Table 2.b.(6) --- Under Test details:
"…. wind speed and direction vs. altitude" should be "….wind speed and direction vs. altitude and time"

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	Simulator level B	Simulator level C	Simulator level D	Test details		
(6) Crosswind Takeoff	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack, ±20 ft (6 m) Altitude, ±2° Bank and Sideslip Angle. Additionally, for those simulators of airplanes with reversible flight control systems: Stick/Column Force; ±10% or ±5 lb (2.2 daN); Wheel Force; ±10% or ±3 lb (1.3daN); and Rudder Pedal Force; ±10% or ±5 lb (2.2 daN).	Ground/Takeoff and First Segment Climb.	X	X	X	X	Record takeoff profile from brake release to at least 200 ft (61 m) AGL. Requires test data, including information on wind profile (*i.e.*, wind speed and direction vs. altitude), for a crosswind component of at least 20 Kts., but not more than the maximum (or maximum demonstrated) crosswind for the airplane.	....	Yes.
(7) Rejected Takeoff	±5% Time or ±1.5 sec; ±7.5% Distance or ±250 ft (±76 m.	Ground/Takeoff	X	X	X	X	Record time and distance from brake application to full stop. The airplane must be at or near the maximum takeoff gross weight. Use maximum braking effort, auto or manual.	Autobrakes will be used where applicable.	Yes.
(8) Dynamic Engine Failure After Takeoff.	±20% Body Rates	1st Segment Climb			X	X	Engine failure speed must be within ±3 Kts of airplane data. Record Hands Off from 5 secs. before to 5 secs. after engine failure or 30° Bank, whichever occurs first, and then Hands On until wings level recovery. Engine failure may be a snap deceleration to idle. (CCA: Test in Normal AND Non-normal control state).	For safety considerations, airplane flight test may be performed out of ground effect at a safe altitude, but with correct airplane configuration and airspeed.	
c. Climb									
(1) Normal Climb	±3 kts Airspeed, ±5% or ±100 FPM (0.5 m/Sec.) Climb Rate.	All Engines Operating..	X	X	X	X	Record results at nominal climb speed and at nominal altitude. Manufacturer's gross climb gradient may be used for flight test data. May be a Snapshot Test.	....	Yes.

Table 2.d.(1) --- Level A and B should be deleted.

Table 2.e. --- Correct typo for Deceleration.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	B	C	D	Test details		
(2) One engine Inoperative Second Segment Climb.	±3 kts Airspeed, ±5% or ±100 FPM (0.5 m/Sec.) Climb Rate, but not less than the FAA-Approved Airplane Flight Manual (AFM) Rate of Climb.	Second Segment Climb with one engine inoperative.	X	X	X	X	Record results at airplane limiting conditions of weight, altitude, & temperature. Manufacturer's gross climb gradient may be used for flight test data. May be a Snapshot Test.	....	Yes.
(3) One Engine Inoperative En route Climb.	±10% Time, ±10% Distance, ±10% Fuel Used.	En route Climb			X	X	Record results for at least a 5000 ft (1550 m) climb segment. Approved Performance Manual data may be used.		
(4) One Engine Inoperative Approach Climb (if Approved AFM requires specific performance in icing conditions).	±3 Kts Airspeed, ±5% or ±100 FPM (0.5 m/Sec.) Climb Rate, but not less than the Approved AFM Rate of Climb.	Approach Climb With One Engine Inoperative.	X	X	X	X	Record results at not less than 80% of the FAA-certificated maximum landing weight. Manufacturer's gross climb gradient may be used for flight test data. May be a Snapshot Test.	....	Yes.
d. Cruise									
(1) Level Acceleration and Deceleration.	±5% Time	Cruise	X	X	X	X	Record results for a minimum of 50 Kts speed change.		
(2) Cruise Performance ..	±.05 EPR ±5% of N_1 and N_2, ±5% of Torque, ±5% of Fuel Flow.	Cruise			X	X	May be a Snapshot Test; however, a minimum of 2 consecutive snapshots with a spread of at least 5 minutes will be required.		
e. Ground Deceleeration									
(1) Deceleration Time and Distance, using manual application of wheel brakes and no reverse thrust.	±5% of Time. For distance up to 4000 ft (1220 m): ±200 ft (61 m) or ±10%, whichever is smaller. For distance greater than 4000 ft (1220 m): ±5% of distance.	Landing, Dry Runway.	X	X	X	X	Record time and distance for at least 80% of the segment from touch down to full stop. Data on brake system pressure and position of ground spoilers (including method of deployment, if used) must be provided. Engineering data may be used for the medium and light gross weight conditions.	Data is required for medium, light, and near maximum landing gross weights.	Yes.

Table 2.f.(1) and (2) --- Terms Ti and Tt as defined in attachment 4 should be elaborated in a figure, with emphasis to clarify Tt.

Table 2.f.(2) --- Should be selected for Levels A, B, C and D

3. Handling Qualities --- This title should move to next page.

TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	B	C	D	Test details		
(2) Deceleration Time and Distance, using reverse thrust and no wheel brakes.	±5% Time and the smaller of ±10% or ±200 ft (61 m) of Distance.	Landing, Dry Runway.	X	X	X	X	Record time and distance for at least 80% of the total demonstrated reverse thrust segment. Data on the position of ground spoilers, (including method of deployment, if used) must be provided. Engineering data may be used for the medium and light gross weight conditions.	Data is required for medium, light, and near maximum landing gross weights.	Yes.
(3) Deceleration Distance, using wheel brakes and no reverse thrust.	±10% of Distance or ±200 ft (61 m).	Landing, Wet Runway.	......	......	X	X	The FAA-approved AFM data or FAA accepted ground handling model calculations are permissible.		
(4) Deceleration Distance, using wheel brakes and no reverse thrust.	±10% of Distance or ±200 ft (61 m).	Landing, Icy Runway.	......	......	X	X	The FAA-approved AFM data or FAA accepted ground handling model calculations are permissible.		
f. Engines									
(1) Acceleration	±10% T_i, ±10% T_t	Approach or landing	X	X	X	X	Record engine power (N_1, N_2, EPR, Torque, etc.) from idle to go-around power for a rapid (slam) throttle movement.	....	Yes
(2) Deceleration	±10% T_i, ±10% T_t	Ground/Takeoff					Record engine power (N_1, N_2, EPR, Torque, etc.) from Max T/O power to 90% decay of Max T/O power for a rapid (slam) throttle movement.	....	Yes.
3. HANDLING QUALITIES									

For simulators requiring Static or Dynamic tests ….. …….with reversible controls. This information should be moved to page 60331, paragraph b. Discussion.

Table 3.a.(3) --- "CCA: Position vs. force not required …. " should be added in Test details. Fly-by-wire rudder system exists now.

Table 3.a.(5) --- Deadband tolerance of +/-0.5 deg is unrealistically too tight. Should be increased to +/-2 deg.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
For simulators requiring Static or Dynamic tests at the controls (i.e., column, wheel, rudder pedal), special test fixtures will not be required during initial or upgrade evaluations if the sponsor's QTG/MQTG shows both test fixture results and the results of an alternative approach, such as computer plots produced concurrently, that show satisfactory agreement. Repeat of the alternative method during the initial or upgrade evaluation would then satisfy this test requirement. For initial and upgrade evaluations, the control dynamic characteristics must be measured at and recorded directly from the cockpit controls, and must be accomplished in takeoff, cruise, and landing flight conditions and configurations. Contact the NSPM for clarification of any issue regarding airplanes with reversible controls.									
a. Static Control Checks									
(1) Column Position vs. Force and Surface Position Calibration.	Breakout: ±2 lb (0.9 daN). Force: ±10% or ±5 lb (2.2 daN) and ±2° Elevator.	Ground	X	X	X	X	Record results for an uninterrupted control sweep to the stops. **CCA:** Position vs. force not required if cockpit controller is installed in the simulator.		Yes.
(2) Wheel Position vs. Force and Surface Position Calibration.	Breakout: ±2 lb (0.9 daN). Force: ±10% or ±3 lb (1.3 daN) and ±1° Aileron, ±3° Spoiler Angle.	Ground	X	X	X	X	Record results for an uninterrupted control sweep to the stops. **CCA:** Position vs. force not required if cockpit controller is installed in the simulator.		Yes.
(3) Rudder Pedal Position vs. Force and Surface Position Calibration.	Breakout: ±5 lb (2.2 daN). Force ±10% or ±5 lb (2.2 daN) and ±2° Rudder Angle.	Ground	X	X	X	X	Record results for an uninterrupted control sweep to the stops.		Yes.
(4) Nosewheel Steering Force & Position.	Breakout: ±2 lb (0.9 daN). Force: ±10% or ±3 lb (1.3 daN) and ±2° Nosewheel Angle.	Ground	X	X	X	X	Record results of an uninterrupted control sweep to the stops.		Yes.
(5) Rudder Pedal Steering Calibration.	±2° Nosewheel Angle, ±0.5° Deadband.	Ground	X	X	X	X	Record results of an uninterrupted control sweep to the stops.		Yes.

Table 3.b.(1), (2) and (3) --- Paragraph 3 should be 5 under Information notes.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
(6) Pitch Trim Calibration (Indicator vs. Computed) and Rate.	±0.5° of Computed Trim Angle, ±10% Trim Rate.	Ground and Go Around.	X	X	X	X	Trim rate must be checked using the pilot primary trim control (ground) and using the autopilot or pilot primary trim control in flight at go-around flight conditions.	....	Yes.
(7) Alignment of Power Lever Angle vs. Selected Engine Parameter (e.g., EPR, N_1, Torque, etc.).	±5° of Power Lever Angle	Ground	X	X	X	X	Requires recording for all engines. No simulator throttle position may be more than 5° (in either direction) from the airplane throttle position. Also, no simulator throttle position may differ from any other simulator throttle position by more than 5°. Where power levers do not have angular travel, a tolerance of ± 0.8 in (2 cm) applies. In the case of propeller powered airplanes, if a propeller lever is present, it must also be checked. May be a series of shapshot test results.	....	Yes.
(8) Brake Pedal Position vs. Force and Brake System Pressure.	±5 lb (2.2 daN) or 10% Force, ±150 psi (1.0 MPa) or ±10% Brake System Pressure.	Ground	X	X	X	X	Hydraulic system pressure must be related to pedal position through a ground static test.	....	Yes.
b. Dynamic Control Checks									
(1) Pitch Control	±10% of time for first zero crossing and ±10 (n+1)% of period thereafter, ±10% amplitude of first overshoot, ±20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement (A_d), ±1 overshoot.	Takeoff, Cruise, and Landing.			X	X	Data must show normal control displacement in both directions. Tolerances apply against the absolute values of each period (considered independently). Normal control displacement for this test is 25% to 50% of full throw. **CCA:** Test not required if cockpit controller is installed in the simulator.	"n" is the sequential period of a full cycle of oscillation. Refer to paragraph 3 of this attachment for more information.	

Table 3.b.(3) --- "CCA: Test not required ….." should be added. Fly-by-wire rudder system exits now.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
(2) Roll Control	±10% of time for first zero crossing, and ±10 (n±1)% of period thereafter, ±10% amplitude of first overshoot, ±20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement (A_d), ±1 overshoot.	Takeoff, Cruise, and Landing.			X	X	Data must show normal control displacement in both directions. Tolerances apply against the absolute values of each period (considered independently). Normal control displacement for this test is 25% to 50% of full throw. **CCA:** Test not required if cockpit controller is installed in the simulator.	"n" is the sequential period of a full cycle of oscillation. Refer to paragraph 3 of this attachment for more information.	
(3) Yaw Control	±10% of time for first zero crossing, and ±10 (n±1)% of period thereafter, ±10% amplitude of first overshoot, ±20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement (A_d), ±1 overshoot.	Takeoff, Cruise, and Landing.			X	X	Data must show normal control displacement in both directions. Tolerances apply against the absolute values of each period (considered independently). Normal control displacement for this test is 25% to 50% of full throw.	"n" is the sequential period of a full cycle of oscillation. Refer to paragraph 3 of this attachment for more information.	
(4) Small Control Inputs	±20% Body Rates	Cruise and Approach.			X	X	This test is applicable in all three axes. Small control inputs are 5% of total travel.		
c. Longitudinal									
(1) Power Change Dynamics.	±3 Kts Airspeed, ±100 ft (30 m) Altitude, ±20% or ±1.5° Pitch.	Approach	X	X	X	X	Wing flaps must remain in the approach position. Record the uncontrolled free response from 5 seconds before the power change is initiated to 15 seconds after the power change is completed. (**CCA:** Test in Normal and Non-normal control state.).		Yes.
(2) Flap/Slat Change Dynamics.	±3 Kts Airspeed, ±100 ft (30 m) Altitude, ±20% or ±1.5° Pitch.	Takeoff, and Approach.	X	X	X	X	Record the uncontrolled free response from 5 seconds before the configuration change is initiated to 15 seconds after the configuration change is completed. (**CCA:** Test in Normal and Non-normal control state).		Yes.

Table 3.c.(4) --- Second Segment Climb should be deleted under Flight conditions.
Also in Test details: Typo – CAA should be CCA.

Table 3.c.(6) --- Tolerance: +/-1 deg Pitch Control (Stab and Elev). Please clarify application of this tolerance. Does it mean +/-1 deg on Stab and no tolerance on Elev, or no tolerance on Stab and +/-1 deg on Elev, or split tolerance (say) +/-0.5 deg on Stab and +/-0.5 deg on Elev? Which is correct?

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	B	C	D	Test details		
(3) Spoiler/Speedbrake Change Dynamics.	±3 Kts Airspeed, ±100 ft (30 m) Altitude, ±20% or ±1.5° Pitch.	Cruise	X	X	X	X	Record the uncontrolled free response from 5 seconds before the configuration change is initiated to 15 seconds after the configuration change is completed. (CCA: Test in Normal and Non-normal control state).	....	Yes.
(4) Gear Change Dynamics.	±3 Kts Airspeed, ±100 ft (30 m) Altitude, ±20% or ±1.5° Pitch.	Takeoff, Second Segment Climb, and Approach.	X	X	X	X	Record the time history of uncontrolled free response for a time increment from 5 seconds before the configuration change is initiated to 15 seconds after the configuration change is completed. (CAA: Test in Normal and Non-normal control state).	....	Yes.
(5) Alternate Landing Gear and Alternate Flap/Slat Operating Times.	±1 second or ±10% of Time	Takeoff and Approach.	X	X	X	X	Record all data throughout full range. Record extension and retraction for alternate flap operation. Record extension only for alternate gear operation. Tabular data from production airplanes are acceptable.	Intermediate increment times are not required.	Yes.
(6) Longitudinal Trim	±1° Pitch Control (Stab and Elev.), ±1° Pitch Angle, ±5% Net Trust or Equivalent.	Cruise, Approach, and Landing.	X	X	X	X	May be Snapshot Tests. (CCA: Test in Normal and Non-normal control state).	....	Yes.
(7) Longitudinal Maneuvering Stability (Stick Force/g).	±5 lb (±2.2 daN) or ±10% Column Force or Equivalent Surface Position.	Cruise, Approach, and Landing.	X	X	X	X	Record results for approximately 20° and 30° of bank for approach and landing configurations. Record results for approximately 20°, 30°, and 45° of bank for the cruise configuration. May be a series of shapshot test results. (CCA: Test in Normal and Non-normal control state).	....	Yes.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
(8) Longitudinal Static Stability.	±5 lb (±2.2 daN) or ±10% Column Force or Equivalent Surface Position.	Approach	X	X	X	X	Record results for at least 2 speeds above and 2 speeds below trim speed. May be a series of shapshot test results. (CCA: Test in Normal or Non-normal control state).		Yes.
(9) Stick Shaker, Airframe Buffet, Stall Speeds.	±3 Kts Airspeed, ±2° Bank for speeds higher than stick shaker or initial buffet. Airplanes with reversible flight control systems, ±10% or ±5 lb (2.2 daN)) Stick/Column force.	Second Segment Climb, and Approach or Landing.	X	X	X	X	Record the stall warning signal and buffet on-set, if applicable. The signal must occur in the proper relation to buffet/stall. Airplanes exhibiting a sudden pitch attitude change or "g break" must demonstrate this characteristic. (CCA: Test in Normal and Non-normal control state).		Yes.
(10) Phugoid Dynamics	±10% of Period, ±10% of Time to ½ or Double Amplitude or ±.02 of Damping Ratio.	Cruise	X	X	X	X	The test must include whichever is less of the following: Three full cycles (six overshoots after the input is completed), or The number of cycles sufficient to determine time to ½ or double amplitude. (CCA: Test in Non-normal control state).		Yes.
(11) Short Period Dynamics.	±1.5° Pitch or ±2°/sec. Pitch Rate, ±0.10g Acceleration.	Cruise		X	X	X	(CCA: Test in Normal and Non-normal control state).		Yes.
d. Lateral Directional									
(1) Minimum Control Speed, Air (V_{mca}), per Applicable Airworthiness Standard or Low Speed Engine Inoperative Handling Characteristics in Air.	±3 Kts Airspeed	Takeoff or Landing (Whichever is most critical in the airplane).	X	X	X	X	(CCA: Test in Normal or Non-normal control state).	Low Speed Engine Inoperative Handling may be governed by a performance or control limit that prevents demonstration of V_{mca} in the conventional manner.	Yes.
(2) Roll Response (Rate)	±10% Roll Rate or ± 2°/sec. Additionally, for those simulators of airplanes with reversible flight control systems: wheel force ±10% or ±3lb (1.3 daN).	Cruise, and Approach or Landing.	X	X	X	X	Record results for normal wheel deflection (about 30%).		

Table 3.d.(3) --- Delete "cockpit" under Test.

Table 3.d.(6) --- Under Test: Add Yaw Damper ON and OFF.

Table 3.d.(7) --- Delete Level A, not in AC 120-40C.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	Simulator level B	Simulator level C	Simulator level D	Test details		
(3) Roll Response to Cockpit Roll Controller Step Input.	±10% or ±2°/sec. roll rate	Approach or Landing.	X	X	X	X	Record from initiation of roll through 15 seconds after control is returned to neutral and released. After the roll rate is established, the controller is returned to neutral and the remaining response is to be "hands-off." (**CCA:** Test in Normal and Non-normal control state).	....	Yes.
(4) Spiral Stability	±2° Bank or ±10% in 20 seconds. Bank must be in the proper direction.	Cruise	X	X	X	X	Record results for both directions. Airplane data averaged from multiple tests may be used. (**CCA:** Test in Non-normal control state).	....	Yes.
(5) Engine Inoperative Trim.	±1° Rudder angle or ±1° Tab angle or equivalent pedal, ±2° Sideslip angle.	Second Segment Climb, and Approach or Landing.	X	X	X	X	May be Snapshot Tests.	....	Yes.
(6) Rudder Response	±2°/sec. or ±10% Yaw Rate	Approach or Landing.	X	X	X	X	Record results for stability augmentation system ON and OFF. A rudder step input of 20%–30% rudder pedal throw is used. (**CCA:** Test in Normal and Non-normal control state).	....	Yes.
(7) Dutch Roll, (Yaw Damper OFF).	±0.5 sec. or ±10% of period, ±10% of time to ½ or double amplitude or ±.02 of damping ratio, ±20% or ±1 sec. of time difference between peaks of bank and sideslip.	Cruise, and Approach or Landing.	X	X	X	X	Record results for at least 6 cycles with stability augmentation OFF. (**CCA:** Test in Non-normal control state).	....	Yes.
(8) Steady State Sideslip	For given rudder position ±2° Bank, ±1° Sideslip, ±10% or ±2° Aileron, ±10% or ±5° Spoiler or equivalent wheel position or force. Additionally, for those simulators of airplanes with reversible flight control systems: Wheel force, ±10% or ±3 lb (1.3 daN), and Rudder pedal force, ±10% or ±5 lb (2.2 daN).	Approach or Landing.	X	X	X	X	Propeller driven airplanes must test in each direction. May be a series of shapshot test results using at least two rudder positions.	....	Yes.
e. Landings									

TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
(1) Normal Landing	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack, ±10% or ±10 ft (3 m) Altitude. Additionally, for those simulators of airplanes with reversible flight control systems: Stick/Column Force ±10% or ±5 lbs (±2.2 daN).	Landing		X	X	X	Record results from a minimum of 200 ft (61 m) AGL to nose-wheel touchdown. Results with medium, light, and near maximum landing weights must be shown. (**CCA:** Test in Normal and Non-normal control state).	Derotation may be shown as a separate segment from the time of MLG touch down.	Yes.
(2) Minimum/No Flap Landing.	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack, ±10% or ±10 ft (3 m) Altitude. Additionally, for those simulators of airplanes with reversible flight control systems: Stick/Column Force, ±10% or ±5 lbs 9/2.2 daN).	Minimum Certified Landing Flap Configuration.			X	X	Record results from a minimum of 200 ft (61 m) AGL to nosewheel touchdown with airplane at near Maximum Landing Weight.	Derotation may be shown as a separate segment from the time of MLG touch down.	
(3) Crosswind Landing	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack, ±10% or ±10 ft (3 m) Altitude, ±2° Bank Angle, ±2° Sideslip Angle. Additionally, for those simulators of airplanes with reversible flight control systems: Wheel force, ±10% or ±3 lb (1.3 daN) and Rudder pedal force, ±10% or ±5 lb (2.2 daN).	Landing		X	X	X	Record results from a minimum of 200 ft (61 m) AGL, through nosewheel touch down, to 50% of V_{REF} speed. Use maximum demonstrated crosswind if available. If not available use 20 kts.		Yes.
(4) One Engine Inoperative Landing (Not required for Single-engine airplanes.).	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack, ±10% Altitude or ±10 ft (3 m), ±2° Bank Angle, ±2° Sideslip Angle.	Landing		X	X	X	Record results from a minimum of 200 ft (61 m) AGL, through nosewheel touch down, to 50% of V_{REF} speed.		Yes.
(5) Autoland (if applicable).	±5 ft (1.5 m) Flare Height, ±0.5 sec T_f, ±140 ft/min (.7 m/sec) Rate of Descent at Touch-down, ±10 ft (3 m) Lateral Deviation from Maximum demonstrated crosswind (autoland) deviation.	Landing			X	X	Record Lateral Deviation and continue to Autopilot disconnect.	This test is not a substitute for the Ground Effects test requirement.	

Table 3.e.(6) --- These are two tests, and should be listed as two separate tests.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level				Test details		
			A	B	C	D			
(6) Go Around	±3 Kts Airspeed, ±1.5° Pitch, ±1.5° Angle of Attack.	Go Around			X	X	Additionally, a Go Around with an engine inoperative is required. This test must be conducted at near maximum landing weight and with the critical engine inoperative. (Not required for single-engine airplanes.) A normal, all-engines-operating, Go Around with the autopilot engaged must also be demonstrated (if applicable) at medium landing weight. (**CCA:** Test in Normal and Non-normal control state).		
(7) Directional Control (Rudder Effectiveness) with symmetric reverse thrust.	±2 deg/sec yaw rate	On Ground		X	X	X	Record results from a speed approximating touchdown speed to the minimum thrust reverser operation speed. Airplane manufacturer's engineering simulator data may be considered as an alternative. Yaw control is applied in both directions until reaching minimum thrust reverser operation speed.		
(8) Directional Control (Rudder Effectiveness) with asymmetric reverse thrust.	±5 knots	On Ground		X	X	X	Maintain heading with yaw control. Record results from a speed approximating touchdown speed to a speed at which control of yaw cannot be maintained. The tolerance applies to this lower speed. Airplane manufacturer's engineering simulator data may be considered as an alternative.		
f. Ground Effect									
Demonstrate Longitudinal Ground Effect.	±1° Elevator or Stabilizer Angle, and ±5% Net Thrust or Equivalent, and ±1° Angle of Attack, and ±10% Height/ Altitude or ±5 ft (1.5 m), and ±3 Knots Airspeed, and ±1° Pitch Attitude.	Landing		X	X	X	The Ground Effect model must be validated by the test selected and a rationale must be provided for selecting the particular test.	The test selected for validation is at the option of the sponsor. See paragraph 6, Ground Effect, in this attachment for additional information.	Yes.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	Simulator level B	Simulator level C	Simulator level D	Test details		
g. Brake Fade									
Demonstrate Decreased Braking Efficiency Due to Brake Temperature.	None	Takeoff or Landing			X	X	An SOC is required. The demonstration must show decreased braking efficiency due to brake temperature. Substantiating data must be provided.		
h. Windshear									
Demonstrate Windshear Models.	See Attachment 6	Takeoff and Landing			X	X	Requires windshear models that provide training in the specific skills needed to recognize windshear phenomena and to execute recovery procedures. See Attachment 6 for tests, tolerances, and procedures.	See Attachment 6 for information related to Level A and B simulators.	
i. Envelope Protection Functions									
The requirements of tests i. (1) through (6), of this attachment are applicable to computer controlled airplanes only. Time history results are required for simulator response to control inputs during entry into envelope protection limits. Flight test data must be provided for both normal and non-normal control states.									
(1) Overspeed	±5 Kts Airspeed	Cruise			X	X	(CCA: Test in Normal and Non-normal control state.).		
(2) Minimum Speed	±3 Kts Airspeed	Takeoff, Cruise, and Approach or Landing.			X	X	(CCA: Test in Normal and Non-normal control state.).		
(3) Load Factor	±0.1g Normal Acceleration	Takeoff and Cruise			X	X	(CCA: Test in Normal and Non-normal control state.).		
(4) Pitch Angle	±1.5° Pitch	Cruise, and Go Around.			X	X	(CCA: Test in Normal and Non-normal control state.).		
(5) Bank Angle	±2° or ±10% Bank	Approach			X	X	(CCA: Test in Normal and Non-normal control state.).		
(6) Angle of Attack	±1.5° AOA	Second Segment Climb, and Approach or Landing.			X	X	(CCA: Test in Normal and Non-normal control state.).		
3. Motion System									
a. Minimum Excursion									
1) Pitch	At least ±40°	N/A	X	X			An SOC is required for 3.a.(1) through (6). (Applicable to Initial evaluations only.) The "*" in the Simulator Level column applies if this DOF is used..		
(2) Roll	At least ±40°	N/A	X	X					
(3) Yaw	At least ±45°	N/A	*	*					
(4) Heave	At least 40 inches total movement.	N/A	*	X					
		N/A	X	X					
(5) Sway	At least 45 inches total movement.	N/A	*	*					
(6) Surge	At least 50 inches total movement.								
(7) Pitch	At least ±50°	N/A			X	X	An SOC is required for 3.a.(7) through (12). (Applicable to Initial evaluations only.).		
(8) Roll	At least ±50°	N/A			X	X			
(9) Yaw	At least ±50°	N/A			X	X			
(10) Heave	At least 68 inches total movement.	N/A			X	X			

Table 3.g. --- This is a demonstration test. It does not belong in Table of Objective Tests. It should be moved to Attachment 1, like other demonstration tests.

Table 3.h. --- Tolerance required in Attachment 6 should be written in Tolerance column.

Table 3.i --- Distinction should be made for those tests that are not necessary if airplane flight control computers are used in simulator.

Table 3. Motion System --- This table number should be 4, and subsequent tables should be changed accordingly.

Comments on proposed requirements:

- What deficiencies in training have been recorded, as track record, for the currently qualified simulators that highlight insufficiency in the AC 120-40B motion system requirements?
- Justify the proposed minimum excursion, acceleration and velocity ranges. How do these compare to a typical current Level C motion system?
- What is the added training value by 'higher' proposed minimum requirements?
- From motion system point of view, the requirements for Levels C and D seem unbalanced. The requirements for surge, heave, pitch, roll and yaw can (generally) be met using a motion system with 60-inch stroke actuators. Sway of 90 inches total operational excursion requires a system with approximately 72-inch actuators.
- Increased foot-print of motion system meeting proposed requirements will limit use of some of existing facilities.- All SOCs, in view of objective tests, are redundant.

Table 3.d --- Under Test details: MQTG should read as QTG and MQTG. Also there is typo – Iinject should be Inject.

Table 3.e --- Motion cue repeatability being a subjective demonstration should be moved to Attachment 1.

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	Simulator level B	Simulator level C	Simulator level D	Test details		
(11) Sway	At least 90 inches total movement.	N/A			X	X			
(12) Surge	At least 68 inches total movement.	N/A			X	X			
b. Minimum Acceleration									
(1) Pitch	At least 80°/sec²	N/A	X	X			An SOC is required for 3.b.(1) through (6). (Applicable to Initial evaluations only.) The "*" in the Simulator Level column applies if this DOF is used.		
(2) Roll	At least 80°/sec²	N/A	X	X					
(3) Yaw	At least 80°/sec²	N/A	*	*					
(4) Heave	At least 0.6g in each direction	N/A	*	X					
(5) Sway	At least 0.6g in each direction	N/A	X	X					
(6) Surge	At least 0.6g in each direction	N/A	*	*					
(7) Pitch	At least 100°/sec²	N/A			X	X	An SOC is required for 3.b.(7) through (12). (Applicable to Initial evaluations only.)		
(8) Roll	At least 100°/sec²	N/A			X	X			
(9) Yaw	At least 100°/sec²	N/A			X	X			
(10) Heave	At least 0.8g in each direction	N/A			X	X			
(11) Sway	At least 0.6g in each direction	N/A			X	X			
(12) Surge	At least 0.6g in each direction	N/A			X	X			
c. Minimum Velocity									
(1) Pitch	At least 20°/sec	N/A	X	X			An SOC is required for 3.c.(1) through (6). (Applicable to Initial evaluations only.) The "*" in the Simulator Level column applies if this DOF is used.		
(2) Roll	At least 20°/sec	N/A	X	X					
(3) Yaw	At least 20°/sec	N/A	*	*					
(4) Heave	At least 20 in/sec	N/A	*	X					
(5) Sway	At least 20 in/sec	N/A	X	X					
(6) Surge	At least 20 in/sec	N/A	*	*					
(7) Pitch	At least 20°	N/A			X	X	An SOC is required for 3.c.(7) through (12). (Applicable to Initial evaluations only.).		
(8) Roll	At least 20°	N/A			X	X			
(9) Yaw	At least 20°	N/A			X	X			
(10) Heave	At least 24/in sec	N/A			X	X			
(11) Sway(12) Surge	At least 28/in sec	N/A			X	X			
	At least 28/in sec	N/A			X	X			
d. Frequency Response									
Phase lag	Not to exceed 45° at 4 Hz	N/A	X	X	X	X	A demonstration is required and must be made part of the MQTG. Iinject an acceleration command into the kinematic transformation equations and measuring the acceleration output of the motion platform. The response bandwidth must be determined in each applicable translational degree of freedom.		
e. Motion Cue									

Begin Information

5. Control Dynamics

a. The characteristics of an airplane flight control system have a major effect on the handling qualities. A significant consideration in pilot acceptability of an airplane is the ‘‘feel’’ provided through the cockpit controls. Considerable effort is expended on airplane feel system design in order to deliver a system with which pilots will be comfortable and consider the airplane desirable to fly. In order for a simulator to be representative, it too must present the pilot with the proper feel; that of the respective airplane. Aircraft control feel dynamics shall duplicate the airplane simulated. This shall be determined by comparing a recording of the control feel dynamics of the simulator to airplane measurements in the takeoff, cruise, and landing configuration.

b. Recordings such as free response to an impulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the simulator control loading system to the airplane systems is essential. The required control feel dynamic tests are described in this attachment. This is usually accomplished by measuring the free response of the controls using a step or pulse input to excite the system.

c. For airplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some airplanes, takeoff, cruise, and landing configurations have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or airplane manufacturer rationale must be submitted as justification for ground tests or for eliminating a configuration.

(1) *Control Dynamics Evaluations.* The dynamic properties of control systems are often stated in terms of frequency, damping, and a number of other classical measurements which can be found in texts on control systems. In order to establish a consistent means of validating test results for simulator control loading, criteria are needed that will clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for both the underdamped system and the overdamped system, including the critically damped case. In the case of an underdamped system with very light damping, the system may be quantified in terms of frequency and damping. In critically damped or overdamped systems, the frequency and damping is not readily measured from a response time history. Therefore, some other measurement must be used.

(2) *For Levels C and D Simulators.* Tests to verify that control feel dynamics represent the airplane show that the dynamic damping cycles (free response of the control) match that of the airplane within the specified tolerances. An acceptable method of evaluating the response and the tolerance to be applied are described below for the underdamped and critically damped cases.

d. Tolerances. (1) *Underdamped Response.* (a) Two measurements are required for the period, the time to first zero crossing (in case a rate limit is present) and the subsequent frequency of oscillation. It is necessary to measure cycles on an individual basis in case there are nonuniform periods in the response. Each period will be independently compared to the respective period of the airplane control system and, consequently, will enjoy the full tolerance specified for that period.

(b) The damping tolerance will be applied to overshoots on an individual basis. Care must be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5 percent of the total initial displacement will be considered significant. The residual band, labeled $T(A_d)$ on Figure 1 is ±5 percent of the initial displacement amplitude A_d from the steady state value of the oscillation. Oscillations within the residual band are considered insignificant. When comparing simulator data to airplane data, the process would begin by overlaying or aligning the simulator and airplane steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. To be satisfactory, the simulator would show the same number of significant overshoots to within one when compared against the airplane data. This procedure for evaluating the response is illustrated in Figure 1 of this attachment.

(2) *Critically Damped and Overdamped Response.* Due to the nature of critically damped responses (no overshoots), the time to reach 90 percent of the steady state (neutral point) value would be the same as the airplane within ±10 percent. The simulator response must be critically damped

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TABLE OF OBJECTIVE TESTS—Continued

QPS requirements								Information notes	Paragraph 8
Test	Tolerance	Flight conditions	Simulator level A	B	C	D	Test details		
Repeatability		N/A	X	X	X	X	A demonstration is required and must be made part of the MQTG. The assessment procedures must be designed to ensure that the motion system continues to perform as originally qualified. An example demonstration is described in paragraph 7, Motion Cue Repeatability.		
4. Sound System [Reserved]									

Begin Information

5. Control Dynamics

a. The characteristics of an airplane flight control system have a major effect on the handling qualities. A significant consideration in pilot acceptability of an airplane is the "feel" provided through the cockpit controls. Considerable effort is expended on airplane feel system design in order to deliver a system with which pilots will be comfortable and consider the airplane desirable to fly. In order for a simulator to be representative, it too must present the pilot with the proper feel; that of the respective airplane. Aircraft control feel dynamics shall duplicate the airplane simulated. This shall be determined by comparing a recording of the control feel dynamics of the simulator to airplane measurements in the takeoff, cruise, and landing configuration.

b. Recordings such as free response to an impulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the simulator control loading system to the airplane systems is essential. The required control feel dynamic tests are described in this attachment. This is usually accomplished by measuring the free response of the controls using a step or pulse input to excite the system.

c. For airplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some airplanes, takeoff, cruise, and landing configurations have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or airplane manufacturer rationale must be submitted as justification for ground tests or for eliminating a configuration.

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(2) *For Levels C and D Simulators.* Tests to verify that control feel dynamics represent the airplane show that the dynamic damping cycles (free response of the control) match that of the airplane within the specified tolerances. An acceptable method of evaluating the response and the tolerance to be applied are described below for the underdamped and critically damped cases.

d. Tolerances. (1) *Underdamped Response.* (a) Two measurements are required for the period, the time to first zero crossing (in case a rate limit is present) and the subsequent frequency of oscillation. It is necessary to measure cycles on an individual basis in case there are nonuniform periods in the response. Each period will be independently compared to the respective period of the airplane control system and, consequently, will enjoy the full tolerance specified for that period.

(b) The damping tolerance will be applied to overshoots on an individual basis. Care must be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5 percent of the total initial displacement will be considered significant. The residual band, labeled $T(A_d)$ on Figure 1 is ±5 percent of the initial displacement amplitude A_d from the steady state value of the oscillation. Oscillations within the residual band are considered insignificant. When comparing simulator data to airplane data, the process would begin by overlaying or aligning the simulator and airplane steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. To be satisfactory, the simulator would show the same number of significant overshoots to within one when compared against the airplane data. This procedure for evaluating the response is illustrated in Figure 1 of this attachment.

(2) *Critically Damped and Overdamped Response.* Due to the nature of critically damped responses (no overshoots), the time to reach 90 percent of the steady state (neutral point) value would be the same as the airplane within ±10 percent. The simulator response must be critically damped also. Figure 2 illustrates the procedure.

(3)(a) The following summarizes the tolerances, T, for an illustration of the referenced measurements. (See Figures 1 and 2 of this attachment):

$T(P_0)$ ±10% of P_0
$T(P_1)$ ±20% of P_1
$T(A)$ ±10% of A_1, ±20% of Subsequent Peaks
$T(A_d)$ ±5% of A_d = Residual Band
Overshoots ±1

(b) In the event the number of cycles completed outside of the residual band, and thereby significant, exceeds the number depicted in figure 1 of this attachment, the following tolerances (T) will apply:

$T(P_n)$ ±10(n+1)% of P_n, where "n" is the next in sequence.

e. Alternative Method for Control Dynamics. (1) An alternative means for dealing with control dynamics applies to airplanes with hydraulically powered flight

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$T(A)$ ±10% of A_1, ±20% of Subsequent Peaks
$T(A_d)$ ±5% of A_d = Residual Band
Overshoots ±1

(b) In the event the number of cycles completed outside of the residual band, and thereby significant, exceeds the number depicted in figure 1 of this attachment, the following tolerances (T) will apply:
$T(P_n)$ ±10(n+1)% of P_n, where ‘‘n’’ is the next in sequence.

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