ERRONEOUS TAKEOFF

Operators have reported the use of excessively low takeoff reference speeds that have resulted in tail strike, high-speed rejected takeoffs (RTO), and other instances of degraded performance. These incidents were caused by a variety of human errors that typically resulted from using an erroneously low value for gross weight or an incorrect flap reference setting when determining takeoff speeds. Boeing is taking several steps to help operators of all transport airplanes improve the process for determining proper takeoff reference speed. These include identification of the points in the calculation process where human error commonly occurs, recommendations for reducing the occurrence of errors and for detecting any errors that still occur, related flight deck equipment options and standard procedures, and a risk assessment checklist for operators' management and flight crews.

REFERENCE SPEEDS

FLIGHT OPERATIONS

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Flight crews consider many factors when determining correct takeoff reference speeds, or V speeds, for a particular airplane on a particular runway. These include gross weight (GW); center of gravity; flap position; engine thrust level; bleed air configuration; pressure altitude; outside air temperature; wind; runway length, slope, and surface conditions; clearway; stopway; obstacles; and status of any minimum equipment list (MEL) items such as inoperative brakes, spoilers, or thrust reversers. GW itself encompasses numerous components, most of which change for each flight. The result is many opportunities for human error during calculation of V speeds, even when the process is highly automated. Operators have addressed this situation through training and by devising reliable processes for flight crews and dispatchers to follow. However, despite these preparations, occasionally an error occurs that is significant enough to cause tail strike or noticeably degraded performance during takeoff and initial climb. Operators may considerably reduce their exposure to such incidents by slightly adjusting their process for determining takeoff reference speeds, making minor revisions to their associated training, and understanding the information available on the following subjects:

1. Typical errors.
2. Magnitude of various types of errors.
3. Consequences of errors.
4. Recommended practices.
5. System aids.
6. Risk assessment checklist.

1 TYPICAL ERRORS

Determining airplane weight and computing takeoff reference speeds both involve numerous steps, which create many opportunities for human error to occur. Based on the assumption that all elements of an airplane's weight are available and accurate, the following are some examples of human errors that can result in erroneous takeoff reference speeds:

- Making a math error when converting diverse units of weight (for example, pounds to kilograms, or gallons or liters of fuel to pounds), or failing to convert mixed units to the standard unit of weight for that airplane.
- Selecting the wrong weight value from multiple figures on the load sheet.
- Making a keystroke or transposition error when entering weight into the control display unit (CDU).
- Line-selecting weight into the wrong field on the Performance Initialization (PERF INIT) page of the CDU.
- Selecting the wrong table in the quick reference handbook when determining speeds manually.
- Making an error while using the chart when determining speeds manually.
- Making a keystroke or transposition error when entering reference speeds manually.
- Line-selecting a speed into the wrong field on the Takeoff Reference (TAKEOFF REF) page.
- Selecting an actual takeoff flap setting that is different from the flap setting used to compute takeoff reference speeds.

2 MAGNITUDE OF VARIOUS TYPES OF ERRORS

Simple human errors can cause surprisingly large inaccuracies in takeoff reference speeds (fig. 1). Some examples are:

- Entering zero fuel weight (ZFW) in the GW field can result in a weight error equal to the weight of fuel on board. This error has been linked to several in-service incidents, and the potential for it to occur exists on all flight management computers (FMC) on large commercial airplanes. The FMC has boundaries that define the acceptable range for ZFW, fuel weight, and GW. In many cases, this error will result in a calculated ZFW less than the minimum allowable, and the FMC will identify the invalid entry. However, each model has a range of ZFW and fuel weight that will permit ZFW to be accepted as GW. For a 777-200 Extended Range

FIGURE 1 V_R SENSITIVITY TO OPERATOR ERROR

	717-200*	737-700	747-400	757-300*	767-400*	777-200
Zero fuel weight (ZFW) used as gross weight	16	26	36	27	27	27
ZFW digits transposed	30	16	17	41	19	16
Fuel in kilograms versus pounds	12	25	34	18	19	38
Incorrect flap	4	13	7	25	13	12

*Flight management computer does not compute takeoff V speeds.

Boeing has identified some guidelines to reduce the likelihood of error while calculating takeoff reference speeds.

airplane with 160,000 lb of fuel and ZFW of 430,000 lb, line-selecting ZFW to the GW line would result in a takeoff rotation speed (V_R) that is 27 kt too low.

- In some cases, a transposition error in which a flight crew member reverses two digits of a number when entering it into the CDU may be undetected by the FMC. Many potential transposition errors involving ZFW will result in values outside the allowable range and will be detected. However, certain transpositions that result in a large weight error can be missed. For a 757-300 with a ZFW of 210,000 lb, entering "120" instead of "210" would result in a V_R that is 41 kt too low.
- Boeing safety records indicate that several incidents were caused by the flight crew using the wrong chart to determine V speeds. Depending on the range of allowable takeoff flap settings, inadvertently using a chart for the wrong flap setting could cause an error in V_R of up to 25 kt. This example of 25 kt is for a 757-300 for which V_R is computed for "flaps 20" but the takeoff is performed with "flaps 5."

3 CONSEQUENCES OF ERRORS

If human error in determining takeoff reference speeds is not caught and corrected, the following adverse effects can result:

- Tail contact with the runway. Premature rotation reduces runway tail clearance. Erroneously low V_R on takeoff has been recorded as the cause of several incidents of tail strike.
- High-speed RTO. The airplane will not lift off at the normal attitude or time. This abnormal performance has prompted flight crews to perform high-speed RTOs.

Other effects may be less obvious, and are usually not significant with all engines running. However, they may become very significant if combined with an engine failure:

- Overweight takeoff. This can occur if the flight crew subsequently uses erroneous GW to decide whether a runway is acceptable for departure.
- Increased runway length required. Premature rotation increases drag and significantly increases the distance from rotation to liftoff.
- Reduced obstruction clearance. Increased drag is present from the point of rotation until the airplane accelerates to the normal climb speed profile. Climb gradient is reduced during this time.
- Degraded handling qualities. After liftoff, there is reduced maneuver margin to stall until the airplane accelerates to the normal climb speed schedule. Achieving the proper climb speed schedule probably will not occur until after the airplane passes acceleration height, because takeoff safety speed (V_2) will also be erroneously low.

4 RECOMMENDED PRACTICES

The systems and procedures that operators use to determine takeoff reference speeds vary considerably. However, Boeing has identified some guidelines to reduce the likelihood of error while calculating these speeds, regardless of the specific process followed:

- Provide accurate weight data to the person responsible for determining takeoff reference speeds.
- Present the weight data in a clear and unambiguous format.
- Establish procedures to manage time pressure and out-of-sequence operations.
- Always enter ZFW on FMC-equipped airplanes.
- Establish reliable procedures for verification of manual operations.

Provide accurate weight data to the person responsible for determining takeoff reference speeds.

Although this may appear to be an obvious step, it is important to perform in order to reduce the many opportunities for error that can occur when determining ZFW and fuel weight. Each operator should provide a robust process and proper training for any personnel who may be responsible for computing ZFW, GW, and fuel weight (when required). All weight computations should be performed in the dispatch office or an equivalent environment that is subject to fewer distractions than exist on the flight deck.

Training and procedures must include information to ensure that conversion to proper units, such as kilograms to pounds, is accomplished when needed and performed correctly. Operators should exercise special care if dispatching an airplane under the MEL with the fuel quantity indication system inoperative. They should also ensure that all airline MEL procedures are followed to determine actual fuel on board. Because human error can occur when transcribing numbers from one document to another, the process for computing the final values for the load sheet should minimize the number of times that numbers must be transcribed from the initial source to the final product.

Present the weight data in a clear and unambiguous format.

The load sheet should be formatted to reduce the possibility that the pilot will select the wrong weight value for making performance calculations. Boeing has revised its standardized load sheet to highlight the ZFW value, and has added the note "Enter ZFW into FMC" to further highlight the ZFW value (fig. 2). Boeing recommends that operators who use their own load sheet review its format and modify it, if necessary, to decrease the number of opportunities for the pilot to select the wrong weight value. This recommendation also applies to the format of the aircraft communications addressing and reporting system (ACARS) display and printout for operators who use ACARS to uplink weight data to the flight deck.

Establish procedures to manage time pressure and out-of-sequence operations.

Operators must first ensure that their normal operating procedures permit sufficient time for the flight crew to perform the steps of determining V speeds carefully and with proper verification. Secondly, if a task must be performed out of the normal sequence, time pressure and multitasking can occur, which increase the risk of error. Therefore, operators should establish processes to ensure that final weight data is ready for the flight crew in time to conduct normal preflight procedures in sequence. Finally, if it becomes necessary to enter or update the weight data after engine start or pushback, the flight crew must be sure to use the same care and verification procedures they would use if the airplane were still at the gate. Operators should encourage flight crews to take whatever measures are necessary to ensure that this can be achieved.

Always enter ZFW on FMC-equipped airplanes.

This is essential because ZFW, once established, is a constant value for the entire flight, but GW changes as fuel is burned. Also, planned fuel weight may not equal actual fuel weight because of variations in fuel density or a math error, such as a unit-conversion error. By entering ZFW, the flight crew uses a known, constant value and lets the FMC perform the calculation. The FMC will apply the current, actual fuel on board to obtain the most accurate and less error-prone value for GW. The FMC will also maintain an accurate GW for the remainder of the flight. Another reason to always enter ZFW is that flight crews who alternate between using GW and ZFW become accustomed to using both fields on the PERF INIT page. The Boeing position is that these flight crews are more likely to enter a weight value on the wrong line (GW on the ZFW line or ZFW on the GW line). In January 2000 Boeing began modifying all operations manuals, as necessary, to indicate that entering ZFW is the normal procedure. These revisions for all Boeing commercial airplanes will be completed by January 2001.

Establish reliable procedures for verification of manual operations.

Human error continues to occur while calculating takeoff reference speed, even with the training and procedures designed to minimize such error. However, a thorough check by another properly trained person should reduce, by several orders of magnitude, the likelihood that these errors will not be caught. Operator procedures and training must be established to ensure that this verification is accomplished consistently and carefully. The appropriate method of verification, however, is different for automated systems and manual systems:

- For the FMC and other computerized systems, one flight crew member should always cross-check CDU entries made by the other

2 FIGURE ZFW INFORMATION ON MODIFIED LOAD SHEET

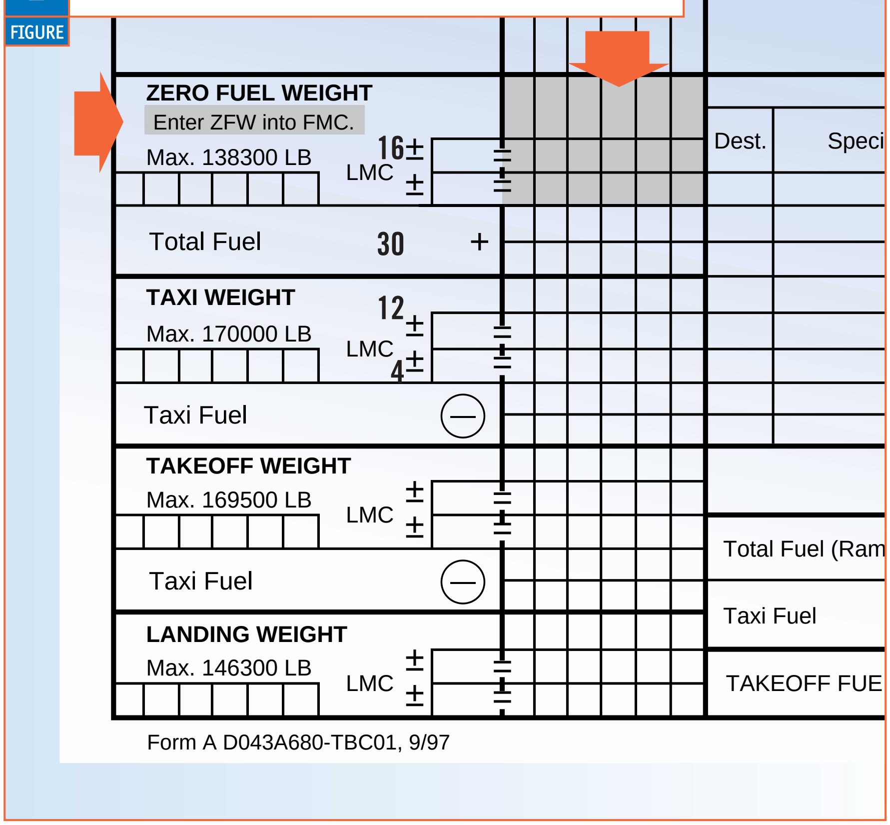
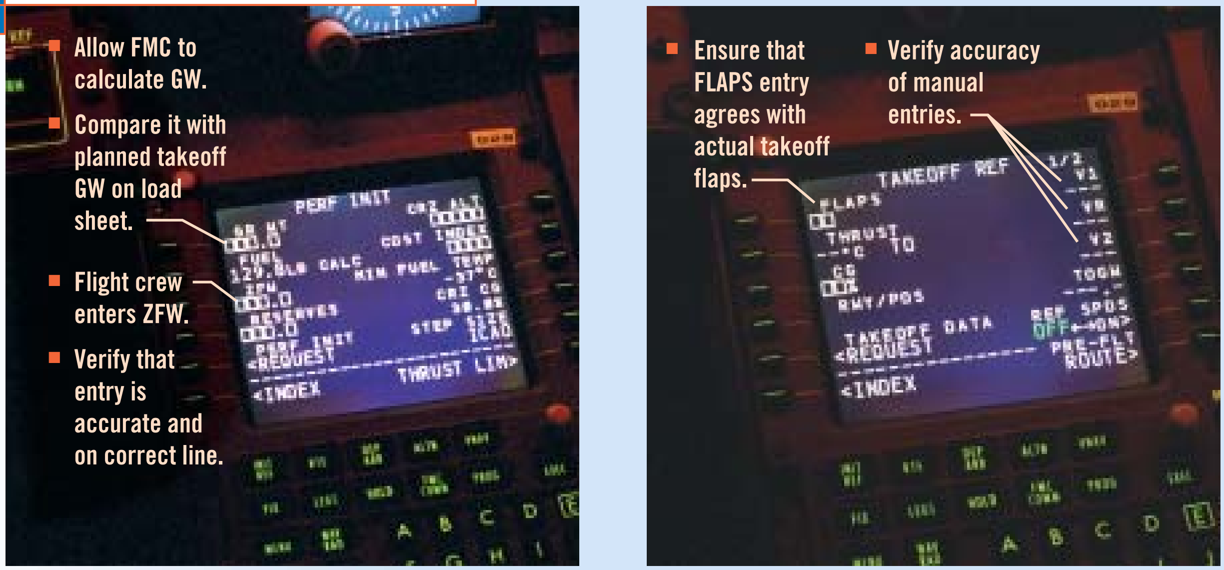


FIGURE 3 VERIFICATION OF CDU DATA ENTRY



flight crew member. The FMC and other equivalent computerized systems are certified to produce accurate results based on accurate input. When the input is wrong, the results are wrong, so operators must ensure that the input is correct. Procedures must be modified, if necessary, to state that the entries of one flight crew member must receive a thorough verification from the other flight crew member. The verifying flight crew member needs to confirm that the correct values have been entered, and that they have been entered onto the correct lines on the PERF INIT and TAKEOFF REF pages (fig. 3). As an additional step to detect an input error, both flight crew members should also cross-check the resulting GW value against the planned GW on the load sheet.

- For operators who use manual processes to compute takeoff parameters, takeoff reference speeds should be determined by two independent processes and compared. The independent processes could involve two personnel, either two flight crew members or a flight crew member and a dispatcher, independently using the same method, such as the airport/runway analysis chart. It could also involve the use of two different methods to determine the values, such as a lookup table and a performance chart.

- Manual operations to set speed bugs also require verification. On airplanes equipped with an FMC that calculates V speeds, or into which dispatch-calculated V speeds can be entered from an uplink, the FMC and display system automatically set the speed bugs. Because this process is not subject to human error, no special speed bug verification is required as long as the original data entries were verified. Other airplanes require manual entry of takeoff reference speeds through the CDU, the speed reference selector, or physical positioning of the bugs. Because manual entry provides an opportunity for human error to enter the process, verification is required at this step as well. Operating procedures should include a requirement for both flight crew members to confirm that the bugs are set correctly. Regardless of how the speed bugs are set, V_2 must also be set manually in the mode control panel IAS/MACH window as the target reference speed. This manual entry also requires verification.

5 SYSTEM AIDS

In addition to a reliable process for calculating takeoff reference speeds, some automated system features can help prevent the errors that may result from this process: ACARS with FMC communications feature and GW entry inhibited.

ACARS with FMC communications feature.

For airplanes with ACARS and a suitably equipped FMC (see paragraph below), ZFW and takeoff reference speeds may be uplinked directly from the operations office into the FMC. Flight crews can send a request for data to their operations center directly from the PERF INIT page of the CDU. Data may also be uplinked to the airplane unsolicited as part of normal procedures. Received data is displayed on the CDU. After verification, the flight crew member simply needs to accept the data, and can do so by pushing the ACCEPT line select button.

4 FIGURE PLANNED FMC UPDATES WITH GW ENTRY INHIBIT

Airplane model	FMC type/software	Target update	Estimated availability
737-NG	4 modular concept units/Ada	10.4	3Q 2001
747-400	Advanced FMC/Pascal	First update after load 15	Potential 3Q 2002
757 and 767	Pegasus/Ada	Pegasus 2001	2001/2002
777	Airplane information management system (AIMS) line replaceable module/Ada	AIMS 2001	3Q 2001

This uplink capability requires the airplane's FMC to be equipped with the FMC communications feature and either the performance initiation function or the takeoff data function, or both. These features are available on current-production 737, 757, 767, and 777 airplanes. The ACARS/FMC system can eliminate several, but not all, potential sources of error. Weight data must be entered manually at some point in the calculation process, so verification is still required in the dispatch or operations office to ensure that the numbers entered manually were correct.

GW entry inhibited.

Another system approach for reducing calculation errors would be to disable the manual entry of GW on the PERF INIT page. This proposed feature would eliminate the possibility of a flight crew member inadvertently line-selecting the ZFW onto the GW line. (This option will not affect the current capability to manually enter GW on the Approach Reference page.) Boeing will make this feature available as an option in future FMC software updates. Figure 4 lists the targeted FMCs and probable incorporation points.

6 RISK ASSESSMENT CHECKLIST

Boeing has developed a risk assessment checklist to help operators assess the adequacy of their own processes for determining correct takeoff reference speeds (see p. 21). This checklist consists of a series of questions and relevant examples for self-evaluation. Operators are encouraged to review their operating procedures using this checklist and to adjust their processes to address any deficiencies that may be revealed as a result.

SUMMARY

The occurrence of human error while establishing takeoff reference speed has caused tail strike, high-speed RTOs, and other instances of degraded performance. These errors can occur in a variety of ways. Operator procedures are the primary means for eliminating these errors. Establishing proper procedures can reduce these errors by helping flight crews avoid situations that make the initial error more probable. These procedures must also ensure that any error that does occur is caught and corrected before it can cause a problem during takeoff or initial climb. The primary method for eliminating error is to ensure that comprehensive, independent verification steps are accomplished at key points where a manual task is performed. Operators are encouraged to review each step of their process and make adjustments to address any deficiencies they may uncover. Boeing has developed a risk assessment checklist as a tool for this review. Operators should also consider two automation features that eliminate known points of error input. One is the ACARS/FMC communications feature, which is available on most current-production airplanes. The other feature is the option to disable FMC GW entry, which will become available with future FMC software updates.

TAKEOFF REFERENCE SPEEDS RISK ASSESSMENT CHECKLIST

By using the following checklist, operators can assess the adequacy of their processes for determining correct takeoff reference (V) speeds. Each process is followed by a question, a rating of the degree to which an error committed in the process can affect takeoff, and examples of practices (best, good, and poor) used to complete the process:

1. Determine zero fuel weight.
2. Determine gross weight.
3. Communicate weights to flight crew.
4. Include complete information for deriving V speeds.
5. Cross-check manual operations.
6. Set speed bugs.

1 DETERMINE ZERO FUEL WEIGHT (ZFW)

1a. Operating empty weight (OEW). How is the OEW established for each airplane? Effect of error: small.

Best practices	Good practices	Poor practices
■ An airplane specifier (e.g., tail number) is used to calculate and track OEW. ■ Each airplane is periodically weighed to keep weight accurate and up to date. ■ Airplanes are weighed after any significant modification (e.g., weight change of ± 0.5% of maximum takeoff weight, or center of gravity (CG) change of ± 0.5% mean aerodynamic chord). ■ A system is in place that documents weight and CG changes for all airplanes or engine modifications that have been accomplished. ■ The weights of different meal services are known and applied to obtain an accurate OEW for different routes.	■ An airplane specifier is used. The airplane is weighed when equipment changes are made, but periodic weighings may not keep up with smaller changes over time (e.g., accumulated dirt). ■ An average operating fleet weight is used for airplanes of the same configuration provided their individual OEW and CG are within established tolerances of the fleet average, as described in AC 120.27c, IATA AHM 531, or equivalent.	■ Airplanes are not weighed at a specified interval or when significant modifications are made. ■ An average operating fleet weight is used for all airplanes of the same type (e.g., 737) regardless of configuration, weight or CG differences.

(continued)

1 DETERMINE ZERO FUEL WEIGHT (ZFW), continued

1b. Cargo (baggage and nonbaggage) weight. How is cargo (baggage and nonbaggage) weight determined?
Effect of error: medium; errors in determining cargo weight can have a sizable effect on airplane weight.

Best practices	Good practice	Poor practices
■ All cargo and baggage are weighed before loading onto the airplane. ■ Load contents are determined according to what is actually loaded, instead of by what is planned to be loaded. ■ Procedures require a final check of the cargo and its position loaded on the airplane.	■ Nonbaggage cargo has not been weighed prior to loading, but the shipper has provided accurate weights.	■ Nonbaggage cargo weight comes from the central load planner based on what is expected to be loaded, but this weight is not compared to actual loading. ■ Nonbaggage cargo weight information comes in with varying weight units (e.g., pounds versus kilograms).

1c. Passenger count and weight. How is passenger count and weight determined?
Effect of error: small; a big passenger difference is required to result in a large weight difference.

Best practices		Poor practices
■ Passenger count is determined when boarding is complete, and differences from expected count are used to update ZFW. ■ Average weight value for passengers and carry-on baggage is adjusted as significant changes occur (e.g., seasonal differences, special charters, or nonstandard weight groups), in accordance with AC 120.27c, IATA AHM 531, or equivalent.		■ Final passenger count is not used to update ZFW. ■ Average passenger weight is not adjusted for significant changes in passenger characteristics.

2 DETERMINE GROSS WEIGHT (GW)

2a. Fuel weight (FW). How is fuel weight determined?
Effect of error: medium; some errors, such as using incorrect units, can have a sizable effect on fuel weight.

Best practices	Good practice	Poor practice
■ Sensed fuel quantity is passed to the flight management computer (FMC); the FMC determines fuel weight. ■ Standard processes are in place to ensure accuracy when manual calculations or entries are required (e.g., when dispatching under Master Minimum Equipment List). ■ All stations use the same units of measurement for fuel quantity.	■ Fuel weight is not input to the FMC automatically, but fuel on board is known. A process exists to ensure that the correct fuel weight is provided to the flight crew. Flight crews manually enter fuel quantity into FMC and verify entry.	■ No fuel quantity indications are available and Dispatch Deviation Guide procedures are not implemented effectively. For example, no adequate procedure exists for ensuring that fuel units are consistent (e.g., gallons or liters must be converted to pounds or kilograms).

2b. Input ZFW into FMC. Do procedures standardize entry of ZFW into the FMC CDU?
Effect of error: large; a GW error equal to the weight of fuel on board could occur.

Best practice		Poor practices
■ The flight crew always enters ZFW onto the Performance Initialization page of the CDU. FMC will compute GW based on entered ZFW and sensed fuel quantity.		■ The flight crew has a choice of entering ZFW or GW into the FMC. ■ The flight crew may enter a GW estimate initially, then enter ZFW later when final data is available.

3 COMMUNICATE WEIGHTS TO FLIGHT CREW

3a. Document weights clearly for flight crew. Are weights put in a form so that it is easy for the flight crew to find the ZFW or the GW without any additional computation? Effect of error: large; significant errors such as selecting the wrong weight can occur when transferring weights from a form.

Best practices	Good practice	Poor practices
■ ZFW and GW values are easy to locate and interpret on the load sheet, and the appropriate weight (ZFW for FMC use, GW for chart method) is highlighted effectively. ■ All stations and FMCs use the same units of measurement for weight. ■ The same load sheet format is used at all stations.	■ ZFW and GW values are easy to locate and interpret on the load sheet.	■ ZFW and GW values are hard to locate or interpret in dispatch papers. ■ The flight crew has to transfer information from multiple sheets to get GW or ZFW. ■ The flight crew has to do some computation or interpretation to get a GW or ZFW value. ■ The flight crew has to convert between different units of measurement.

3b. Provide timely information. Do crews receive weight information in a timely manner? Effect of error: large; late-arriving information and time pressure can lead to significant input errors.

Best practice	Good practice	Poor practice
■ The flight crew receives final weight information by the time it is needed for the normal preflight sequence. There is little time pressure.	■ Weight data is sometimes provided out of sequence, but procedures have been established to ensure that the flight crew can enter and verify the data without distraction or high time pressure.	■ The flight crew frequently receives final weight data out of the normal sequence, when time pressure is high.

3c. Communicate weights to flight crew; aircraft communications addressing and reporting system (ACARS) is used. Is accurate weight data input to ACARS, verified, and uplinked to airplane? Effect of error: large; significant errors such as transposing numbers can occur while entering weights in ACARS and transmitting them.

Best practice	Good practices	Poor practices
■ An accurate ZFW is checked, uplinked via ACARS and loaded automatically into the FMC.	■ An accurate ZFW is checked and uplinked via ACARS to the flight deck. ■ ZFW is clearly identified.	■ ACARS presentation/format is confusing or poorly laid out (e.g., ACARS values are not clearly labeled). ■ Either ZFW or GW are missing from ACARS; only their components are provided. ■ Weight data is not verified prior to ACARS uplink.

4 INCLUDE COMPLETE INFORMATION FOR DERIVING V SPEEDS

4a. Gather all relevant information. Is all relevant information available for calculating V speeds? Effect of error: medium or small, depending on which factors are not included.

Best practice		Poor practices
■ Complete information (GW or ZFW and fuel weight, pressure altitude, temperature, flap setting, wind component, runway slope, thrust derate, obstacles, bleed status, defects) is sensed or provided, and incorporated.		■ Atmospheric variables estimated for time of departure are not updated despite weather change. ■ Incomplete information is provided for deriving V speeds.

5 CROSS-CHECK MANUAL OPERATIONS

5a. Make flight crews aware of potential for errors. Does the flight crew give consideration to the potential for errors? Effect of error: small; errors may occur regardless of training.		
Best practice ■ The flight crew has been trained on the possible adverse outcomes of a V-speed error.		**Poor practice** ■ The flight crew is insufficiently cautious about V-speed errors.
5b. Input check (FMC or other computer system). Do standard procedures require verification of FMC or other computer entries? Effect of error: large; a good check by the other flight crew member can catch big errors.		
Best practice ■ Airline procedures require that the CDU entries made by one flight crew member are always verified by the other flight crew member. The verifying flight crew member confirms that the entries are accurate, complete, and entered in the correct field.		**Poor practices** ■ No verification procedures are in place. ■ Verification procedures are vague.
5c. Final check (FMC or other computer-based V-speed calculation). Is a GW check in place for checking V-speed values? Effect of error: large; a good check system can catch big errors.		
Best practice ■ Dispatch provides their GW value and airline procedures direct flight crew members to cross-check this value against the GW computed by the FMC.		**Poor practice** ■ No GW check is used.
5d. Process check (manual V-speed calculation). Is an alternate method used for computing V-speed values? Effect of error: large; a good check system can catch big errors.		
Best practices ■ Dispatch makes an independent V-speed calculation as a check on the method used by the flight crew. ■ One flight crew member makes an independent V-speed calculation as a check on the method used by the other flight crew member. ■ Prior to entering the manually computed V speeds into the FMC, the flight crew member compares them to the FMC-computed V speeds.		**Poor practice** ■ No backup method is used to verify manual calculations.
5e. Final check (manual V-speed calculation). Do standard procedures require verification of manually entered V-speed values? Effect of error: large; a good check system can catch big errors.		
Best practice ■ Airline procedures require that manual V-speed entries into the CDU are always verified by the other flight crew member.		**Poor practices** ■ No verification procedures are in place. ■ Verification procedures are vague.

6 SET SPEED BUGS

6a. Set V speeds on airspeed indicator. Are airspeed bugs set correctly?
Effect of error: large; flight crew member will respond to speed bugs rather than actual V speeds (if different).

Best practice	Good practice	Poor practice
■ Speed bugs are set automatically from FMC values accepted by the flight crew.	■ Speed bugs are set manually and procedures require verification by the other flight crew member.	■ Manual entry is required to set speed bugs and procedures do not require verification by the other flight crew member.

BOEING ACTIVITIES RELATED TO ERRONEOUS TAKEOFF REFERENCE SPEED

March 1999	Discussion topic at Boeing Flight Operations Symposium.
December 1999	Technical bulletin issued.
December 1999	Format improvements for Boeing standardized load sheets.
March 2000	Risk Assessment Checklist sent to operators.
January 2001	Operations Manuals updated.
May 2000	Topic incorporated into Flight Operations Safety Program (airline visits).
2001	Flight management computer option to disable gross weight entry on Performance Initialization page, beginning with Airplane Information Management System on 777 airplane.