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The Boeing Company
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Seattle, WA 98124-2207

01 July 1999
B-H200-16716-ASI

Mr. A. G. Xidias
Acting Manager, ANM-100S
Department of Transportation
Federal Aviation Administration
Seattle Aircraft Certification Office
1601 Lind Avenue Southwest
Renton, WA 98055-4056

Subject: NTSB Recommendation A-99-27, Block Maneuvering Speeds-USAir 737-300 N513AU Accident near Pittsburgh, Pennsylvania-8 September 1999

Reference: a) NTSB Safety Recommendations letter from Jim Hall to Jane Garvey, 16 April 1999

b) Flight Standards Information Bulletin for Air Transportation, number 99-2, Maneuvering Speeds and Recovery Procedures for Boeing 737 Airplanes, 24 March 1999

c) Operations Manual Bulletin TBCE-11, Maneuvering Speeds for the 737-100/-200/-300/-400/-500, 28 May 1999

Dear Mr. Xidias:

The following information provides the rationale and action taken by The Boeing Company to accommodate the subject recommendation.

Summary

Boeing 737 maneuvering speeds have been adjusted to provide a margin to the flight test demonstrated speeds where the lateral control system can just balance the roll due to rudder sometimes called the "crossover speed". Figures are enclosed which show the crossover speeds and recommended maneuvering speeds (Block Speeds) as a function of weight for each flap setting where the Block Speeds were changed. The crossover speed data were determined using flight test data from the 737-200, 737-300, 737-400 and 737-500 models. Block Speeds were increased from 0 to 20 knots depending on weight and flap setting.

Introduction

The National Transportation Safety Board (NTSB) in reference (a), recommended evaluation of the Boeing 737's block maneuvering speed schedule to ensure the adequacy of airspeed margins above crossover airspeed for each flap configuration. The NTSB recommended that the results of the evaluation be provided to air carrier operators of the Boeing 737 and the NTSB, and that Boeing be required to revise recommended block-maneuvering speeds "to ensure the adequacy of airspeed margins above crossover speed for each flap configuration".

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The Federal Aviation Administration (FAA) responded to the NTSB recommendation by issuing a Flight Standards Information Bulletin (reference b) to increase the existing operational speeds by 10 knots. Boeing has evaluated the block maneuvering speed schedule relative to crossovers speeds and has released an Operations Manual Bulletin (reference c), that revises the 737 block maneuvering speed. This letter documents the process that led to the recommended maneuvering speeds and the crossover speeds obtained from the flight test data.

Discussion

Recent flight testing of the various 737 classic models (all models were tested except the 737-100) currently in service was conducted to obtain data for pending simulator updates. As part of that testing, full rudder sideslips were conducted starting at relatively high airspeeds and slowing until full lateral control was required to maintain heading or until stick shaker was encountered. The speed at which full lateral control was required to counter the rolling moment due to rudder induced sideslip has been termed the crossover speed. These data were used to establish crossover speed as a function of weight and flap setting, independent of 737-model type.

The crossover speeds were used by a team comprised of airlines, Boeing and the FAA to determine the recommended Block Speeds. Airlines involved included USAirways, Canadian International, Lauda, Continental, United, Alaska and Southwest. The operational impacts of proposed changes to the maneuvering speeds were discussed in detail and airline contributions were very influential in reaching consensus on final recommendations. The following points were considered important by the airlines and are discussed in more detail in the enclosed Operations Manual Bulletin.

- A new weight category was added for low weights where crossover speed is not limiting
- Block Speeds for flap settings greater than flaps 10 do not need to be revised

- Increasing Block Speeds during takeoff is not required since exposure time is very limited
- Airspeeds specified by non-normal procedures should continue to be followed
- VNAV operation may have to be altered to follow the recommended speeds
- Current simulator aerodynamic models may not adequately reflect the crossover speeds
- Crews must use all available flight controls to maintain airplane control as specified in the Uncommanded Yaw or Roll checklist, regardless of maneuvering airspeed
- The revised Block Speeds will be in effect until the new Rudder Pressure Reducer is installed and an evaluation of the speeds relative crossover speed is completed
- The 737-6/7/800 models are not affected by this increase since they are equipped with a Rudder Limiter System at the time of delivery and flight testing showed that crossover speed is below maneuvering speed for all flap settings

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Several other important factors were considered during discussions of the operational Block Speeds:

- Revised speeds must be set to allow some margin between the Block Speed and the speed placard for each flap setting
- Overweight landings were considered to be improbable, so that Block Speeds at weights well above the maximum landing weights need not be above the crossover speeds
- Adding the same speed increment for all flaps and weights, while simpler to implement, was not in the best interest of the airlines

The original and revised recommended Block Speeds along with the crossover speeds are shown in figures 1-4 for flaps up through 10 respectively. Note that the revised Block Speeds are equal to or greater than the crossover speeds up to well beyond the maximum landing weight for any 737 model.

Boeing is updating our 737 simulator packages to reflect flight test data on crossover speed. The following is the schedule for release of these packages to customers who have purchased the simulator data packages.

Model 737-300	30 April 1999	(Completed: 29 April 1999)
Model 737-200	11 June 1999	(Completed: 25 June 1999)
Model 737-500	30 July 1999	(Revised ECD: 20 August 1999)
Model 737-400	27 August 1999	(Revised ECD: 17 September 1999

The simulator data packages for 737-6/7/800 airplanes already contain this information.

The information being forwarded to the FAA and the NTSB by or with this correspondence is for the exclusive purpose of supporting the FAA regulatory activities, contains data that is considered proprietary to The Boeing Company, and is provided on a confidential basis.

If you have any questions, please do not hesitate to call.

BOEING

Very truly yours,

[redacted]

for Ronald J. Hinderberger
Director, Airplane Safety
Org. B-H200, M/S 67-PR
[redacted]

Enclosures

- Boeing Figures 1-4, *Block Speeds – Flaps Up, 1, 5, 10*
- (reference (c))

cc: Mr. Tom Haueter, NTSB, AS-10
Mr. Ben Berman, NTSB, AS-30
Ms. Vikki Anderson, FAA, AAI-100
Mr. Steve O'Neal, FAA, SACO

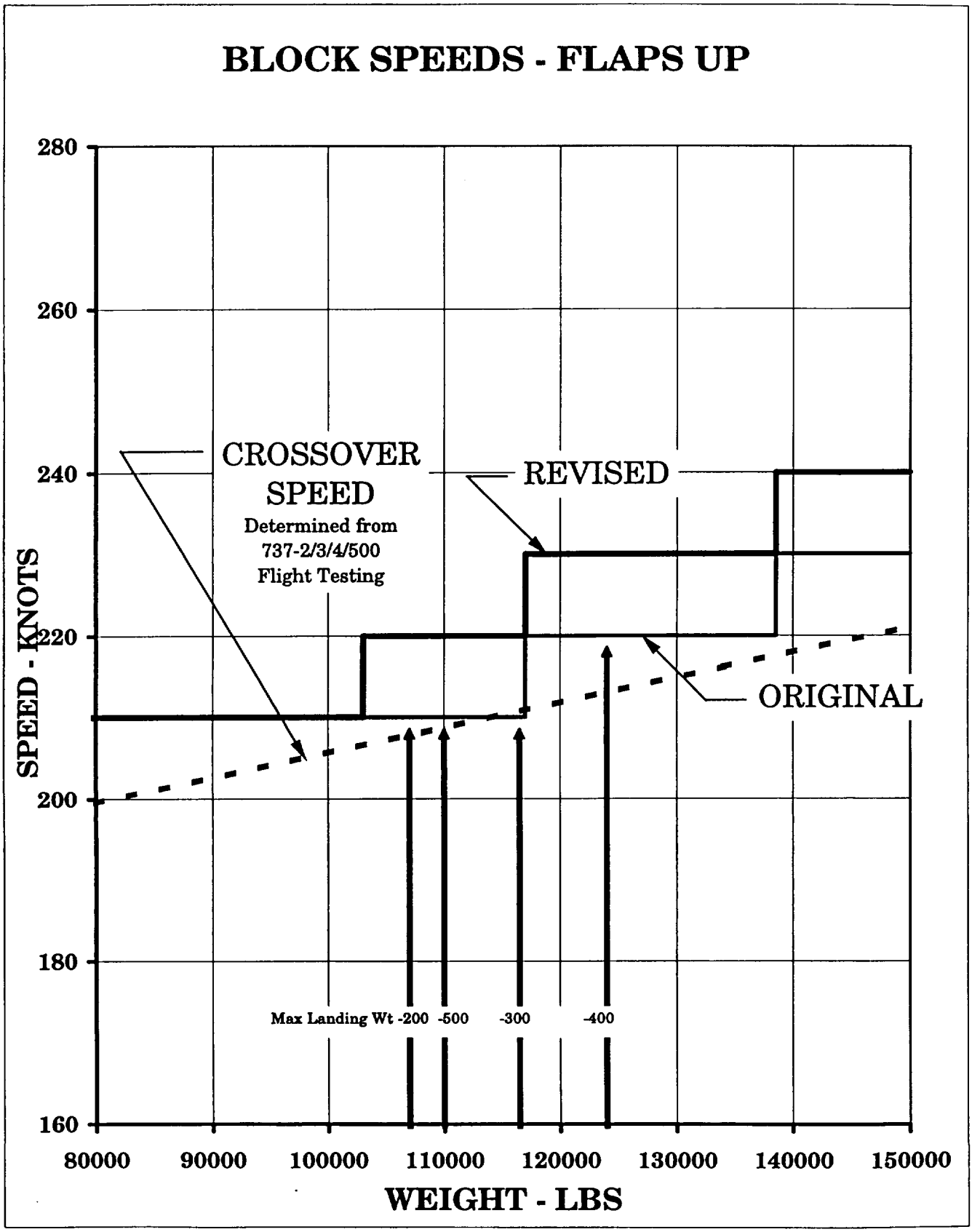
BLOCK SPEEDS - FLAPS UP
280
260
240
220
200
180
160
SPEED - KNOTS
CROSSOVER SPEED
Determined from 737-2/3/4/500 Flight Testing
REVISED
ORIGINAL
Max Landing Wt -200 -500 -300 -400
80000
90000
100000
110000
120000
130000
140000
150000
WEIGHT - LBS

Figure 1

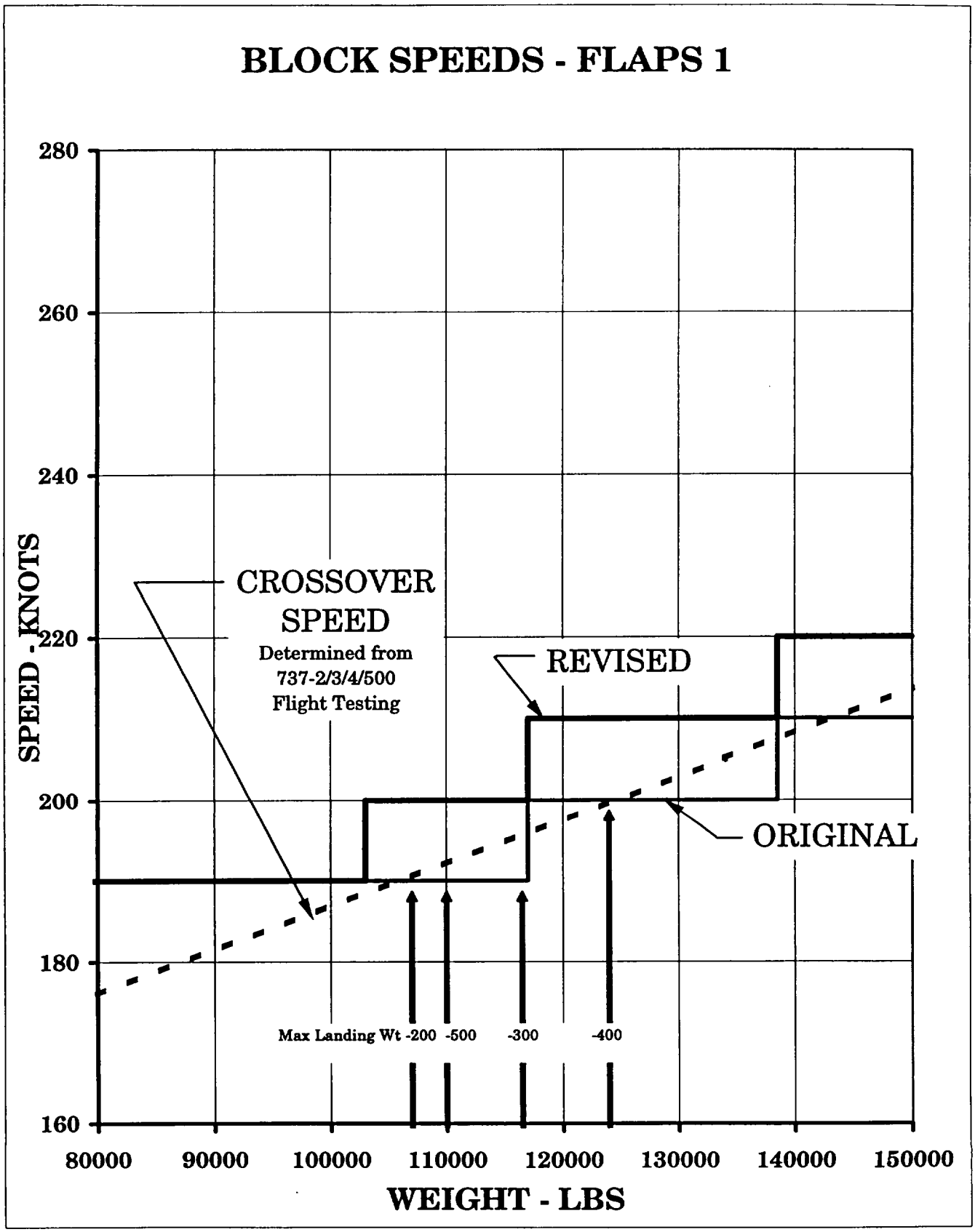
BLOCK SPEEDS - FLAPS 1
280
260
240
220
200
180
160
SPEED - KNOTS
CROSSOVER SPEED
Determined from 737-2/3/4/500 Flight Testing
REVISED
ORIGINAL
Max Landing Wt -200 -500 -300 -400
80000
90000
100000
110000
120000
130000
140000
150000
WEIGHT - LBS

Figure 2

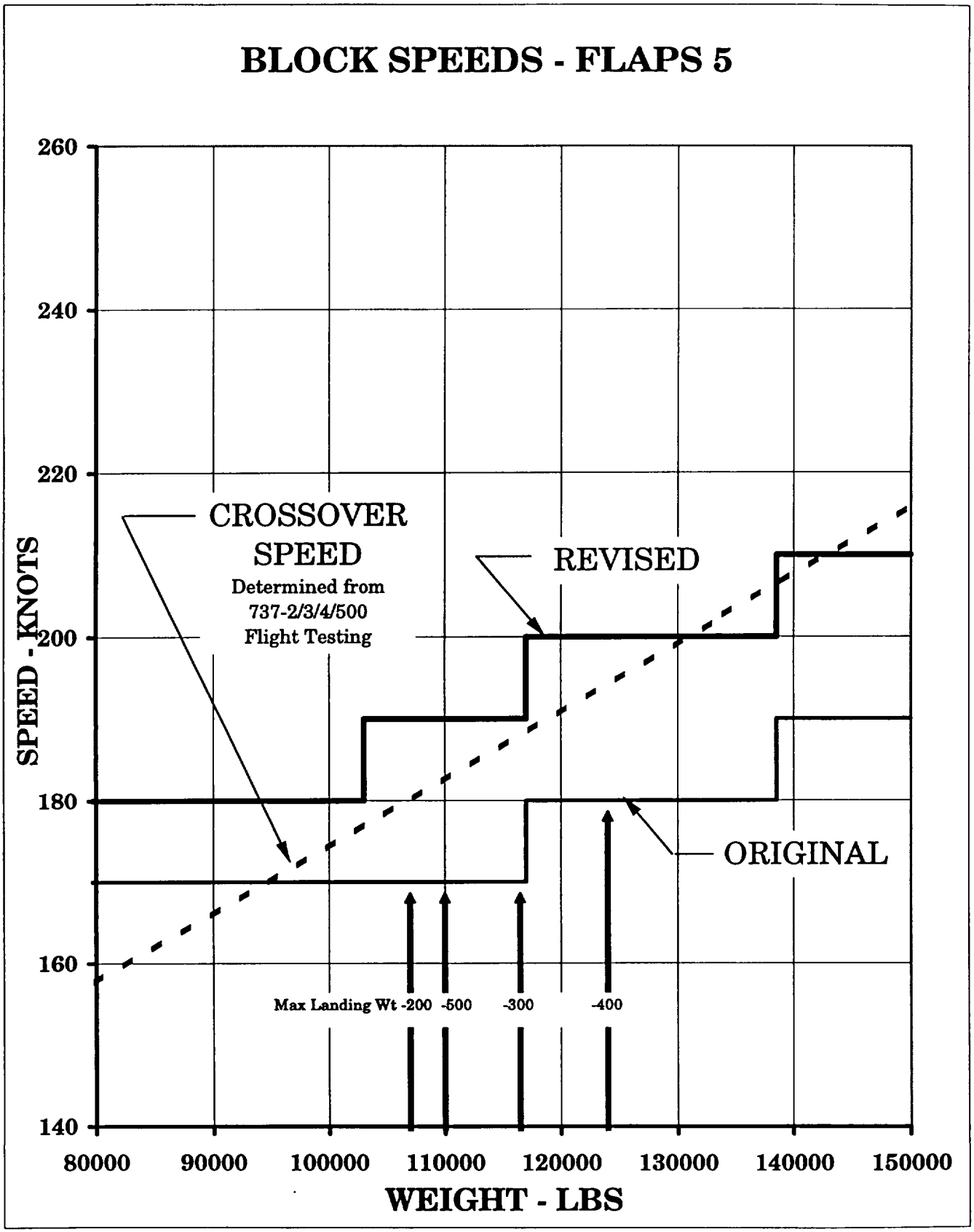
BLOCK SPEEDS - FLAPS 5
260
240
220
200
180
160
140
SPEED - KNOTS
CROSSOVER SPEED
Determined from 737-2/3/4/500 Flight Testing
REVISED
ORIGINAL
Max Landing Wt -200 -500 -300 -400
80000
90000
100000
110000
120000
130000
140000
150000
WEIGHT - LBS

Figure 3

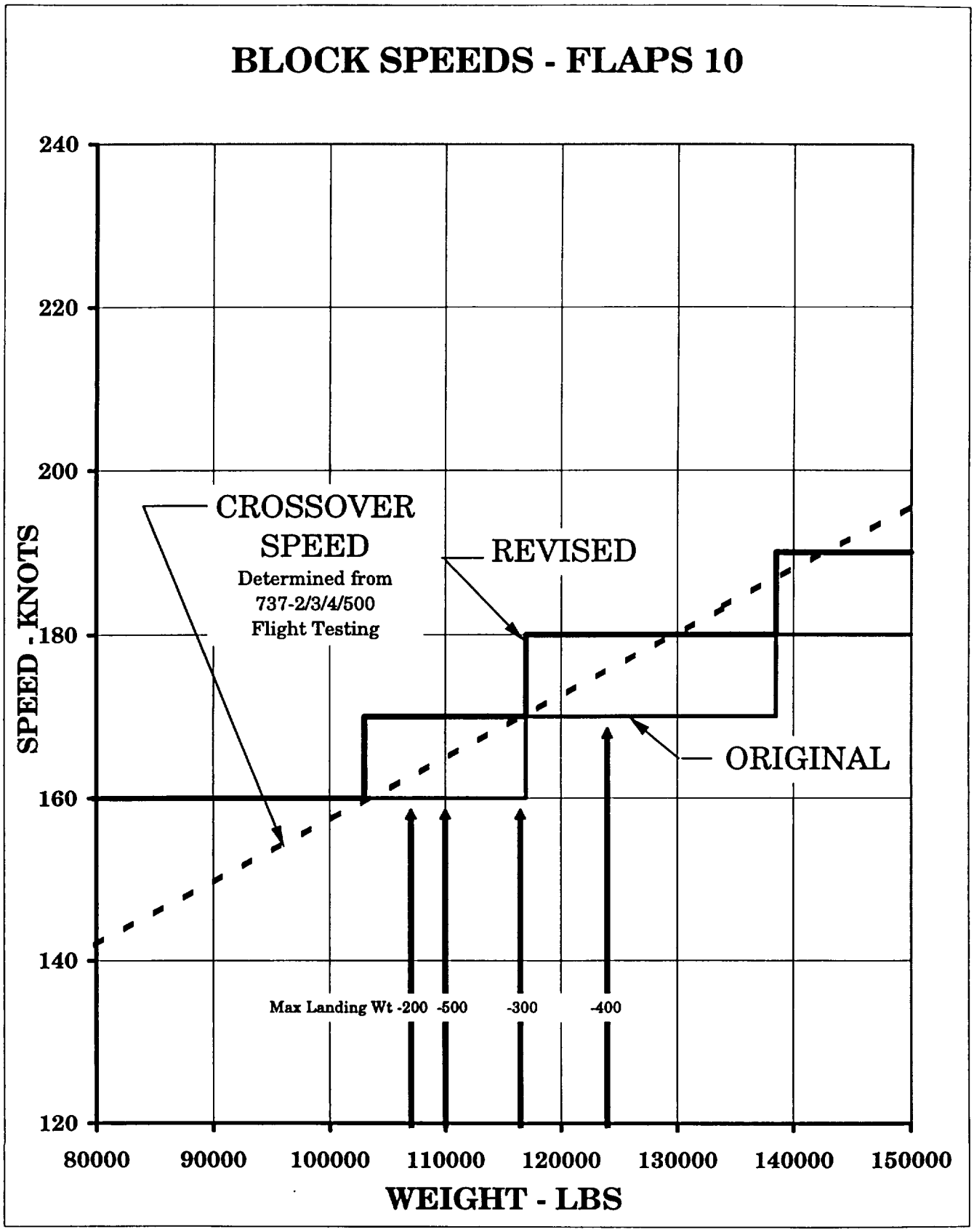
BLOCK SPEEDS - FLAPS 10
240
220
200
180
160
140
120
SPEED - KNOTS
CROSSOVER SPEED
Determined from 737-2/3/4/500 Flight Testing
REVISED
ORIGINAL
Max Landing Wt -200 -500 -300 -400
80000
90000
100000
110000
120000
130000
140000
150000
WEIGHT - LBS

Figure 4

Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

Number: TBCE-11

Date: May 28, 1999

Document Effectivity: D6-27370-400E-TBCE

Subject: MANEUVERING SPEEDS FOR 737-100/200/300/400/500

Reason: Revise the Boeing Recommended Maneuvering Speeds

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

At a public meeting held March 23-24, 1999, the United States National Transportation Safety Board (NTSB) provided an Abstract of the Final Report regarding the accident investigation of US Air Flight 427. This abstract included in its safety recommendations that the Federal Aviation Administration (FAA) "Evaluate the Boeing 737's block maneuvering speed schedule to ensure the adequacy of airspeed margins above crossover speed for each flap configuration, provide the results of the evaluation to air carrier operators of the Boeing 737 and the Safety Board, and require Boeing to revise block maneuvering speeds to ensure a safe speed margin above crossover speed."

The FAA's response has been to release a Flight Standards Information Bulletin for Air Transportation (FSAT) number 99-2 titled Maneuvering Speeds and Recovery Procedures for Boeing 737 Airplanes. The FSAT recommends that "For the interim period and prior to completion of fleet retrofit" (of a redesigned rudder power control unit (PCU) and the installation of both a digital yaw damper system and a rudder pressure reducer), "that all 'Block Speeds' for flap settings of UP, 1, 5, and 10 be increased by at least 10 knots and that these increased speeds be used in lieu of the published Block Speeds."

An industry team comprised of airlines, Boeing and the FAA worked together to develop the content and revised "Block Speeds" included in this bulletin.

The maneuvering speeds recommended by Boeing are referred to as the Block Speeds. Block Speeds are approach speeds for a specific flap setting for a corresponding range of weights. The "crossover" speed is the airspeed that requires full lateral (roll) control from the ailerons and spoilers to counteract roll due to yaw caused by a full rudder input. At speeds slower than the crossover speed, with a full rudder input, the roll induced by the rudder starts to exceed the lateral control authority.

Since the crossover speed is dependent on airplane gross weight, analysis of flight test data demonstrates that an additional Block Speed category for low gross weight airplanes can be added. This new category is for airplane weights at or below 103,000 LBS (46,818 KGS).

The Block Speed increases are recommended when maneuvering for landing at flaps UP through flaps 10. At flaps greater than 10, normal Block Speeds may be used. For airplanes operating at weights at or below 103,000 LBS (46,828 KGS), for flaps 5 only, a 10 knot increase to Block Speeds is recommended. For airplanes operating at weights above 103,000 LBS (46,818 KGS), a 10 knot increase to current Block Speeds for flaps UP, 1, and 10 is recommended. For flaps 5, a 20 knot increase to current Block Speeds is recommended.

Increasing Block Speeds during takeoff is not required. The exposure time at speeds below the crossover speed is very limited, since the airplane is generally accelerating quickly through the crossover speed. If operation at reduced airspeed is required, consideration should be given to operating at the revised Block Speeds. Climb and obstacle clearance calculations may be affected by using increased Block Speeds.

Airspeeds required by non-normal procedures shall be followed instead of the revised Block Speeds. In heavy weight return to land situations where the revised Block Speed is equal to the flap placard speed for the next flap, Boeing recommends slowing 5 knots below the maneuver speed prior to flap extension.

VNAV maneuvering speeds are calculated by the FMC and are based on current Block Speeds. These FMC speeds do not reflect these revised Block Speeds. Airplanes equipped with Speed Intervention may use this feature to fly the revised Block Speeds. For airplanes without Speed Intervention, operators must determine alternate means to comply with the revised Block Speeds during VNAV operations.

Current simulator aerodynamic models may not adequately reflect the effect on controllability when operating at crossover speeds. Future simulator aerodynamic model updates will incorporate aerodynamic data accurately modeling crossover conditions. These updates will be available during the second and third quarter 1999.

Crews are reminded that for the Uncommanded Yaw or Roll non-normal procedure, it is imperative that control of the airplane is maintained by use of all available flight controls. If roll is uncontrollable, immediately reduce pitch/angle of attack and increase airspeed. Do not attempt to maintain altitude until control is recovered.

The new Rudder Pressure Reducer (RPR) limits the amount of rudder input during non-critical phases of flight by reducing hydraulic pressure to the rudder, thereby limiting the amount of rudder travel. Until the RPR is installed, the increased Block Speeds will provide additional control authority, ensuring that sufficient lateral control (ailerons and spoilers) is available to counter the effect of a full rudder input.

The 737-600/700/800s are not affected by this increase in maneuvering speeds, since they are equipped with a Rudder Limiter System at the time of delivery.

Operating Instructions

The following revised Block Speeds are to be used until the airplanes are retrofitted with the RPR by incorporation of Service Bulletin 737-27A1206. Analysis is continuing to validate the Block Speeds once the RPR is installed.

FLAP POSITION	AT & BELOW 103,000 LBS (46,818 KGS)	ABOVE 103,000 LBS (46,818 KGS UP TO 117,000 LBS (53,070 KGS)	ABOVE 117,000 LBS (53,070 KGS UP TO 1138,500 LBS (62,823 KGS)	ABOVE 138,500 LBS (62,823 KGS
FLAPS UP	210	220	230	240
FLAPS 1	190	200	210	220
FLAPS 5	180	190	200	210
FLAPS 10	160	170	180	190

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-11 "In Effect" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Service Bulletin 737-27A1206 and upon completion of analysis and notification by Boeing of appropriate block speeds with the RPR installed. Analysis will be completed by September, 1999.

Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

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