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AEROMAGAZINE

AERO

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Alteon works with customers and regulatory authorities around the world to enhance global standards for proficiency and training excellence.



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Remote Management of Real-Time Airplane Data

Designed by Boeing and airline users, Airplane Health Management collects in-flight airplane information and relays it in real-time to maintenance personnel on the ground.

Airplane Identifier	Join Info	Eligible Number
ZGCA099	Info R G	0CA8E2
ZGCA094	Info	0CA438
ZGCA098	Info R	0CA371
ZGCA096	Info	0CA407
ZGCA097	Info	0CA101
ZGCA090	Info	0CA361
ZGCA088	Info	0CA8E2
ZGCA091	Info R G	
ZGCA093	Info	

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Boeing continually communicates with operators through such vehicles as technical meetings, service letters, and service bulletins. This assists operators in addressing regulatory requirements and Air Transport Association specifications.

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Boeing Provides Total Training Solutions Through Alteon



SHERRY CARBARY
President, Alteon

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This is a responsibility we don't take lightly. We believe that your trust is earned through cooperative working relationships that exceed your expectations and support your economic goals. We are listening to your concerns and responding to your needs to engage you in a profitable long-term training partnership.

Alteon is proud to be Boeing's training company providing global training solutions. In response to your requests, Alteon training is now available in more locations worldwide than ever before. We currently offer globally dispersed flight and maintenance training on more than 80 full-flight simulators at 23 training locations on six continents. By establishing flight centers around the world, Alteon can offer training close to your home base, saving you the time and money of flying to distant training centers. This proactive approach

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The new 70,000-square-foot Singapore training center is the most recent example of Alteon's global outreach.



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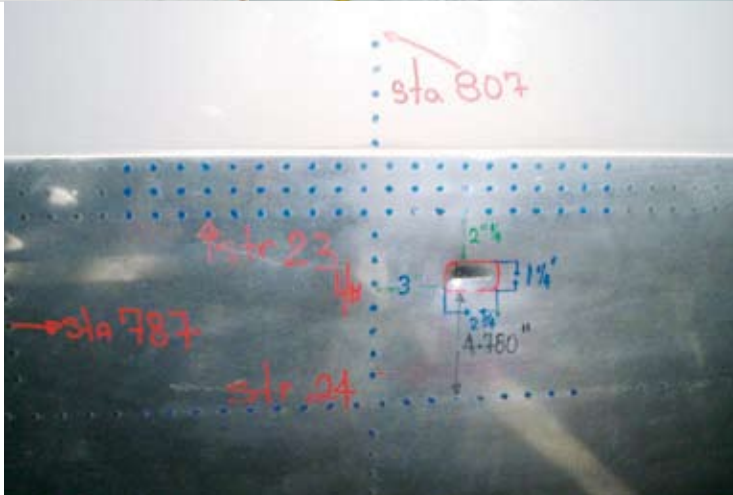
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We look forward to working together with you.

SHERRY CARBARY

President
Alteon

Approved Versus Acceptable Repair Data: How to Make Sure You Have What You Need



CLASSIFYING A REPAIR AS
"MAJOR" OR "MINOR" IS
BASED ON THE COMPLEXITY
OF THE REPAIR AND
THE CAPABILITY OF THE
OPERATOR.

by Dale Johnson and Ron Lockhart,
Regulatory and Industry Liaison Program Managers,
Commercial Aviation Services

Boeing aims to provide a quick and accurate response to operator requests for repair data. However, the escalating operator demand for approved repair data can mean longer response times and result in operators having airplanes out of service longer than desired. By understanding the different types of repair data, applicable regulations, and the process for submitting requests for repair data, operators can receive the repair data they need and minimize the length of time an airplane is out of revenue service.

Operators are often faced with a dilemma when determining the type of repair data that is needed to meet regulatory requirements. Under the United States Federal Aviation Administration (FAA) system, repair data can be classified as either “acceptable” or “approved.” In European Aviation Safety Agency (EASA) regulations, all repair data shall be “approved.”

In addition, a new bilateral agreement between the United States (U.S.) and the European Union (EU) is refocusing attention on the issue of approved versus acceptable repair data. Many operators and maintenance, repair, and overhaul (MRO) organizations in the EU are not familiar with “acceptable” repair data because it is not commonly allowed by EASA.

This article defines “acceptable” and “approved” repair data, explains the differences between the FAA and EASA regulations, outlines the repair data section of the new bilateral agreement between the U.S. and the EU, and familiarizes operators with the most effective ways to receive the appropriate repair data needed from Boeing.

**APPROVED VERSUS
ACCEPTABLE REPAIR DATA**

By understanding the type of repair data needed for each classification of damage, operators can minimize delays and return airplanes to revenue service quickly. The FAA and EASA definitions of each classification of damage and authorized repair

data type are summarized in figure 1, and further explained in subsequent sections of this article.

Boeing and the FAA expect appropriately approved airline, maintenance, and MRO personnel to assess whether a repair is major or minor, and to use an assessment process preapproved by their national aviation authority.

FAA SYSTEM

Operators under FAA jurisdiction are responsible for ensuring that repairs are accomplished according to all applicable regulations under U.S. Code of Federal Regulations 14 CFR Part 43. Airplane repairs of damage can be classified as either “major” or “minor.” This assessment is

FAA VERSUS EASA OVERVIEW

Figure 1

Although the FAA and EASA have similar definitions for what constitutes major and minor repairs, the requirement for acceptable or approved data is quite different.

FAA DEFINITION PART 1

MAJOR REPAIR

Major repairs are those that if improperly done, might appreciably affect weight, balance, structural strength, performance, power-plant operation, flight characteristics, or other qualities affecting airworthiness or that; are not done according to accepted practices or elementary operations.

MINOR REPAIR

Minor repair is any repair, other than a major repair.

based on the scope and complexity of the repair and the experience and capability of the operator.

The responsibility for determining whether a repair is major or minor rests with operators, repair stations, and holders of an inspection or maintenance authorization. Because the classification of a repair as either major or minor is not a 14 CFR Part 25 requirement, this classification is outside the scope of FAA authority delegated to Boeing. In the U.S., all operators have authority to use acceptable repair data for minor repairs without additional FAA approval.

FAA Advisory Circular (AC) 43-18 describes acceptable data as data acceptable to the FAA

that can be used for maintenance, minor repair, or minor alteration that complies with applicable airworthiness regulations. Acceptable data can be provided by a type certificate (TC)/supplemental type certificate (STC) holder or third-party operator or MRO qualified engineer.

FAA AC 120-77 defines approved data as: "Technical and/or substantiating data that has been approved by the FAA" or by an FAA delegate such as a FAA-designated engineering representative (DER) or FAA-authorized representative (AR). If the operator's qualified personnel determine the damage necessitates a major repair, then FAA

approval of the repair data is required. Operators have many ways to obtain FAA-approved repair data:

- Accomplish the repair per the Boeing structural repair manual (SRM) because all repairs in the Boeing SRM are FAA approved.
- Apply to the FAA directly.
- Use a DER, who has a "special delegation" from the FAA, to approve data for major repairs using an FAA form 8110-3.
- Where FAA authorization has been delegated to Boeing under delegation option authorization (14 CFR Part 21.231), a Boeing AR may approve the engineering repair data on an FAA form 8100-9.

EASA DEFINITION
PART 21

FAA REPAIR
DATA

EASA REPAIR
DATA

All other repairs that are not minor.

(Ref. EASA GM 21A.91 and GM 21A.435[a])

Approved data from the FAA or FAA designee — designated engineering representative (DER) or authorized representative (AR)

Approved by EASA or EASA design organization approval (DOA)

A minor repair is one that has no appreciative effect on the mass, balance, structural strength, reliability, operational characteristics, noise, fuel venting, exhaust emissions, or other characteristics affecting the airworthiness of the airplane.

Acceptable data from the operator or type certificate (TC)/ supplemental type certificate (STC) holder

Approved data by EASA or EASA DOA; or acceptable data from the TC/STC holder or third party*

* Acceptable data developed under the FAA system for a minor repair will be automatically approved by EASA under the pending U.S.-EU Bilateral Aviation Safety Agreement.

EASA SYSTEM

EASA regulations (Commission Regulation European Community [EC] 2042/2003 Annex I Part M) require “approved” data for both minor and major classifications of airplane repairs. This policy is in contrast to the FAA system that requires “approved” data for major repairs only and “acceptable” data for minor repairs.

Additionally, EU operators under EASA regulations cannot make determinations of minor or major for repairs unless they hold an EASA design organization approval (DOA). EU operators without

an EASA DOA must rely on EASA directly or contract with an EASA-authorized DOA holder to have the repair classified.

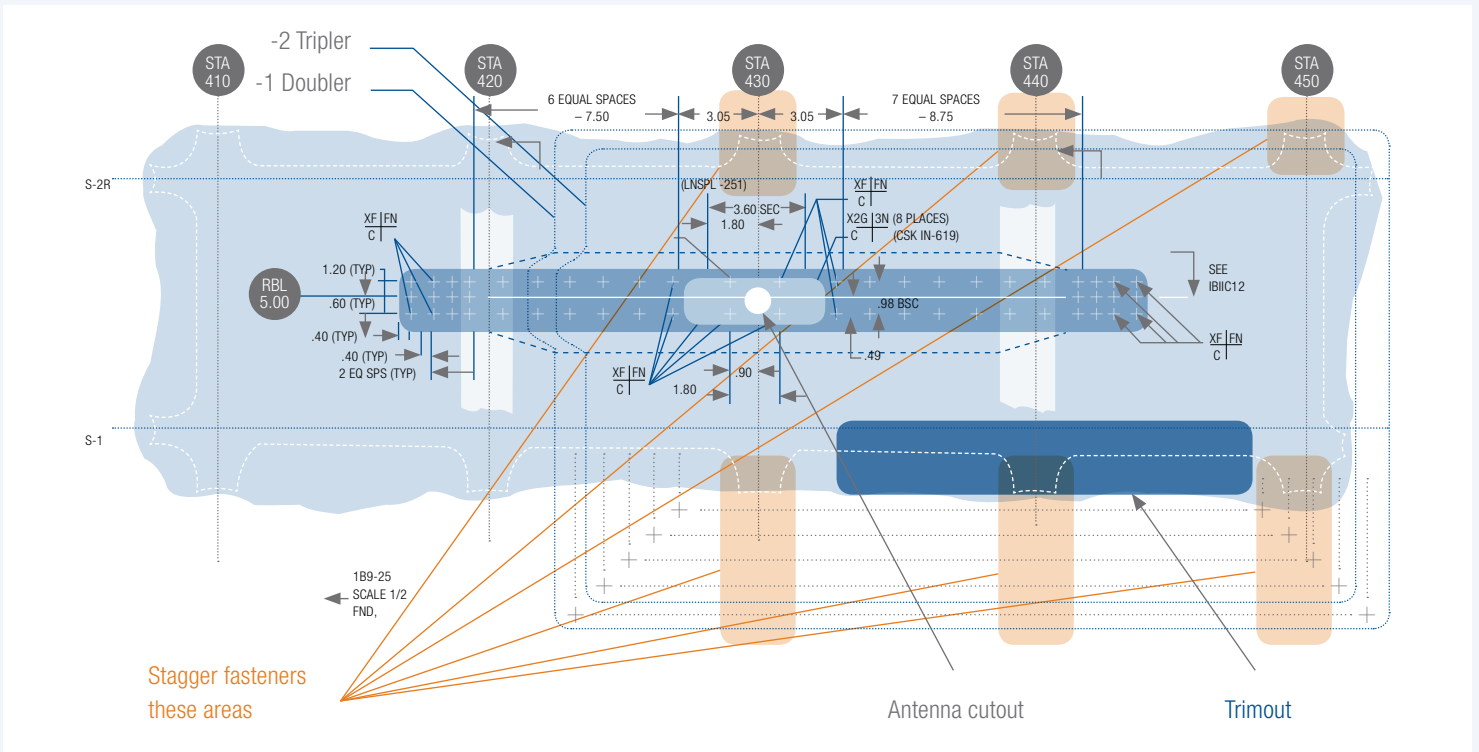
There are different levels of EASA DOA authorization. For example, Basic DOA allows the holder to classify major or minor repairs and approve minor repairs only. A TC/STC holder with an EASA DOA can also approve both major and minor repairs.

Regulations similar to EASA’s are being adopted by global national aviation authorities outside the EU, including Australia and India.

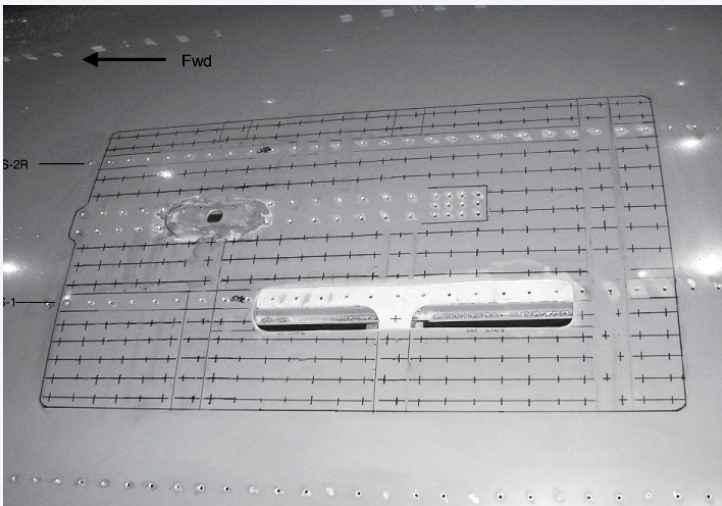
U.S.-EU BILATERAL AVIATION
SAFETY AGREEMENT

Both the FAA and EASA continue to work to harmonize regulations with joint principles and processes. To minimize the impact to operators resulting from two distinct repair data approval systems, a special interim provision from the U.S.-EU Bilateral Aviation Safety Agreement was released on April 1, 2007.

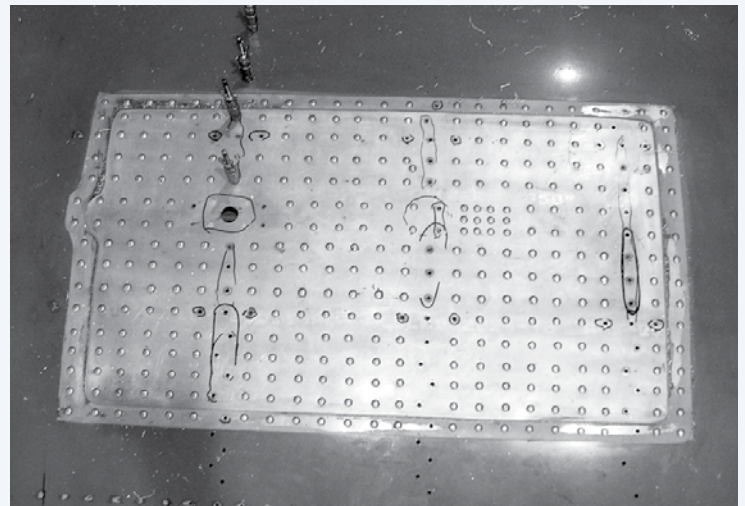
Amending the Implementation Procedures for Airworthiness (IPA) in existing Joint Aviation Authorities (JAA) bilateral agreements between the U.S. and six EU member states (France, Germany,



1. Sample repair design for fuselage skin cracks



2. Operator layout of repair design



3. Operator repair doubler installation

Example of a wing spar chord repair.



Example of a wing spar web splice repair.

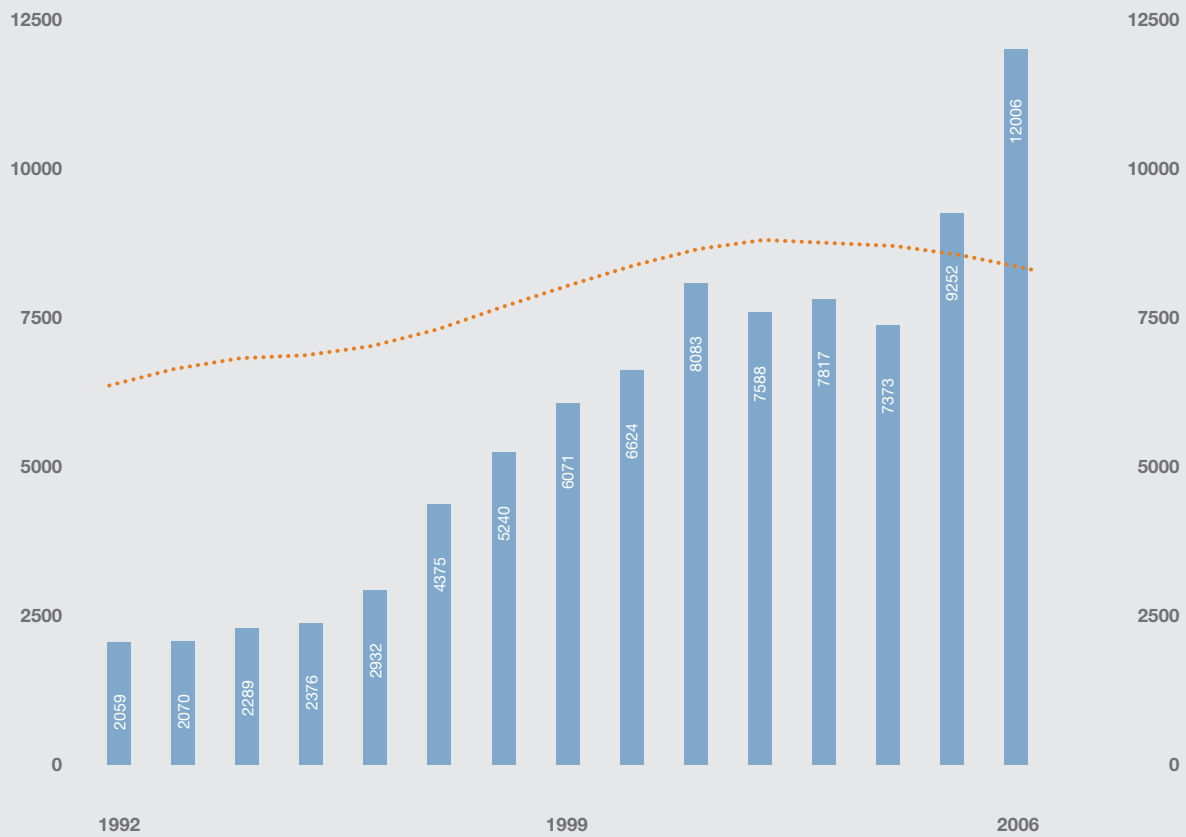


**STRUCTURES 8110-3/8100-9
REQUESTS VERSUS FLEET SIZE**

(707, 727, 737, 747, 757, 767, 777)

Figure 2

■ = 8110-3/8100-9
..... = Fleet Size



The number of requests for approved repair data via an FAA form 8100-9 for 707, 727, 737, 747, 757, 767, and 777 airplanes has increased nearly sixfold since 1992, a rate disproportionate to the growth in the size of the worldwide Boeing fleet.

The data suggests that operators may not fully understand the regulatory requirements that dictate approved versus acceptable data.

Italy, Netherlands, Sweden, and the United Kingdom), this provision clarifies the mutual acceptance of repair data between the FAA and EASA. This allows acceptable structural repair data from TC/STC holders under the FAA system to be automatically approved by EASA.

Although this means Boeing will continue to provide an 8100-9 approval for major repairs, an EU operator and MRO in those six EU member states can now use Boeing acceptable data for minor repairs without additional EASA or EASA DOA approval.

A new bilateral agreement between the U.S. and the EU is planned to be signed in the near future, allowing implementation of the mutual acceptance of repair data by all EU member states.

GROWING DEMAND FOR APPROVED DATA

During the last 15 years, Boeing has seen a significant increase in demand for approved structural repair data requests from operators, while the number of Boeing airplanes in the fleet has remained somewhat level (see fig. 2). This increase primarily involves Boeing 707, 727, 737, 747, 757, 767, and 777 airplanes. The demand for approved structural repair data for the Douglas fleets — DC-8, DC-9, MD-80/90, DC-10, MD-11, etc. — has remained relatively steady during the last several years.

The aging of the airplane fleet alone does not appear to explain this significant increase in operator requests. The data suggests that operators may not fully understand the regulatory requirements that dictate approved versus acceptable data, or are asking for approved data for nonregulatory purposes, such as for records to support future airplane ownership transfer. There is also a higher demand for approved data from EU member states than the rest of the world.

The increased demand challenges Boeing Delegated Compliance Organization resources, resulting in extended — and often unnecessary — airplane downtime.

HOW OPERATORS CAN GET THE DATA THEY NEED FROM BOEING


Boeing encourages all operators and MROs to use the Boeing SRM whenever possible, because all repairs in the SRM have been approved by the FAA. Additionally, operators and MROs should familiarize themselves with FAA AC 120-77, which provides guidance for minor deviations from allowable damage limits in the SRM and other manufacturer's service documents resulting in greater applicability to more repairs.

Finally, when submitting a request to Boeing for either acceptable or approved repair data, follow the process contained in the appropriate multi-

model service letter "BCA Review and Delegated Approval of Airplane Structural Repair and Modification Data" (e.g., 737-SL-51-027-E). Using this process helps ensure that all the information needed to evaluate the repair design is available and can be efficiently processed.

SUMMARY

Boeing strives to provide accurate and responsive fleet support to operator requests for repair data. By understanding applicable regulations, using the Boeing SRM, and following established procedures, operators can receive the information they need efficiently, reducing airplane downtime. The value of structural repairs contained in the Boeing SRM is that they are available for immediate use by the operator and are approved by both the FAA and EASA.

For more information, please contact your local Boeing Field Service representative or Dale Johnson at dale.r.johnson2@boeing.com or Ron Lockhart at ronald.j.lockhart2@boeing.com. 

Overweight Landing? Fuel Jettison?

What to Consider



*THERE ARE IMPORTANT ISSUES
WHEN DECIDING TO LAND
OVERWEIGHT, BURN OFF FUEL,
OR JETTISON FUEL.*

by Rick Colella,
Flight Operations Engineer

An overweight landing is defined as a landing made at a gross weight in excess of the maximum design (i.e., structural) landing weight for a particular model. A pilot may consider making an overweight landing when a situation arises that requires the airplane to return to the takeoff airport or divert to another airport soon after takeoff. In these cases, the airplane may arrive at the landing airport at a weight considerably above the maximum design landing weight. The pilot must then decide whether to reduce the weight prior to landing or land overweight. The weight can be reduced either by holding to burn off fuel or by jettisoning fuel. There are important issues to consider when a decision must be made to land overweight, burn off fuel, or jettison fuel.

Due to continuing increases in the cost of fuel, airlines want help deciding whether to land overweight, burn off fuel, or jettison fuel. Each choice has its own set of factors to consider. Holding to burn off fuel or jettisoning fuel prior to landing will result in increased fuel cost and time-related operational costs. Landing overweight requires an overweight landing inspection with its associated cost. Many airlines provide their flight

crews with guidelines to enable the pilot to make an intelligent decision to burn off fuel, jettison fuel, or land overweight considering all relevant factors of any given situation.

This article provides general information and technical data on the structural and performance aspects of an overweight landing to assist airlines in determining which option is best suited to their operation and to a given situation. The article

covers these facets of overweight landings and fuel jettisoning:

- Regulatory aspects.
- Safety and ecological aspects.
- Airplane structural capability.
- Airplane performance capability.
- Automatic landings.
- Overweight landing inspection requirements.

Landing overweight and jettisoning fuel are both considered safe procedures.

REGULATORY ASPECTS

The primary Federal Aviation Administration (FAA) regulations involved in landing overweight and fuel jettison are:

- Federal Aviation Regulation (FAR) 25.1519 — Requires the maximum landing weight to be an operating limitation.
- FAR 91.9 — Requires compliance with operating limitations.
- FAR 121.557 and FAR 121.559 — Allow the pilot in command to deviate from prescribed procedures as required in an emergency situation in the interest of safety. In June 1972, the FAA issued Air Carrier Operations Bulletin No. 72-11 giving three examples of situations the FAA considered typical of those under which pilots may be expected to use their emergency authority in electing to land overweight:
 - Any malfunction that would render the airplane unairworthy.
 - Any condition or combination, thereof, mechanical or otherwise, in which an expeditious landing would reduce the exposure to the potential of additional problems which would result in a derogation or compromise of safety.

- Serious illness of crew or passengers which would require immediate medical attention.
- FAR 25.1001 — Requires a fuel jettison system unless it can be shown that the airplane meets the climb requirements of FAR 25.119 and 25.121(d) at maximum takeoff weight, less the actual or computed weight of fuel necessary for a 15-minute flight comprising a takeoff, go-around, and landing at the airport of departure.

To comply with FAR 24.1001, the 747 and MD-11, for example, require a fuel jettison system. Some models, such as the 777 and some 767 airplanes have a fuel jettison system installed, but it is not required by FAR. Other models such as the DC-9, 717, 737, 757, and MD-80/90 do not require, or do not have, a fuel jettison system based on compliance with FAR Part 25.119 and 25.121(d).

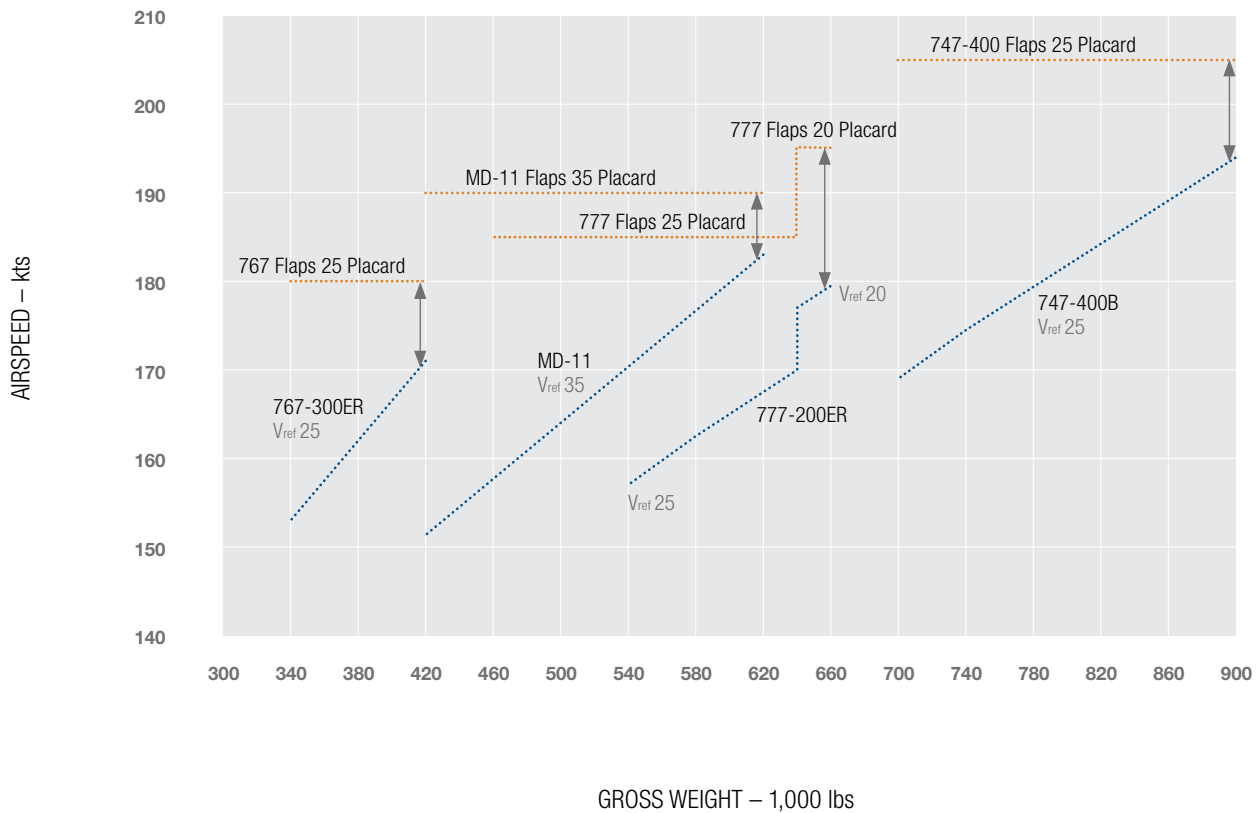
SAFETY AND ECOLOGICAL ASPECTS

Landing overweight and fuel jettisoning are both considered safe procedures: There are no accidents on record attributed to either cause. In the preamble to Amendment 25-18 to FAR Part 25, relative to fuel jettison, the FAA stated, "There has been no adverse service experience with airplanes certificated under Part 25 involved in overweight

landings." Furthermore, service experience indicates that damage due to overweight landing is extremely rare.

Obviously, landing at weights above the maximum design landing weight reduces the normal performance margins. An overweight landing with an engine inoperative or a system failure may be less desirable than landing below maximum landing weight. Yet, delaying the landing with a malfunctioning system or engine failure in order to reduce weight or jettison fuel may expose the airplane to additional system deterioration that can make the situation worse. The pilot in command is in the best position to assess all relevant factors and determine the best course of action.

Some operators have questioned whether fuel jettison is permissible when an engine or airframe fire exists. There is no restriction on fuel jettison during an in-flight fire, whether inside or outside the airplane. During airplane certification, Boeing demonstrates to the FAA in a variety of flight conditions that jettisoned fuel does not impinge or reattach to airplane surfaces. As fuel is jettisoned, it is rapidly broken up into small droplets, which then vaporize. Boeing does not recommend operator-improvised fuel jettison procedures, such as jettisoning fuel from only one side during an engine fire. Such procedures are not only



unnecessary but also can increase jettison time and crew workload.

The ecological aspects of fuel jettison have been most closely studied by the United States Air Force (USAF). These studies have shown that, in general, fuel jettisoned above 5,000 to 6,000 feet will completely vaporize before reaching the ground. Therefore, Boeing's general recommendation is to jettison fuel above 5,000 to 6,000 feet whenever possible, although there is no restriction on jettisoning at lower altitudes if considered necessary by the flight crew.

Fuel jettison studies have indicated that the most significant variables related to fuel vaporization are fuel type and outside air temperature. Some studies found that temperature can have a very significant effect on the altitude needed to completely vaporize fuel. For example, one USAF study found that a 36-degree Fahrenheit (20-degree Celsius) reduction in temperature can change the amount of liquid fuel reaching the ground by as much as a factor of 10. Other factors such as fuel jettison nozzle dispersion characteristics, airplane wake, and other atmospheric conditions can affect the amount of fuel that reaches the ground.

Even though fuel is vaporized, it is still suspended in the atmosphere. The odor can be pronounced, and the fuel will eventually reach

the ground. Boeing is not aware of any ecological interest promoting a prohibition on fuel jettisoning. Because of the relatively small amount of fuel that is jettisoned, the infrequency of use, and the safety issues that may require a fuel jettison, such regulations are not likely to be promulgated.

AIRPLANE STRUCTURAL CAPABILITY

Overweight landings are safe because of the conservatism required in the design of transport category airplanes by FAR Part 25.

FAR criteria require that landing gear design be based on:

- A sink rate of 10 feet per second at the maximum design landing weight; and
- A sink rate of 6 feet per second at the maximum design takeoff weight.

Typical sink rates at touchdown are on the order of 2 to 3 feet per second, and even a "hard" landing rarely exceeds 6 feet per second. Additionally, the landing loads are based on the worst possible landing attitudes resulting in high loading on individual gear. The 747-400 provides an excellent example. The 747-400 body gear, which are the most aft main gear, are designed to a 12-degree nose-up body attitude condition. In essence, the body gear can absorb the entire

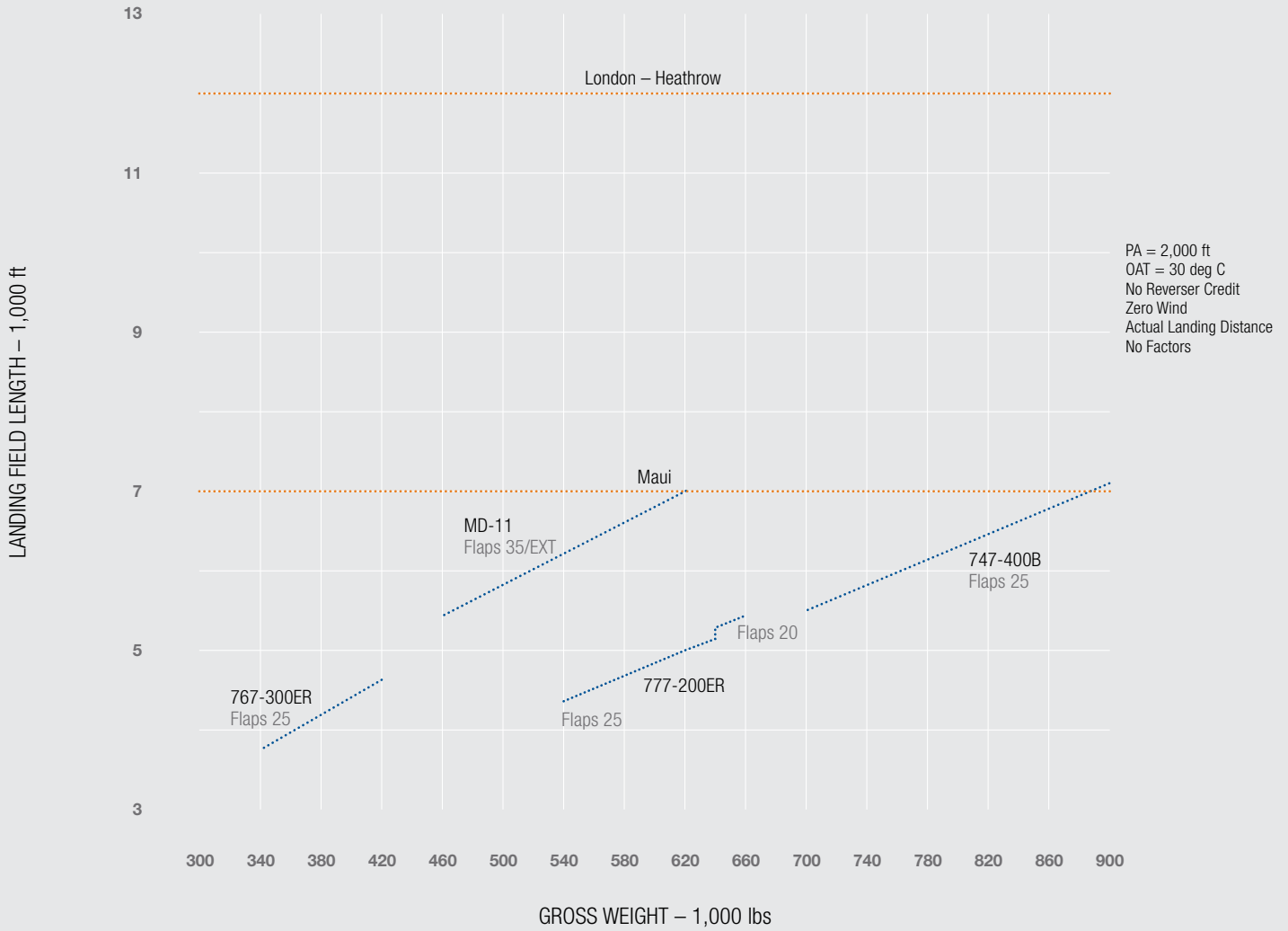
landing load. The wing gear criteria are similarly stringent: 8 degrees roll at 0 degrees pitch. Other models are also capable of landing at maximum design takeoff weight, even in unfavorable attitudes at sink rates up to 6 feet per second. This is amply demonstrated during certification testing, when many landings are performed within 1 percent of maximum design takeoff weight.

When landing near the maximum takeoff weight, flap placard speeds at landing flap positions must be observed. Due to the conservative criteria used in establishing flap placard speeds, Boeing models have ample approach speed margins at weights up to the maximum takeoff weight (see fig. 1).

In addition to specifying a maximum landing weight, the FAA-approved airplane flight manual (AFM) for some 747-400 and MD-11 airplanes includes a limitation on the maximum in-flight weight with landing flaps. This weight is conservatively established to comply with FAR 25.345, flaps down maneuvering to a load factor of 2.0. Compliance with FAR 25.345 is shown at a weight sufficiently above the maximum design landing weight to allow for flap extension and maneuvering prior to landing. Because the loads developed on the flaps are primarily a function of airspeed and are virtually independent of weight, the flaps will

LANDING FIELD LENGTH MARGIN AT WEIGHTS UP TO MAXIMUM TAKEOFF WEIGHT

Figure 2



Overweight automatic landings are not recommended. Autopilots on Boeing airplanes are not certified for automatic landing above the maximum design landing weight.

not be overstressed as long as airspeed does not exceed the flap placard speed.

If the maximum in-flight weight with landing flaps is exceeded, no special structural inspection is required unless the flap placard speed or the maximum landing weight is also exceeded. Generally, if the maximum in-flight weight with landing flaps is exceeded, the maximum design landing weight will also be exceeded and, by definition, an overweight landing inspection will be required.

Loading on the basic wing structure due to increased landing weight can be controlled by limiting the bank angle. To maintain reasonable structural margins, Boeing recommends that operating load factors be limited to those corresponding to a stabilized 30-degree banked turn.

All Boeing airplanes have adequate strength margins during overweight landings when normal operating procedures are used, bank angle does not exceed 30 degrees, and flap placard speeds are not exceeded.

AIRPLANE PERFORMANCE CAPABILITY

Increased gross weight can have a significant effect on airplane performance. Whenever possible, it is strongly recommended that normal FAR landing performance margins be maintained even during

overweight landing. The AFM typically provides landing performance data at weights significantly above the maximum design landing weight and can be used in conjunction with landing analysis programs to calculate landing performance.

The landing field length capability of Boeing airplanes is such that, even ignoring reverse thrust, excess stopping margin is available at weights well above the maximum design landing weight (see fig. 2). The data in figure 2 are based on a dry runway with maximum manual braking. Wet and slippery runway field-length requirements, as well as autobrake performance, should be verified from the landing distance information in the performance section of the flight crew operations manual (FCOM) or quick reference handbook (QRH).

Climb performance exceeds the FAA landing climb gradient requirements (3.2% gradient with all engines operating, landing flaps and gear down), even at the maximum design takeoff weight as shown by the Landing Climb symbols in Figure 3. Climb performance generally meets the FAA approach gradient requirements (one engine inoperative with approach flaps and gear up) at weights well above maximum design landing weight as shown by the App Climb curves in figure 3, and a positive approach climb gradient is available with one engine inoperative even at the maximum design takeoff weight.

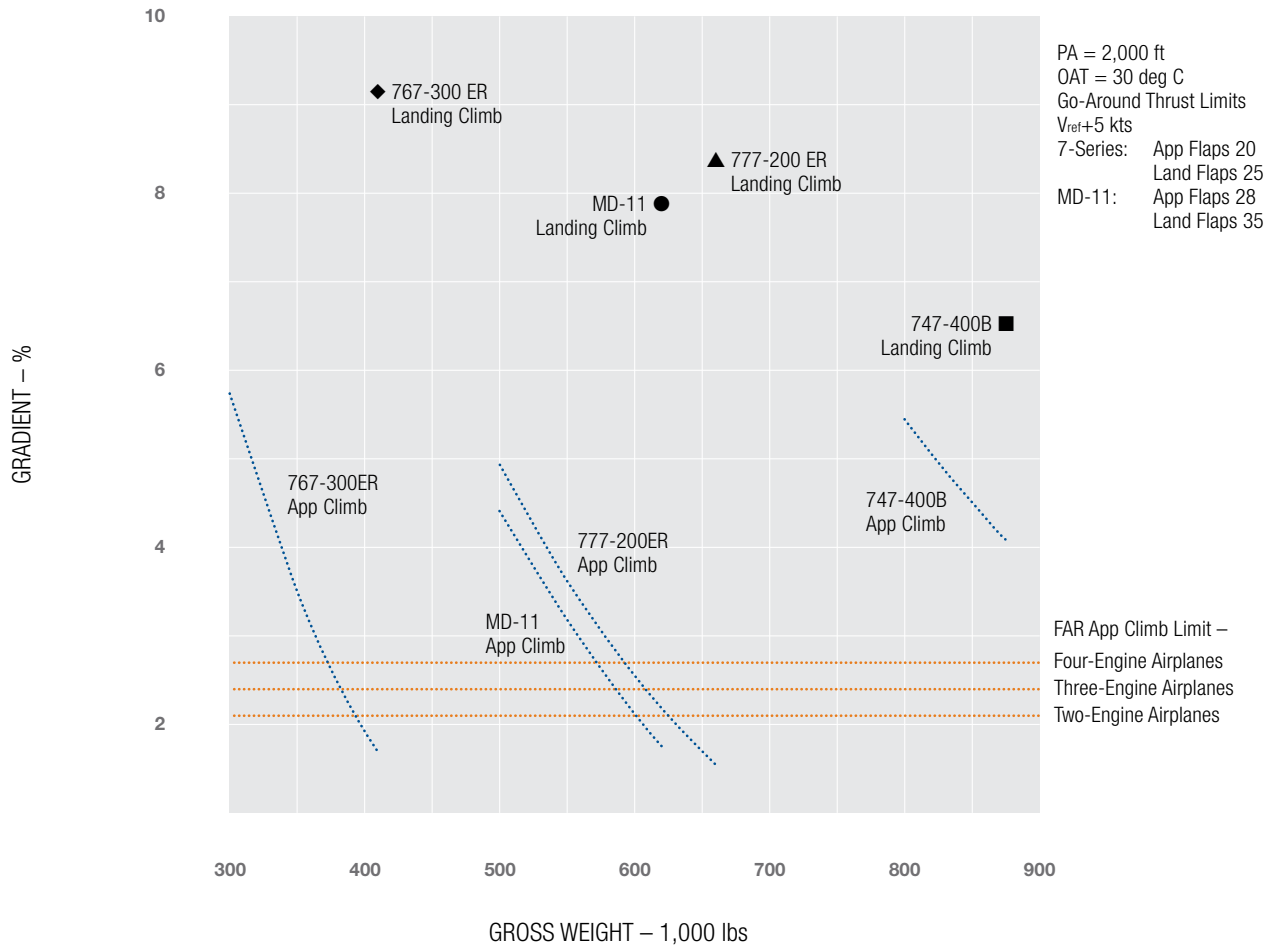
Normally, landing brake energy is not a problem for an overweight landing because the brakes are sized to handle a rejected takeoff at maximum takeoff weight. When using normal landing flaps, brake energy limits will not be exceeded at all gross weights. When landing at speeds associated with non-normal procedures with nonstandard flap settings, maximum effort stops may exceed the brake energy limits. In these cases, Boeing recommends maximizing use of the available runway for stopping. For Boeing 7-series models other than the 717, techniques for accomplishing this are provided in the overweight landing discussion in the “Landing” chapter of the Boeing flight crew training manuals (FCTM).

The stability and control aspects of overweight landings have been reviewed and found to be satisfactory. Stabilizer trim requirements during approach are unchanged provided normal V_{ref} speeds are flown. Speed stability, the control column force required to vary airspeed from the trimmed airspeed, is slightly improved. Pitch and roll response are unchanged or slightly improved as the increased airspeed more than compensates for increased mass and inertia effects.

Additional information on overweight landing techniques for Boeing 7-series models other than the 717 can be found in the “Landing” chapter of the FCTM.

CLIMB PERFORMANCE MARGINS AT WEIGHTS UP TO MAXIMUM TAKEOFF WEIGHT

Figure 3



AUTOMATIC LANDINGS

Overweight automatic landings are not recommended. Autopilots on Boeing airplanes are not certified for automatic landing above the maximum design landing weight. At higher-than-normal speeds and weights, the performance of these systems may not be satisfactory and has not been thoroughly tested. An automatic approach may be attempted; however, the pilot should disengage the autopilot prior to flare height and accomplish a manual landing.

In an emergency, should the pilot determine that an overweight autoland is the safest course of action, the approach and landing should be closely monitored by the pilot and the following factors considered:

- Touchdown may be beyond the normal touchdown zone; allow for additional landing distance.
- Touchdown at higher-than-normal sink rates may result in exceeding structural limits.

- Plan for a go-around or manual landing if autoland performance is unsatisfactory; automatic go-around can be initiated until just prior to touchdown and can be continued even if the airplane touches down after initiation of the go-around.

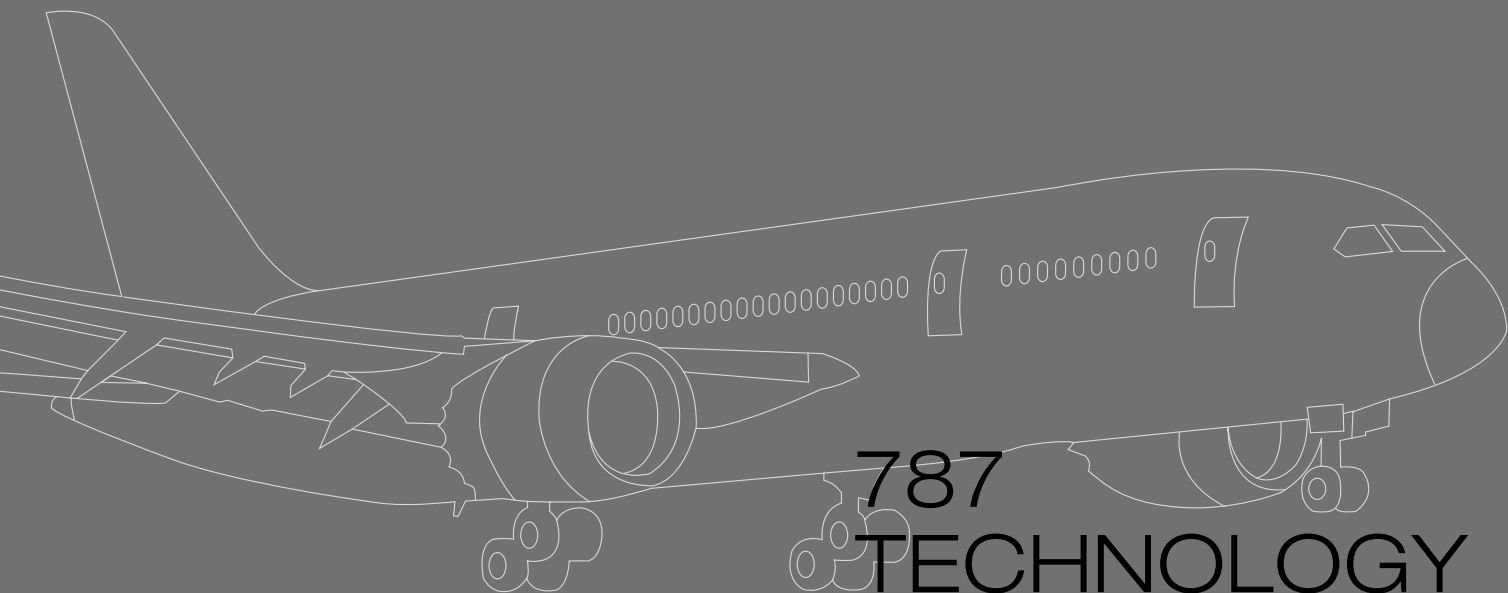
OVERWEIGHT LANDING INSPECTION REQUIREMENTS

The Boeing airplane maintenance manual (AMM) provides a special inspection that is required any time an overweight landing occurs, regardless of how smooth the landing. The AMM inspection is provided in two parts. The Phase I (or A-check) conditional inspection looks for obvious signs of structural distress, such as wrinkled skin, popped fasteners, or bent components in areas which are readily accessible. If definite signs of overstressing are found, the Phase II (or B-check) inspection

must be performed. This is a much more detailed inspection and requires opening access panels to examine critical structural components. The Phase I or A-check conditional inspection can typically be accomplished in two to four labor hours. This kind of inspection is generally not a problem because an airplane that has returned or diverted typically has a problem that takes longer to clear than the inspection itself.

SUMMARY

When circumstances force a pilot to choose between an overweight landing or jettisoning fuel, a number of factors must be considered. The information in this article is designed to facilitate these decisions. For more information, please contact Boeing Flight Operations Engineering at FlightOps.Engineering@boeing.com. **4**



787 TECHNOLOGY HIGHLIGHT

The 787 design incorporates onboard structural health management technologies which will mitigate the operational impact and costs associated with structural inspections after an overweight or hard landing. This technology will greatly simplify the process of determining whether or not a landing has exceeded the capabilities of the airplane structure and will significantly reduce the inspection burden on the operator. This capability will reduce the overall downtime and maintenance costs associated with overweight and hard landing events without impacting flight crew workload or operational procedures. More information on this new technology will be covered in a future issue of *AERO*.

Remote Management of Real-Time Airplane Data

by John B. Maggiore,
Manager, Airplane Health Management,
Aviation Information Services

Operators are reducing flight delays, cancellations, air turnbacks, and diversions through an information tool called Airplane Health Management (AHM). Designed by Boeing and airline users, AHM collects in-flight airplane information and relays it in real-time to maintenance personnel on the ground via the Web portal MyBoeingFleet.com. When an airplane arrives at the gate, maintenance crews can be ready with the parts and information to quickly make any necessary repairs. AHM also enables operators to identify recurring faults and trends, allowing airlines to proactively plan future maintenance.

AHM is a key part of an aviation system in which data, information, and knowledge can be shared instantly across an air transport enterprise. AHM integrates remote collection, monitoring, and analysis of airplane data to determine the status of an airplane's current and future serviceability. By automating and enhancing the real-time and long-term monitoring of airplane data, AHM enables proactive management of maintenance. AHM is intended to provide economic benefit to the airline operator by applying intelligent analysis of airplane data currently generated by existing airplane systems.

This article addresses the following:

- How AHM works.
- Available data.
- Benefits.
- Recent AHM enhancements.

HOW AHM WORKS

AHM collects data (e.g., maintenance messages and flight deck effect [FDE] faults) from the airplane in real-time (see fig. 1). The primary source of the data is the airplane's central maintenance computer (CMC) for the 747-400 and 777 or airplane condition monitoring systems (ACMS) on

other models. AHM also collects electronic logbook data from the Boeing Electronic Flight Bag. Data is collected and downlinked via the airplane communication addressing and reporting system.

The data received in real-time directly from airplanes is hosted by Boeing within the MyBoeingFleet.com Web portal. If an issue is detected, alerts and notifications are automatically sent to a location specified by the airline via fax, personal digital assistant, e-mail, or pager. Maintenance personnel can then access complete AHM information about the issue through an application service provider tool and reports on MyBoeingFleet.com.

AHM REAL-TIME DATA

Figure 1

AHM automatically collects airplane data and fault information, then prioritizes and organizes the data to assist operators in formulating a plan for repairs.

AHM LEVERAGES BOEING KNOWLEDGE AND FLEET DATA TO PROVIDE ENHANCED TROUBLESHOOTING.

The screenshot shows the Boeing Airplane Health Management (AHM) interface. At the top, there's a navigation bar with options like 'Inbound Flight Deck Effects', 'Actionable Items', 'Work Items', 'History Items', 'Reports', 'Manager', and 'Engr Order'. Below this is a search section with filters for Model (777), Fleet List (All), and Airplane Identifier (All). The main area displays a table of flight data:

Airplane Identifier	Link Info	Flight Number	Flight Date	Repair Status	Arrival	ACARS Date	OUT	OFF	ON	IN	ETA
ZGCA099	Info	GCA452	29-Mar-12:16	FRA	PER	29-Mar-14:36	12:16	12:31			29-Mar-21:31
ZGCA094	Info	GCA439	29-Mar-14:32	ORD	FRA	29-Mar-14:32	14:32				30-Mar-00:21
ZGCA098	Info	GCA371	29-Mar-02:06	DRB	SFO	29-Mar-14:30	08:06	08:27	14:30		29-Mar-14:52
ZGCA096	Info	GCA07	29-Mar-20:51	FRA	JFK	29-Mar-14:04	05:51	06:07	12:53	14:04	29-Mar-14:14
ZGCA097	Info	GCA51	29-Mar-12:36	ORD	FRA	29-Mar-12:37	12:36	12:58			29-Mar-19:56
ZGCA090	Info	GCA81	29-Mar-07:13	SFO	ORD	29-Mar-12:43	07:13	07:28	12:38	12:43	29-Mar-12:49
ZGCA088	Info	GCA82	29-Mar-01:46	PEK	FRA	29-Mar-12:36	01:46	02:28	12:16	12:36	29-Mar-12:30
ZGCA091	Info	GCA051	29-Mar-04:58	ORD	FRA	29-Mar-12:14	04:58	05:29	12:00	12:14	29-Mar-12:12
ZGCA093	Info	GCA88	29-Mar-10:55	FRA	ORD	29-Mar-11:51	10:55	11:11			29-Mar-18:01
ZGCA083	Info	GCA87	29-Mar-11:14	SFO	TPE	29-Mar-11:27	11:14	11:27			30-Mar-00:27
ZGCA085	Info	GCA16	29-Mar-10:19	FRA	HIT	29-Mar-10:58	10:19	10:39			29-Mar-23:39
ZGCA080	Info	GCA71	29-Mar-09:29	FRA	TPE	29-Mar-09:59	09:29	09:59			29-Mar-17:59
ZGCA082	Info	GCA31	29-Mar-05:01	LAX	EDX	29-Mar-05:21	05:01	05:20			29-Mar-16:20
ZGCA084	Info	GCA751	29-Mar-04:36	SEA	ICN	29-Mar-04:36	04:16	04:36			29-Mar-18:16
ZGCA086	Info	GCA71	29-Mar-18:19	ORD	JFK	29-Mar-02:05	18:19	18:44	01:52	02:05	29-Mar-02:01
ZGCA089	Info	GCA421	29-Mar-13:48	FRA	ORD	29-Mar-23:31	13:48	14:03	23:25	23:31	29-Mar-23:31
ZGCA095	Info	GCA26	29-Mar-14:45	SFO	ORD	29-Mar-22:43	14:48	15:18	22:38	22:43	29-Mar-22:49

This screenshot shows the 'Actionable Items' section of the AHM interface. It displays a table of items that require attention:

Model	Fleet List	Airplane Identifier	Flight Number	ATA	Title	TTT/Alarms	Log	Message Time	Status	Update Date	Priority
ZGCA099	Info	GCA452	38	Fault MM30	Active		0	29-Apr-14:36	New	29-Apr	L
29-20050 Fault Quantity Exceeded Unit Not an Internal Task											
ZGCA099	Info	GCA452	36	Fault MM30	Active		0	29-Apr-14:36	New	29-Apr	L
29-20012 Task Unit (Center Left No.2) signal is out of range.											
ZGCA099	Info	GCA452	36	Fault FDE	Active		0	29-Apr-14:36	New	29-Apr	H
382 803 41 BLEED LOSS WING L - ADVISORY											
382 803 41 BLEED LOSS WING L - ADVISORY - PREP											

This screenshot shows the 'Fault Item Details' for a specific fault. The details include:

- Airplane Identifier:** ZGCA099
- Status:** New
- Flight Number:** GCA452
- Log Count:** 0
- Log Date:** 2007/04/29 12:16
- Departure-Arrival:** FRA-PEK

Below the details, there is a list of associated messages:

Message ID	Text	Time	Status	Priority
382 803 41	PREP BLEED LOSS WING L - ADVISORY	29-Apr-2007 14:36	Active	H
1136-10250	Crews Held Press Regulating and SOV (left) failed closed.	29-Apr-2007 14:36	Active	H
382 803 41	BLEED LOSS WING L - ADVISORY	29-Apr-2007 14:36	Active	H
1136-10250	Crews Held Press Regulating and SOV (left) failed closed.	29-Apr-2007 14:36	Active	H

The primary benefit provided by AHM is the opportunity to substantially reduce schedule interruption costs such as delays, cancellations, air turnbacks, and diversions.

Exactly which data will result in alerts and notifications to maintenance staffs is set by individual operators; operators also determine what particular data and information each of their employees can view via AHM, and that information is prioritized, based on its urgency. Having information packages customized to fit the role of each user ensures that users get the particular information they need.

For example, after encountering a flap drive problem en route, a flight crew called in the discrepancy. The AHM notification made it possible for the airline's maintenance control organization to troubleshoot the problem before the airplane landed. Through real-time uplinks, the airline used AHM to interrogate systems information, identify the problem, and prepare the arrival station for repair. The information made it possible for the airline to avoid a flight diversion and the subsequent repair delay was reduced from several hours to a few minutes.

AVAILABLE DATA

AHM facilitates proactive maintenance by providing ground crews with real-time interpretation of airplane data while flights are in progress, and it leverages Boeing knowledge and fleet data to provide enhanced troubleshooting. With AHM,

operators can access Boeing engineering knowledge, worldwide fleet in-service experience, and operator-unique knowledge. It also institutionalizes the use of this knowledge in a repeatable manner, allowing the operator to maintain and grow its engineering- and maintenance-usable knowledge.

AHM is currently available for the 777, 777 freighter, 747-400, 757, 767, and Next-Generation 737 airplanes. The type and availability of flight data vary by model. The 747-400 and 777 have a CMC, as will the 747-8 and 787. The CMC allows for fault collection, consolidation, and reporting. AHM relies on other data types, such as ACMS data, on airplanes without CMCs.

BENEFITS

AHM is designed to deliver airplane data when and where it's needed, allowing operators to make informed operational decisions quickly and effectively. The primary benefit provided by AHM is the opportunity to substantially reduce schedule interruption costs. Schedule interruptions consist of delays, cancellations, air turnbacks, and diversions. The three primary ways that AHM reduces schedule interruptions are prognostics, fault forwarding, and prioritization.

Prognostics. AHM helps operators forecast and address conditions before failure, a process referred to as "prognostics." With AHM, operators can identify precursors that are likely to progress to FDE faults, which will affect airplane dispatch and possibly cause schedule interruptions. AHM provides an operator's engineers with the information they need to make sound economic decisions regarding these precursors, so that the operator can perform maintenance on monitored faults on a planned basis, rather than having to react to unexpected problems with unplanned maintenance.

Fault forwarding. When a fault occurs in-flight, AHM allows the operator to make operational decisions immediately, and if maintenance is required, to make arrangements for the people, parts, and equipment sooner rather than later. This enables operators to substantially reduce the number of delays (e.g., a delay is prevented altogether) and the length of delays (e.g., a three-hour delay is shortened to one hour — see fig. 2). AHM provides both the information and the context to enable operators to make appropriate decisions while the airplane is still en route.

Prioritization. Information about fuel efficiency, economic impacts, and other performance factors is provided according to its importance to the

Maintenance personnel can get a significant head start in their decision making through the proactive use of airplane data.



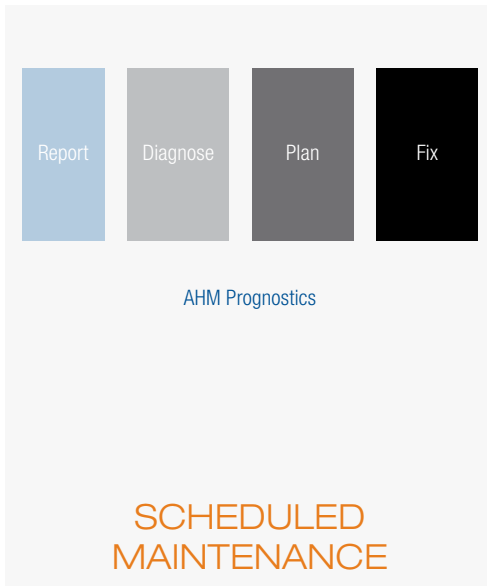
AHM enables operators to report and diagnose faults and plan for repairs before the airplane even reaches the gate, maximizing the ramp maintenance opportunity. This deals with conditions which affect airworthiness (i.e., affect next release), and which typically take place in an unscheduled manner. In addition, condition monitoring allows for purely economic conditions to be considered and resolved, thus allowing them to be addressed in a scheduled manner, and reducing in-service interruptions.

AHM ENABLES AIRLINE CUSTOMERS TO MINIMIZE FLIGHT DELAYS AND CANCELLATIONS

In one instance, a flight experienced a weather radar condition en route. The required part was identified via AHM, ordered, and sent to the arrival airport. As a result of AHM's in-flight notification, the part was replaced immediately after landing, substantially reducing the delay.

In another case, an exhaust gas temperature problem was encountered en route. The crew began an air turnback, but after AHM interrogated the central maintenance computer and investigated the airplane's history, the operator determined that the flight could continue.

In one more example of AHM in use, an airplane experienced an engine control fault en route. Via AHM, which reports engine and engine accessory fault messages, the needed part was identified and sent on a subsequent flight to the airplane's destination airport. The flight departed with minimal delay compared to what it could have been had initial fault notification occurred after landing.



operator, allowing the operator to determine the best course of action.

A number of secondary benefits result from the reduced schedule interruptions realized by using AHM:

Reduced down-line disruptions. AHM can be used by operators to calculate the likelihood of down-line disruptions and estimate the cost of such disruptions.

Reduction of missed Air Traffic Control slots. AHM can help operators reduce missed Air Traffic Control slots that result from technical delays.

Improved supply chain efficiencies. With AHM prognostics, operators can better predict line-replaceable unit failures, which means fewer cases of unscheduled removals. That results in fewer parts being borrowed and fewer parts being prepositioned at remote stations.

Reduced No Fault Found (NFF). AHM reduces the likelihood of NFF, which in turn reduces labor and spares requirements.

RECENT AHM ENHANCEMENTS

AHM has recently been enhanced to provide an even greater amount and depth of information. Called the “parametric module,” these enhancements comprise four primary components.

Systems condition monitoring. AHM uses available parametric data to assess the condition of airplane systems. It collects airplane system data using existing and new ACMS reports and compares system performance against system models.

Servicing management. By gathering data on monitored systems — including auxilliary power unit oil, engine oil, oxygen, tire pressure, and hydraulic fluid levels — AHM can provide alerts on system conditions approaching operational limits. This data-based remote condition monitoring identifies airplanes requiring system maintenance to enable replenishment prior to exceeding operational limits.

Airplane performance monitoring (APM). AHM calculates airplane performance using the ACMS APM/engine stable reports and allows operators to compare airplanes through a fleet summary view. It also integrates engine health monitoring alerts, displaying engine manufacturer (OEM) alerts of abnormal conditions and automatically linking to the engine OEM system.

ACMS report viewer and data extractor. AHM incorporates an enhanced means for viewing and analyzing ACMS data.

SUMMARY

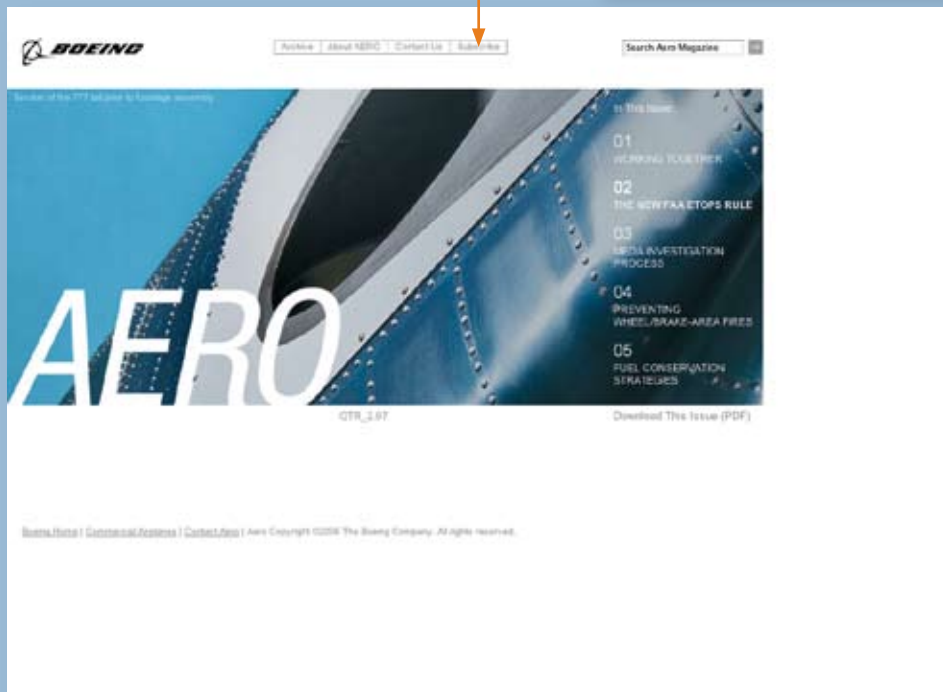
The vast potential of condition monitoring airplane systems is being realized today through the innovative use of available airplane data. These advances have been fostered through the team efforts of Boeing and commercial operators. This journey continues, with ample areas for new applications and new directions. For more information, please contact John Maggiore at john.b.maggiore@boeing.com. **A**

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