined that it is advisable to supplement the inspection process in the case of an extremely high load event that is well in excess of the limit design strength. The committee has developed such a process with the goal of enhancing aircraft safety while not being unnecessarily burdensome to the aircraft operators and the aircraft OEM. In addition, the process addresses the roles of both the OEM and the operator while recognizing that the operator is responsible for making the determination that the aircraft can be safely returned to service. That process is reported in this guide.

Table 7.1

Sampling of AMM Special Inspections

FLIGHT	LANDING	GROUND OPERATIONS
Severe Turbulence Encounter Stall, Buffet Severe Maneuvers Exceed AFM Limits Extreme/Excessive Maneuvers Exceedance of Maneuver Nz Flight High Lateral Loads Unusual Flight Attitudes Bank angle Exceedance Flap/Slat Overspeed Landing Gear Limit Speed Exceeded Exceedance of Vmo/Mmo Slat Sys after Torq Lim Trip in combo with slat interconnect fuse failure Rudder Control Sys Malfunction Cabin Pressure Differential Exceedance Cabin Decompression Engine Failure / Seizure Engine Side Loads Engine Vibe Engine Shock Load Nacelle after excess vib or partial sudden engine stoppage Fan Blade Out Engine windmilling (in flight shut down) Powerplant Over torque Engine Overspeed Compressor Stall or Surge Air Driven Gen Deployment Airframe Vibration	Hard/Overweight Landing High Drag/side Load Landing Landing with Fuel in Trim Tank Landing Short of Runway Landing with Excess Fuel or Excess Fuel Imbalance ------ Gear, but not landing specific------- Failure of Wheel or Tire Tire Burst, Fuse Release or Tread Throw Brake Overheat/Emerg Application/RTO	Aircraft Steering Angle Exceeded NLG towing overload or overrun Aircraft departure from runway or taxiway (including bearing surface failure and aircraft penetration) Overweight Taxi High Drag/side Load - Ground Ops Towing with Large Fuel Imbalance Very High wind Gust Inspection Gear Insp after Excessive Braking - RTO NLG after severe braking during turn Tail strike Replacement of Flap Actuator following Jam &Panel Skew Track roller & pin after impact Replacement of Slat Track roller & pin after impact Wing Strike Prop Strike Dragged Engine Nacelle

8.0 Aircraft Inspection Process

8.1 General

Specific inspections may be required when the pilot reports a high load flight or ground event. Aircraft damaged during ground handling will usually be reported by maintenance or ground handling personnel and may require inspections dependent on the event.

Aircraft Maintenance Manual (AMM) Chapter 5 should spell out inspections required after certain flight, landing, or ground events that may be critical to the airworthiness of the aircraft. Inspections should follow a progressive, two (or more) phase approach, where the first phase of the inspection may trigger a second phase based on inspection findings. The second phase would be a more detailed inspection and may include OEM contact.

Phase 1 AMM inspections should be developed to inspect known structural fuses or areas known to be early or typical indicators in these events. If event related damage is noted in the Phase 1 inspection, then the AMM should provide additional inspections in Phase 2 that would be required to ensure airworthiness.

Phase 2 AMM inspections are more detailed and inspect areas that are suspected to have damage. If there are findings in Phase 2, there may be a instructions to contact the OEM since additional actions may be required. In cases where the OEM knows the effects of the event, the OEM may not require any additional inspections.

For any event where exposure to high load levels is suspected, it would benefit the operator to provide flight data when possible to the OEM, who is best able to recommend specific maintenance actions, if any are needed. Ultimately, it is the operator's responsibility to maintain the airworthiness of the aircraft and return the aircraft to service in an airworthy state.

8.2 Unique Process for High Load Events

This document describes a unique process that should be considered for certain high load events. These particular high load events are those for which the subsequent inspection process might benefit from the use of flight data. For these events, AMMs should include instructions for event assessment as outlined in sections 8, 9 and 10. These events may include, but are not limited to the following:

Flight

- A severe turbulence encounter
- Extreme maneuvering
- Exceedance of speed limitations
- Heavy stall buffet

<u>Ground</u>

- Hard landings
- Over-weight landings
- Drift landings resulting in excessive side/drag load

8.3 Inspection Procedure Flowchart

For the events specified above, the Figure 8.1 Inspection Process Flow Chart is intended to describe the activities recommended in cases of exposure to high loads. The committee recommends that OEMs and operators use this figure and the accompanying description of this section to develop the AMM Chapter 5 requirements for special inspections. It is not intended that this flow chart should appear in the AMM.

The discriminating criterion is a threshold value for selected parameters from the aircraft's flight data system. Here, two threshold values are recommended; a low threshold level indicating possible excursions at or near limit load values, and a high threshold value indicating possible excursions significantly above limit load. Since actual values are a function of aircraft design, they will be determined by the OEM. In cases where measured parameters are below established threshold levels, no action is recommended and the aircraft is returned to service. In cases where levels are above the low threshold but below the high threshold, the operator executes a series of phased inspections according to the AMM. In cases where levels are at or above the high threshold level, the OEM is contacted and works closely with the operator assisting in event analysis and recommended actions.

The process diagram is color-coded. The red activities are those activities involved in identifying an event. The blue activities are activities executed by the operator. Yellow activities are executed by the OEM. Finally, gray activities are activities requiring close coordination between OEM and operator.

The most important link in the process is continual feedback between the OEM, Operators and the FAA. The process begins with the pilot reporting events, continues with the operator providing feedback to the OEM and the OEM/Operator reporting legitimate events through existing regulatory requirements.

<u>Identifying and Assessing an Event: Activities 1 thru 4</u>

The primary responsibility for identifying an event lies with the pilot. In this process, the pilot's evaluation of potential events could be enhanced using selected outputs from the flight data system presented on suitable displays. These are aids to the crew in determining the severity of the aircraft event. It is possible for an event to be identified based only on the pilots "feel" regardless of the data indications. This allows for data malfunctions and cases where the required data is not available to the crew. Once an event is identified, the assessment begins. Assessment involves querying the flight data system, if available, and assembling any event reports available. Flight data output is compared to appropriate threshold values, if they are defined, and action is taken accordingly.

Data Below the Low Threshold (if defined): Activity 5

As described in section 9, the AMM may or may not include a low threshold. The low threshold provides a basis for avoiding an inspection, should that low threshold not be reached. Therefore, a low threshold should only be established for those events where a review of the specified data can reliably predict whether or not structural damage has occurred.

Data Above the Low Threshold and Below the High Threshold or if the Threshold Exceedance is Unknown: Activities 5 thru 12

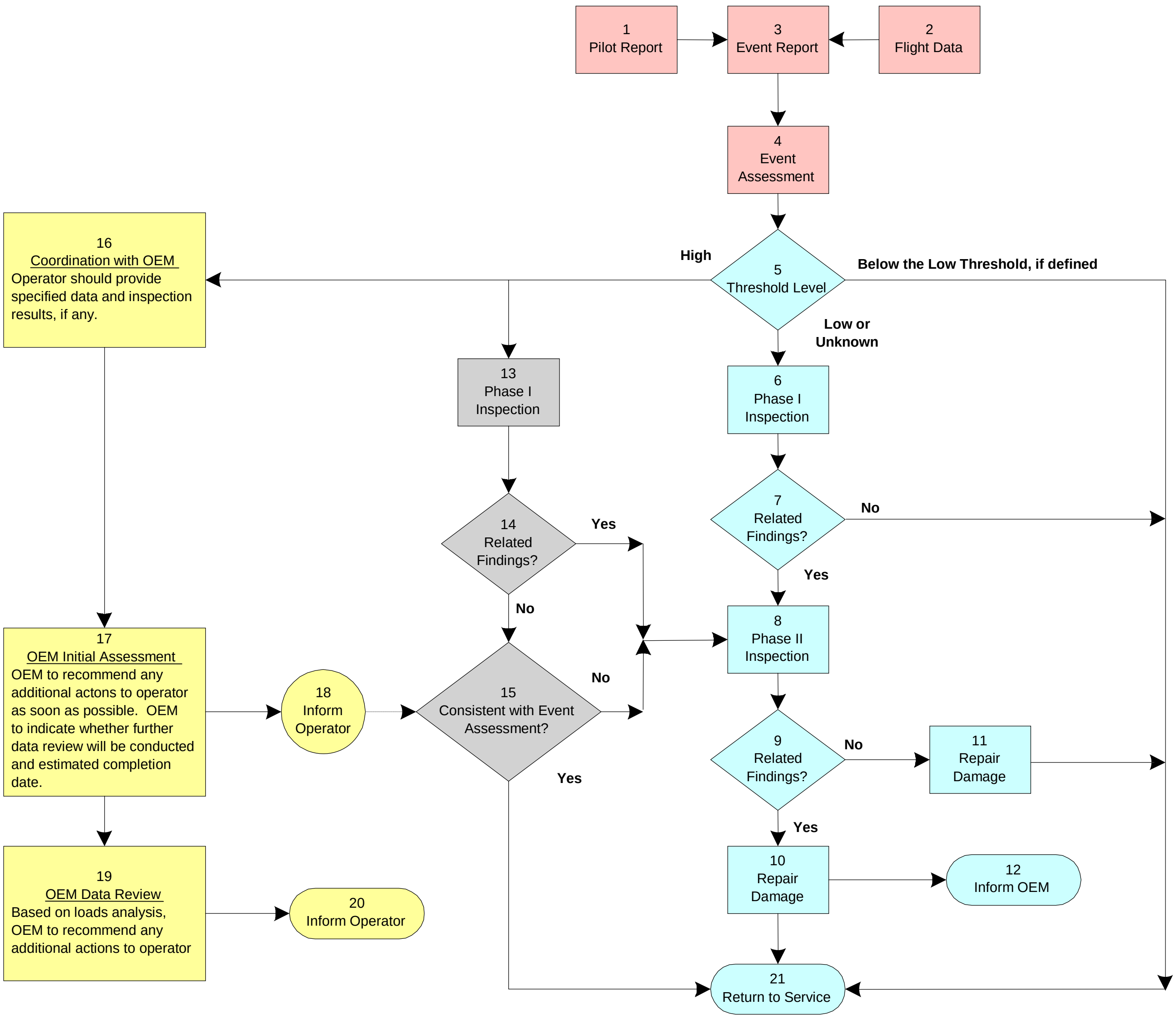
The operator executes a phase I inspection (6) according to the AMM. If no damage is found, the aircraft is returned to service (21). If there are related findings, a Phase II inspection is conducted (8). If there are no further related findings (9), any damage detected during (6) is repaired and the aircraft is returned to service (21). If there are related findings, all of the damage is repaired (or a grace period can be granted) (10), the OEM is informed (12) and the aircraft is returned to service (21). This procedure is also followed in the absence of any data to compare to the threshold or in absence of any specified threshold.

Data Above the High Threshold: Activities 13 thru 20

A series of concurrent activities is initiated. A phase I inspection is started (13). The OEM is contacted (16). The OEM is made aware of the nature of the event and any applicable data is provided as soon as available. Phase I inspection results are provided as soon as they are available. The OEM begins an initial assessment (17). A preliminary assessment is made, the need for any further data assessment is identified, and the OEM indicates when a final determination will be made, possibly accompanied by additional inspection activities. In the meantime, results of the phase I inspection are reviewed (14). If there are related findings, the process continues as described above at activity (8), a phase II inspection. If there are no related findings, coordination of any OEM analyses (18) and operator information are all reviewed to make sure the absence of detected damage is consistent with all the remaining information (15). If so, the aircraft is returned to service (21). If not, proceed directly to the phase II inspection, (8). At the conclusion of the phase II inspection, the OEM may have concluded any further review (19), and if so, these analyses should be reported and reviewed before proceeding. If there are not additional activities defined, then the aircraft is returned to service (21) after any damage is repaired either at (10) or (11), and a report is forwarded to the OEM (12). The OEM response (20) may be available after return to service and would need to be addressed by the operator at that time.

All of the above steps should be reflected in the AMM instructions, which are, of course, intended for the operator. However, the steps outlined herein also include OEM actions. Therefore, the AMM should also outline OEM involvement in the process as described above.

Figure 8.1 Inspection Process Flow Chart



9.0 Evaluation of High Load Event Measured Data

9.1 Flight Events

9.1.1 Event types

This document applies to high load events for which the subsequent inspection process might benefit from the use of flight data. This may include, but is not limited to the following flight events:

- A severe turbulence encounter
- Extreme maneuvering
- Exceedance of speed limitations
- Heavy stall buffet

9.1.2 Event Criteria

Often there are no quantitative criteria provided by the AMM to evaluate the severity of flight events, and the essential element needed to initiate maintenance action is a pilot report based on subjective assessment. The committee recognizes the value of, and wishes to preserve, an approach where the pilot is always able to make a judgment that maintenance action should be initiated following an unusual event.

In other cases, a simple metric, for example, the value of a single parameter such as normal load factor, is defined by the AMM and used by the operator to aid in the declaration of an event. These data, whether obtained from the flight data system or from pilot observation of cockpit instrumentation, are suitable for a rapid determination that a potential high load situation might have occurred. However, the data currently employed, while valuable at the initial assessment phase, do not necessarily provide confirmation that an excessive structural load has in fact occurred, nor do they necessarily provide adequate information on the severity of an event relative to the limit and ultimate structural strength capability.

In line with the capabilities of currently available systems and the further recommendations for flight data systems as presented in section 10, the committee believes that AMM improvements are possible with respect to:

1. The introduction of additional objective criteria in the AMM using flight data (if available) to assist in the evaluation of events previously considered only subjectively.
2. The development of low and high threshold levels by the manufacturer.
3. The development of refined algorithms by the manufacturer that use multiple data parameters to arrive at improved evaluations of the severity of the loads actually experienced, and corresponding required actions.

Even with improved AMM procedures and increased access to flight data, most operators alone may not have sufficient information for establishing reliable structural loads for all events, because it is unlikely that algorithms can be developed which would be sufficiently robust to predict loads in all situations. Estimated exceedances at the high-threshold load level should result in the involvement of the OEM.

Some specific opportunities exist for the development of improved AMM criteria with respect to flight events, which we recommend for consideration by the manufacturers:

(i) *Effects of Airplane Weight* and CG: Although airplane weight and cg are fundamental determinants of structural loads in flight maneuvers and turbulence, they have traditionally not been referenced in the AMM, nor used during Phase I evaluations. Weight and cg are not parameters recorded on the flight data system, but it is relatively easy to obtain an estimated value based on the dispatch manifest and recorded fuel load. Since the load on many structural elements that are critically loaded by aerodynamic forces is proportional to the product of weight and airplane acceleration, improved accuracy of load estimation would result. For structural mass items primarily loaded by inertia, the aircraft acceleration would remain the relevant parameter.

(ii) *Consider all Directions of Loading*: Separate limitations should be presented for positive and negative symmetric maneuvering, as well as for lateral maneuver loading. At the basic level, this would be represented by a maximum allowable 'g' at the aircraft center of gravity, although a manufacturer might elect to develop additional or alternative threshold criteria including aircraft weight, control surface position, angular acceleration, or any other relevant parameter.

(iii) *Consider Dynamic Maneuvering*: High load conditions could occur on the control surfaces or other structure during dynamic maneuver transients involving large and rapidly alternating control inputs. These dynamic maneuvering conditions could result in locally critical loads even if the primary thresholds for aircraft center of gravity accelerations are not exceeded. The AMM should specifically address the need for maintenance action following dynamic maneuvering events.

9.2 Landing Events

9.2.1 Event Types

This document applies to high load events for which the subsequent inspection process might benefit from the use of flight data. This may include, but is not limited to the following ground events:

- Hard landings
- Over-weight landings
- Drift landings resulting in excessive side/drag load

These events are associated with high loads in the landing gear and, potentially, the entire structure. A number of other events which may be related to heavy landing, such as tail strike, tire burst and tread separation have usually been addressed separately.

Critical loads may occur locally in landing gear and airframe structure when landing at less than design vertical impact velocity with the presence of unusual or non-steady attitudes. For example, a touchdown that occurs with one wing low, and/or with an adverse rolling velocity may result in gear forces on one side of the aircraft that are much higher than would be indicated based upon the aircraft vertical impact velocity. In addition, nose landing gear loads resulting from a landing event can be significantly increased due to the development of excessive nose down pitching velocity prior to touch down of the nose landing gear.

9.2.2 Event Criteria

Hard landing declarations are normally initiated by the flight crew, although it is also common for accelerometer data to be examined and used to confirm that a hard landing has in fact occurred. When flight data are used for this purpose, it is typically limited just to the vertical acceleration measurement at the aircraft center of gravity.

As with the flight events discussed in section 9.1, additional objective criteria, in some cases based on multiple data parameters, could be established by the manufacturers and incorporated into the AMM to improve confidence that high landing load events will be identified, and to provide additional information on the level of load experienced. These criteria would consider one or more of the following factors:

(i) *Sideload*: Lateral drift landings introduce sideload at the wheels and landing gear. If sufficiently large, this could be critical in itself, though a lower level of sideload might still compromise the ability of the landing gear to react vertical loads, and thereby reduce the sink speed tolerance in heavy landings. An indication of sideload is available from the recorded lateral acceleration.

(ii) *Aerodynamic lift*: Structural design criteria requires that an aircraft at maximum landing weight tolerate a vertical impact velocity of at least 10 feet per second without damage. An embedded assumption is that the aircraft be in a wings-level steady descent prior to touchdown with the wing fully supporting the aircraft weight, in other words, 1g flight. If the aerodynamic lift is not present, or only partially present, then the aircraft is in fact accelerating downwards at the time of ground contact, and the landing gear will consequently be subject to additional vertical force. Hence the normal load factor immediately preceding touchdown (and in particular the difference between the peak load factor and the load factor prior to touchdown) is of relevance to the gear loads experienced.

(iii) *Landing Weight*: The variability of landing weight might be considered, in as much as a specified landing gear force results in measured airplane accelerations that are inversely proportional to gross weight.

(iv) *Un-symmetrical Load Distribution*: While the landing response of the airplane is the result of ground contact forces from both the left and the right landing gears combined, these gear forces are not in general equal. In the most extreme case, the airplane may be temporarily in ground contact on only one gear, with all response measurements resulting from the forces on that gear.

9.3 Thresholds

Consider the process described in section 8, where post-incident actions are based in part on the estimated peak threshold load levels experienced during an event. While all events represent cases where loads are significantly higher than expected in normal operations, we nevertheless define events at two different levels of severity:

Low Threshold Exceedance: An event where the design limit load of the airframe is exceeded. Limit load is the load the manufacturer designs the structure to withstand without damage. The low threshold exceedance level should be such that there is a very high probability of capturing any event which subjects the airplane to 100% design limit load in any part of the structure, the threshold for possible structural damage. When uncertainty exists in the ability to reliably estimate loads, the low threshold should take this into account.

High Threshold Exceedance: An event significantly greater than limit load. Ultimate load is generally, but not always, equal to 150% of limit load, and it is a load level that the manufacturer designs the structure to survive and continue to carry load, even though there might be significant damage.

The high threshold exceedance level should be set to capture any event which reaches approximately 125% limit load. This corresponds to a load level at which experience shows structural damage to become probable and is characterized as an exceptional event. The appropriate high threshold level may vary according to the type of event and the aircraft design and materials used.

It is recognized that it may not be necessary or advisable in all cases to separately identify both a low and a high load threshold level. In particular, caution should be exercised when establishing a low threshold, because if this threshold is not exceeded, then an inspection will not be performed. The low threshold should be established at a level at which the specified data can reliably predict whether or not structural damage has occurred.

Both types are very low probability events, with high threshold events at least one or two orders of magnitude less probable than low threshold events. It is appropriate that the OEM continue to retain responsibility for the selection of appropriate load threshold criteria for each model and AMM under consideration.

9.4 Committee Recommendations

In summary, the committee recommends:

1. Where practicable, the AMM should provide threshold guidance to the operator sufficient to determine not only that a high load event may have occurred, but also an indication of the likely severity of that event relative to structural strength capability.
2. OEM's should consider the development of algorithms to quantify the severity of the event based on multiple data parameters.
3. AMMs should provide additional maintenance instructions, if required, for:
    a. Vertical positive, negative, and lateral maneuver and turbulence exceedances.
    b. High load events related to dynamic flight maneuvers and excessive use of flight controls.
4. OEM's should consider expanding hard landing event maintenance instructions to fully address inspections for landings with non-datum attitudes and angular rates or in the absence of normal one g wing lift.

10.0 Flight Data Systems

10.1 History of Flight Data Systems

Flight data recorders (FDRs) were first introduced in the 1950s. Many first-generation FDRs used metal foil as the recording medium, with each single strip of foil capable of recording 200 to 400 hr of data. This metal foil was housed in a crash- survivable box installed in the aft end of an airplane. Beginning in 1965, FDRs (commonly known as "black boxes") were required to be painted bright orange or bright yellow, making them easier to locate at a crash site.

Second-generation FDRs were introduced in the 1970s as the requirement to record more data increased, but they were unable to process the larger amounts of incoming sensor data.

FAA rule changes in the late 1980s required the first-generation FDRs to be replaced with digital recorders. Most of these DFDRs could process up to 18 input parameters (signals). This requirement was based upon an airplane with four engines and a requirement to record 11 operational parameters for up to 25 hours.

Another FAA rule change that took effect October 11, 1991, led to the installation of digital Flight Data Acquisition Units (DFDAUs) and DFDRs with solid-state memory. This FDR system was required to record a minimum of 34 parameters. The DFDAU processes approximately 100 different sensor signals per second for transmission to the DFDR, which uses solid state memory to accommodate data for a 25-hr period.

In late 1997, the FAA adopted a change requiring a further increase in the number of recorded signals for flight data recorders. This rule change affects many airplanes that operate under FAA rules, including all airplanes registered in the United States and those in other countries where regulatory authorities use the FAA rules as their own.

10.2 Current Requirements

Current flight data recording requirements are spelled out in §§ 91.609, 121.343, 121.344, 121.344a, 125.225, 125.226, 129.20, 135.152, and related appendices. The requirements vary widely in terms of parameters that must be recorded, depending on type of operation, number of passengers, type of aircraft, date of manufacture, etc. However, the full 88 parameter list is required on all turbine-engine-powered airplanes manufactured after August 19, 2002, except for Part 91 operated airplanes. In general, these parameters include CG accelerations, aircraft attitude, control inputs, and air data. Normal acceleration is required to be recorded at 8 samples per second. Longitudinal and lateral accelerations are required to be recorded at 4 samples per second. Most control inputs are to be recorded from 1 to 2 samples per second. All other parameters are to be recorded at rates of 1 or less samples per second.

10.3 Purpose and Function of Flight Data Systems

The primary purpose of an airplane flight data system has been to collect and record data from a variety of airplane sensors onto a medium designed to survive an accident. Depending on the age of an airplane, the flight data system may consist of (1) an analog or digital flight data acquisition unit (FDAU) and a digital flight data recorder (DFDR) that may have a tape or solid-state memory, or (2) simply a flight data recorder. The protected medium that collects data resides in the FDR or DFDR. This recording system has been installed in thousands of airplanes, and continues to play a key role in making airplane travel as safe as possible. The dominant function has been to preserve key data parameters on a robust medium for analysis of catastrophic events. As such, most systems are commonly referred to as flight data recorder (FDR) systems.

10.4 Committee Recommendations

The committee recommends for future designs that the OEM develop systems and procedures such that operators can quickly, effectively, and dependably evaluate a broad range of events. This recommendation can be accomplished via the following key steps:

1. Re-evaluate the Purpose and Function of Flight Data Systems

   Manufacturers should re-evaluate the purpose and function of flight data systems. The original purpose of providing indestructible documentation of accident events needs to be preserved. But experience has shown that potential improvements are possible in evaluation of non-catastrophic events that might inflict damage but not result in immediate catastrophe. These improvements should come in the form of increased frequency resolution of recorded data, increased situational awareness for crews, more rapid distribution of recorded data, limited real-time data processing and distribution to all the stakeholders involved in safe operation (operators and OEMs).

2. Improve Data Fidelity

   To make data suitable for monitoring high load magnitudes and frequencies, it is recommended that a minimum frequency resolution with adequate aliasing protection be established by the OEM. These requirements should be applied to a subset of recorded data used in load event evaluation, such as aircraft accelerations and flight control positions. It would be left to manufacturers to ensure appropriate frequency resolution through the use of combinations of sampling and filtering strategies. As far as threshold definition is concerned, it is important that the preconditioning, filtering and sampling process of the parameters selected for threshold evaluation be understood and taken into account. Information on sampling can be found in a University of Dayton Research Institute report entitled "A Study of Sampling Rate Requirements for Some Load Parameter Statistics," Report No. UDR-TR-2004-00146, dated September, 2004.

The flight data system should only need to capture a small time sample, but it would need to have adequate frequency resolution, anti-aliasing strategies, real time algorithm calculations, appropriate qualification, and dispatch reliability. The data should be recorded and annunciated in a manner that provides optimum visibility by all stakeholders. Stakeholders in a high load event include the operator maintenance organizations, operator crews and management, and OEMs. Data processing technology should be implemented that would provide function and service to all stakeholders in these events.

3. Expand the Architecture of Flight Data Systems

Most current systems involve a data acquisition unit and a recording unit. This could be expanded to include data distribution units, data analysis units, multiple data streams and even various data links. Flight data systems could manage several data streams, each optimized for a particular stakeholder. A data stream could be processed in real-time and provided to the crew as a cockpit display. This would increase situational awareness for the crew and provide guidance for signaling significant events. Another data stream could be made available to operator maintenance personnel and still another formatted for use by operator and OEM engineering organizations. Data links supported by wireless technologies possibly combined with intra and internet capabilities could insure rapid and immediate distribution.

11.0 Notification Requirements

The most important link in the process is continual feedback between the OEM, Operators and the FAA. The process begins with the pilot reporting events, continues with the operator providing feedback to the OEM and the OEM/Operator reporting legitimate events through existing regulatory requirements. Sections 11.1 through 11.3 are designed to ensure continuous information flow between all parties.

11.1 Flight Crew Requirements to Notify Maintenance

The flight crew is required to make a log book entry anytime they suspect that the aircraft has exceeded its operational limits or experienced an atmospheric condition that may have affected the airworthiness of the aircraft. The operator's flight manuals should contain this reporting requirement.

11.2 Operator Requirements to Notify the OEM

If the high threshold has been exceeded and/or damage related to the event is noted in the Phase II portion of the inspection, then the aircraft may have exceeded its limit loading and possibly ultimate loading. As outlined above, the operator should notify the OEM who may then provide additional inspections if required. Results of any additional inspections by the operator will be reported back to the OEM, as verification of effectiveness of the inspections.

11.3 Operator/OEM Requirements to Notify to FAA

Operator and OEM will notify the FAA through the existing reporting requirements.