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General

Subpar- C
Airplane Flight Simulation Training Devices

1 **GENERAL.**

1.1 This Section contains Advisory Circulars (AC) providing acceptable means of compliance and/or interpretative/explanatory material that have been agreed for inclusion in JCAR–FSTD A.

1.2 Where a particular JCAR paragraph does not have an Advisory Circular (AC), it is considered that no supplementary material is required.

2 **PRESENTATION.**

2.1 The ACs are presented in full-page width on loose pages, each page being identified by the date of issue and the Amendment number under which it is amended or re-issued.

2.2 A numbering system has been used in which the Advisory Circular (AC) uses the same number as the JCAR paragraph to which it refers. The number is introduced by the letters AC to distinguish the material from the JCAR itself.

2.3 The acronym AC also indicates the nature of the material and for this purpose the type of material is defined as follows: Advisory Circulars (AC) illustrate a means, or several alternative means, but not necessarily the only possible means by which a requirement can be met. An AC as interpretative/explanatory material may contain material that helps to illustrate the meaning of a requirement. Such AC will be designated by (interpretative/explanatory material).

2.4 Explanatory Notes not forming part of the AC text appear in a smaller typeface.

2.5 New, amended and corrected text will be marked with a vertical bar to the left until a subsequent ‘Amendment’ is issued.

SUBPART – B
GENERAL

AC to JCAR-FSTD A.005
Terminology, Abbreviations
See JCAR–FSTD A.005

1 **Terminology.**

1.1 In addition to the principal terms defined in the requirement itself, additional terms used in the context of JCAR–FSTD A and JCAR-FSTD H have the following meanings:

a. **Acceptable Change**: A change to configuration, software etc., which qualifies as a potential candidate for alternative approach to validation.

b. **Aircraft Performance Data**: Performance data published by the aircraft manufacturer in documents such as the Airplane or Rotorcraft Flight Manual, Operations Manual, Performance Engineering Manual, or equivalent.

c. **Airspeed:** Calibrated airspeed unless otherwise specified (knots).

d. **Altitude**: Pressure altitude (meters or feet) unless specified otherwise.

e. **Audited Engineering Simulation**: An aircraft manufacturer's engineering simulation which has undergone a review by CARC and been found to be an acceptable source of supplemental validation data.

f. **Automatic Testing**. Flight Synthetic Training Device (FSTD) testing where in all stimuli are under computer control.

g. **Bank**: Bank/Roll angle (degrees)

h. **Baseline**: A fully flight-tests validated production aircraft simulation. May represent a new aircraft type or a major derivative.

i. **Breakout:** The force required at the pilot's primary controls to achieve initial movement of the control position.

j. **Closed Loop Testing**: A test method for which the input stimuli are generated by controllers which drive the FSTD to follow a pre-defined target response.

k. **Computer Controlled Aircraft**: An aircraft where the pilot inputs to the control surfaces are transferred and augmented via computers.

l. **Control Sweep**: A movement of the appropriate pilot's control from neutral to an extreme limit in one direction (Forward, Aft, Right, or Left), a continuous movement back through neutral to the opposite extreme position, and then a return to the neutral position.

m. **Convertible FSTD**: An FSTD in which hardware and software can be changed so that the FSTD becomes a replica of a different model or variant, usually of the same type aircraft. The same FSTD platform, cockpit shell, motion system, visual system, computers, and necessary peripheral equipment can thus be used in more than one simulation.

n. **Critical Engine Parameter**: The engine parameter which is the most appropriate measure of propulsive force.

o. **Damping (critical):** The CRITICAL DAMPING is that minimum damping of a second order system such that no overshoot occurs in reaching a steady state value after being displaced from a position of equilibrium and released. This corresponds to a relative damping ratio of 1:0

p. **Damping (over-damped)**. An OVER-DAMPED response is that damping of a second order system such that it has more damping than is required for Critical Damping, as described above. This corresponds to a relative damping ratio of more than 1:0.

q. **Damping (under-damped)**: An UNDER-DAMPED response is that damping of a second order system such that a displacement from the equilibrium position and free release results in one or more overshoots or oscillations before reaching a steady state value. This corresponds to a relative damping ratio of less than 1:0.

r. **Daylight Visual**: A visual system capable of meeting, as a minimum, system brightness, contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide full color presentations and sufficient surfaces with appropriate textural cues to successfully conduct a visual approach, landing and airport movement (taxi).

s. **Dead band**: The amount of movement of the input for a system for which there is no reaction in the output or state of the system observed.

t. **Distance**: Distance in Nautical Miles unless specified otherwise.

u. **Driven:** A state where the input stimulus or variable is 'driven' or deposited by automatic means, generally a computer input. The input stimulus or variable may not necessarily be an exact match to the flight test comparison data - but simply driven to certain predetermined values.

v. **Engineering Simulation**: An integrated set of mathematical models representing a specific aircraft configuration, which is typically used by the aircraft manufacturer for a wide range of engineering analysis tasks including engineering design, development and certification: and to generate data for checkout, proof of-match/validation and other training FSTD data documents.

w. **Engineering Simulator**: The term for the aircraft manufacturer's simulator which typically includes a full-scale representation of the simulated aircraft flight deck, operates in real time and can be flown by a pilot to subjectively evaluate the simulation. It contains the engineering simulation models, which are also released by the aircraft manufacturer to the industry for FSTDs: and may or may not include actual on-board system hardware in lieu of software models.

x. **Engineering Simulator Data**: Data generated by an engineering simulation or engineering simulator, depending on the aircraft manufacturer's processes.

y. **Engineering Simulator Validation Data**: Validation data generated by an engineering simulation or engineering simulator.

z. **Entry into Service**: Refers to the original state of the configuration and systems at the time a new or major derivative aircraft is first placed into commercial operation.

aa. **Essential Match**: A comparison of two sets of computer-generated results for which the differences should be negligible because essentially the same simulation models have been used. Also known as a virtual match.

bb. **FSTD Approval**: The extent to which an FSTD of a specified Qualification Level may be used by an operator or training organization as agreed by CARC. It takes account of differences between aircraft and FSTDs and the operating and training ability of the organization.

cc. **FSTD Data:** The various types of data used by the FSTD manufacturer and the applicant to design, manufacture, test and maintain the FSTD.

dd. **FSTD Evaluation**: A detailed appraisal of an FSTD by CARC to ascertain whether or not the standard required for a specified Qualification Level is met.

ee. **FSTD Operator**: That person, organization or enterprise directly responsible to CARC for requesting and maintaining the qualification of a particular FSTD.

ff. **FSTD Qualification Level**: The level of technical capability of a FSTD.

gg. **Flight Test Data:** Actual aircraft data obtained by the aircraft manufacturer (or other supplier of acceptable data) during an aircraft flight test program.

hh. **Free Response**: The response of the aircraft after completion of a control input or disturbance.

ii. **Frozen/Locked**: A state where a variable is held constant with time.

jj. **Fuel used**: Mass of fuel used (kilos or pounds).

kk. **Full Sweep**: Movement of the controller from neutral to a stop, usually the aft or right stop, to the opposite stop and then to the neutral position.

ll. **Functional Performance**: An operation or performance that can be verified by objective data or other suitable reference material that may not necessarily be flight test data.

mm. **Functions Test**: A quantitative and/or qualitative assessment of the operation and performance of an FSTD by a suitably qualified evaluator. The test can include verification of correct operation of controls, instruments, and systems of the simulated aircraft under normal and non-normal conditions. Functional performance is that operation or performance that can be verified by objective data or other suitable reference material which may not necessarily be Flight Test Data.

nn. **Grandfather Rights**: The right of an FSTD operator to retain the Qualification Level granted under a previous regulation of JCARs. Also the right of an FSTD user to retain the training and testing/checking credits which were gained under a previous regulation of JCARs.

oo. **Ground Effect:** The change in aerodynamic characteristics due to modification of the air flow past the aircraft caused by the presence of the ground.

pp. **Hands-off Maneuver**: A test maneuver conducted or completed without pilot control inputs.

qq. **Hands-on Maneuver**: A test maneuver conducted or completed with pilot control inputs as required.

rr. **Heavy**: Operational mass at or near maximum for the specified flight condition.

ss. **Height**: Height above ground = AGL (meters or feet)

tt. **Highlight Brightness**: The maximum displayed brightness, which satisfies the appropriate brightness test.

uu. **Icing Accountability**: A demonstration of minimum required performance whilst operating in maximum and intermittent maximum icing conditions of the applicable airworthiness requirement. Refers to changes from normal (as applicable to the individual aircraft design) in takeoff, climb (en-route, approach, landing) or landing operating procedures or performance data, in accordance with the AFM/RFM, for flight in icing conditions or with ice accumulation on unprotected surfaces.

vv. **Integrated Testing**: Testing of the FSTD such that all aircraft system models are active and contribute appropriately to the results. None of the aircraft system models should be substituted with models or other algorithms intended for testing only. This may be accomplished by using controller displacements as the input. These controllers should represent the displacement of the pilot’s controls and these controls should have been calibrated.

ww. **Irreversible Control System**: A control system in which movement of the control surface will not back drive the pilot’s control on the flight deck.

xx. **Latency**: The additional time, beyond that of the basic perceivable response time of the aircraft due to the response time of the FSTD.

yy. **Light**: Operational mass at or near minimum for the specified flight condition.

zz. **Line Oriented Flight Training (LOFT):** Refers to aircrew training which involves full mission simulation of situations which are representative of line operations, with special emphasis on situations which involve communications, management and leadership. It means ‘real-time’, full-mission training.

aaa. **Manual Testing:** FSTD testing wherein the pilot conducts the test without computer inputs except for initial setup. All modules of the simulation should be active.

bbb. **Master Qualification Test Guide (MQTG)**: CARC approved QTG which incorporates the results of tests witnessed by CARC. The MQTG serves as the reference for future evaluations.

ccc. **Medium**: Normal operational weight for flight segment.

ddd. **Night Visual**: A visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide, as a minimum, all features applicable to the twilight scene, as defined below, with the exception of the need to portray reduced ambient intensity that removes ground cues that are not self-illuminating or illuminated by own ship lights (e.g. landing lights).

eee. **Nominal:** Normal operational weight, configuration, speed etc. for the flight segment specified.

fff. **Non-normal Control**: A term used in reference to Computer Controlled Aircraft. Non-normal Control is the state where one or more of the intended control, augmentation or protection functions are not fully available.

NOTE: Specific terms such as ALTERNATE, DIRECT, SECONDARY, BACKUP, etc, may be used to define an actual level of degradation.

ggg. **Normal Control**: A term used in reference to Computer Controlled Aircraft. Normal Control is the state where the intended control, augmentation and Protection Functions are fully available.

hhh. **Objective Test (Objective Testing)**: A quantitative assessment based on comparison with data.

iii. **One Step**: Refers to the degree of changes to an aircraft that would be allowed as an acceptable change, relative to a fully flight-test validated simulation. The intention of the alternative approach is that changes would be limited to one, rather than a series, of steps away from the baseline configuration. It is understood, however, that those changes which support the primary change (e.g. weight, thrust rating and control system gain changes accompanying a body length change) are considered part of the 'one step'.

jjj **Operator**: A person, organization or enterprise engaging in or offering to engage in an aircraft operation.

kkk. **Power Lever Angle**: The angle of the pilot's primary engine control lever(s) on the flight deck. This may also be referred to as PLA, THROTTLE, or POWER LEVER.

lll. **Predicted Data**: Data derived from sources other than type specific aircraft flight tests.

mmm. **Primary Reference Document**: Any regulatory document which has been used by CARC to support the initial evaluation of a FSTD.

nnn. **Proof-of-Match (POM):** A document which shows agreement within defined tolerances between model responses and flight test cases at identical test and atmospheric conditions.

ooo. **Protection Functions**: Systems functions designed to protect an aircraft from exceeding its flight and maneuver limitations.

ppp. **Pulse Input**: An abrupt input to a control followed by an immediate return to the initial position.

qqq. **Qualification Test Guide (QTG):** The primary reference document used for the evaluation of an FSTD. It contains test results, statements of compliance and other information to enable the evaluator to assess if the FSTD meets the test criteria described in this manual.

rrr. **Reversible Control System**: A partially powered or unpowered control system in which movement of the control surface will back drive the pilot’s control on the flight deck and/or affect its feel characteristics.

sss. **Robotic Test:** A basic performance check of a system’s hardware and software components. Exact test conditions are defined to allow for repeatability. The components are tested in their normal operational configuration and may be tested independently of other system components.

ttt. **Sideslip**: Sideslip Angle (degrees).

uuu. **Snapshot**: A presentation of one or more variables at a given instant of time.

vvv. **Statement of Compliance (SOC)**: A declaration that specific requirements have been met.

www. **Step Input**: An abrupt input held at a constant value.

xxx. **Subjective Test (Subjective Testing)**: A qualitative assessment based on established standards as interpreted by a suitably qualified person.

yyy. **Throttle Lever Angle (TLA)**: The angle of the pilot's primary engine control lever(s) on the flight deck.

zzz. **Time History**: A presentation of the change of a variable with respect to time.

aaaa. **Transport Delay**: The total FSTD system processing time required for an input signal from a pilot primary flight control until the motion system, visual system, or instrument response. It is the overall time delay incurred from signal input until output response. It does not include the characteristic delay of the aircraft simulated.

bbbb. **Twilight (Dusk/Dawn) Visual:** A visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide, as a minimum, full color presentations of reduced ambient intensity (as compared with a daylight visual system), sufficient to conduct a visual approach, landing and airport movement (taxi).

cccc. **Update**: The improvement or enhancement of an FSTD.

dddd. **Upgrade**: The improvement or enhancement of an FSTD for the purpose of achieving a higher qualification.

eeee. **Validation Data**: Data used to prove that the FSTD performance corresponds to that of the aircraft.

ffff. **Validation Flight Test Data**: Performance, stability and control, and other necessary test parameters electrically or electronically recorded in an aircraft using a calibrated data acquisition system of sufficient resolution and verified as accurate by the organization performing the test to establish a reference set of relevant parameters to which like FSTD parameters can be compared.

gggg. **Validation Test**: A test by which FSTD parameters can be compared with the relevant validation data.

hhhh. **Visual Ground Segment Test**: A test designed to assess items impacting the accuracy of the visual scene presented to the pilot at a decision height (DH) on an ILS approach.

iiii. **Visual System Response Time**: The interval from an abrupt control input to the completion of the visual display scan of the first video field containing the resulting different information.

jjjj **Well-Understood Effect**: An incremental change to a configuration or system which can be accurately modeled using proven predictive methods based on known characteristics of the change.

2 Abbreviations

A	= Airplane
AC	= Advisory Circular
A/C	= Aircraft
Ad	= Total initial displacement of pilot controller (initial displacement to final resting amplitude)
AFM	= Airplane Flight Manual
AFCS	= Automatic Flight Control System
AGL	= Above Ground Level (meters or feet)
An	= Sequential amplitude of overshoot after initial X axis crossing, e.g. A1 =1st overshoot.
AEO	= All Engines Operating
AOA	= Angle of Attack (degrees)

BC = ILS localizer back course

CAT I/II/III = Landing category operations
CARC = Civil Aviation Regulatory Commission
CCA = Computer Controlled Airplane
cd/m2 = Candela/metre2, 3.4263 candela/m2 = 1 ft-Lambert
CG = Centre of gravity
cm(s) = Centimeter, centimeters
CT&M = Correct Trend and Magnitude

daN = Deca Newtons
dB = Decibel
deg(s) = Degree, degrees
DGPS = Differential Global Positioning System
DH = Decision Height
DME = Distance Measuring Equipment
DPATO = Defined Point After Take-off
DPBL = Define Point Before Landing

EGPWS = Enhanced Ground Proximity Warning System
EPR = Engine Pressure Ratio
EW = Empty Weight

FAA = United States Federal Aviation Administration (U.S.)
FD = Flight Director
FOV = Field Of View
FPM = Feet Per Minute
FTO = Flying Training Organization
ft = Feet, 1 foot = 0.304801 meters
ft-Lambert = Foot-Lambert, 1 ft-Lambert = 3.4263 candela/m2

g = Acceleration due to gravity (meters or feet/sec2), 1g = 9.81 m/sec2 or 32.2 feet/sec2
G/S = Glide slope
GPS = Global Positioning System
GPWS = Ground Proximity Warning System

H = Helicopter
HGS = Head-up Guidance System

IATA = International Air Transport Association
ICAO = International Civil Aviation Organization
IGE = In Ground Effect
ILS = Instrument Landing System
IMC = Instrument Meteorological Conditions
in = Inches 1 in = 2.54 cmIOS = Instructor Operating Station
IPOM = Integrated proof of match
IQTG = International Qualification Test Guide (RAeS Document)

JCAR = Jordan Civil Aviation Regulation
JAWS = Joint Airport Weather Studies

km = Kilometers 1 km = 0.62137 Statute Miles
kPa = Kilopascal (Kilo Newton/Metres2). 1 psi = 6.89476 kPa
kts = Knots calibrated airspeed unless otherwise specified, 1 Knot = 0.5148 m/sec or 1.689 ft/sec

lb = Pounds
LOC = Localizer
LOFT = Line oriented flight training
LOS = Line oriented simulation
LDP = Landing Decision Point

m = Meters, 1 Meter = 3.28083 feet
MCC = Multi-Crew Co-operation
MCTM = Maximum certificated take-off mass (kilos/pounds)
MEH = Multi-engine Helicopter
min = Minutes
MLG = Main landing gear
mm = Millimeters
MPa = Mega pascals [1 psi = 6894.76 Pascal]
MQTG = Master Qualification Test Guide
ms = Millisecond(s)
MTOW = Maximum Take-off Weight

n = Sequential period of a full cycle of oscillation
N = NORMAL CONTROL Used in reference to Computer Controlled Aircraft N/A = Not Applicable
N1 = Engine Low Pressure Rotor revolutions per minute expressed in percent of maximum
N1/Ng = Gas Generator Speed
N2 = Engine High Pressure Rotor revolutions per minute expressed in percent of maximum
N2/Nf = Free Turbine Speed
NDB = Non-directional beacon
NM = Nautical Mile, 1 Nautical Mile = 6 080 feet = 1 852m
NN = Non-normal control a state referring to computer controlled aircraft
NR = Main Rotor Speed
NWA = Nose wheel Angle (degrees)

OEI = One Engine Inoperative
OGE = Out of Ground Effect
OM-B = Operations Manual – Part B (AFM)
OTD = Other Training Device

P0 = Time from pilot controller release until initial X axis crossing (X axis defined by the resting amplitude)
P1 = First full cycle of oscillation after the initial X axis crossing
P2 = Second full cycle of oscillation after the initial X axis crossing
PANS = Procedure for air navigation services
PAPI = Precision Approach Path Indicator System
PAR = Precision approach radar
Pf = Impact or Feel Pressure
PLA = Power Lever Angle
PLF = Power for Level Flight
Pn = Sequential period of oscillation
POM = Proof-of-Match
PSD = Power Spectral Density
psi = pounds per square inch. (1 psi = 6·89476 kPa)
PTT = Part-Task Trainer

QTG = Qualification Test Guide

R/C	= Rate of Climb (meters/sec or feet/min)
R/D	= Rate of Descent (meters/sec or feet/min)
RAE	= Royal Aerospace Establishment
RAeS	= Royal Aeronautical Society
REIL	= Runway End Identifier Lights
RNAV	= Radio navigation
RVR	= Runway Visual Range (meters or feet)
s	= second(s)
sec(s)	= second, seconds
sm	= Statute Mile 1 Statute Mile = 5280 feet = 1609m
SOC	= Statement of Compliance
SUPPS	= Supplementary procedures referring to regional supplementary procedures
TCAS	= Traffic alert and Collision Avoidance System
TGL	= Temporary Guidance Leaflet
T (A)	= Tolerance applied to Amplitude
T (p)	= Tolerance applied to period
T/O	= Take-off
Tf	= Total time of the flare maneuver duration
Ti	= Total time from initial throttle movement until a 10% response of a critical engine parameter
TLA	= Throttle lever angle
TLOF	= Touchdown and Lift Off
TDP	= Take-off Decision Point
Tt	= Total time from Ti to a 90% increase or decrease in the power level specified
VASI	= Visual Approach Slope Indicator System
VDR	= Validation Data Roadmap
VFR	= Visual Flight Rules
VGS	= Visual Ground Segment
Vmca	= Minimum Control Speed (Air)
Vmcg	= Minimum Control Speed (Ground)
Vmcl	= Minimum Control Speed (Landing)
VOR	= VHF Omni-directional Range
Vr	= Rotate Speed
Vs	= Stall Speed or minimum speed in the stall

V1	= Critical Decision Speed
VTOSS	= Take-off Safety Speed
Vy	= Optimum Climbing Speed
Vw	= Wind Velocity
WAT	= Weight, Altitude, Temperature

1st Segment = that portion of the take-off profile from lift-off to completion of gear retraction (JCAR 25)

2nd Segment = that portion of the take-off profile from after gear retraction to end of climb at V2 and initial flap/slat retraction (JCAR-25)

3rd Segment = that portion of the take-off profile after flap/slat retraction is complete (JCAR-25)

JCAR-FSTD A Section 2
AC C – Airplane Flight Simulation Training Devices

AC No. 1 to JCAR-FSTD A.015 (acceptable means of compliance) FSTD Qualification – Application and Inspection

See JCAR–FSTD A.015

1 **Letter of Application.**

A sample of letter of application is provided overleaf.

Letter of application for initial CARC evaluation of a flight simulation training device

Part A.

To be submitted not less than 3 months prior to requested qualification date

(Date) ………………………

Type of FSTD	**Aircraft Type/Class**	**Qualification Level Sought**			
Flight Simulator (FFS)		A	B	C	D
Flight Training Device (FTD)		1		2	
Flight and Navigation Procedures Trainer (FNPT)		I	II	MCC	
Basic Instrument Training Device (BITD)					

Dear, Director of Flight Operations Standards Department

..........……....... (Name of Applicant)................…....... requests the evaluation of its Flight Simulation Training Device for JCAR-FSTD A qualification. The...…... (FSTD Manufacturer Name) FSTD with it’s ...………... (Visual System Manufacturer Name, if applicable) Visual System is fully defined on page ......…..... of the accompanying Qualification Test Guide (QTG) which was run on.....….. (Date)...…...... at....... (Place)......………

Evaluation is requested for the following configurations and engine fits as applicable:
e.g. 767 PW/GE and 757RR
1……………..
2…………….
3…………….
Dates requested are…………………and the FSTD will be located at
…………………………………………………………………………………………………
The QTG will be submitted by…… (Date)………… and in any event not less than 30 days before the requested evaluation date unless otherwise agreed with the CARC.

Comments:
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Signed
……………………………………..…………
Print name…………….…………….…………
Position / appointment held………………….……
E-mail address………………….……………….………
Telephone number……………….…………….……

Part B.
To be completed with attached QTG results

(Date)………….

We have completed tests of the FSTD and declare that it meets all applicable requirements of the JCAR– FSTD A except as noted below. Appropriate hardware and software configuration control procedures have been established and these are appended for your inspection and approval.

The following MQTG tests are outstanding:

Tests	Comments

(Add boxes as required)

It is expected that they will be completed and submitted 3 weeks prior to the evaluation date.

Signed
………………………………….……

Print name…............................….……
Position / appointment held……………
E-mail address………………….………
Telephone number……………….…….

Part C.

To be completed not less than 7 days prior to initial evaluation

(Date)…………

The FSTD has been assessed by the following evaluation team:
.... (Name)...................... Qualification..
.... (Name)...................... Qualification..
.... (Name)...................... Qualification..
.... (Name)...................... Pilot’s License Nr...
.... (Name)...................... Flight Engineer’s License Nr (if applicable)...............

This team attests that it conforms to the airplane flight deck configuration of.......... (Name of FSTD operator).......... (Type of airplane) airplane and that the simulated systems and subsystems function equivalently to those in that airplane. This pilot has also assessed the performance and the flying qualities of the FSTD and finds that it represents the designated airplane.

(Additional comments as required)
……………………………………………………………
…………………………………………………………….
…………………………………………………………….
Signed
………………………………………
Print name…......................................
Position/appointment held……………
E-mail address……………………….
Telephone number…………………….

2 Composition of Evaluation Team.

2.1 To gain a Qualification Level, an FSTD is evaluated in accordance with a structured routine conducted by a technical team which is appointed by CARC. The team normally consists of at least the following personnel:

a. A technical FSTD inspector of CARC, qualified in all aspects of flight simulation hardware, software and computer modeling or, exceptionally, a person designated by CARC with equivalent qualifications; and

b. One of the following:
   i. A flight operations inspector of CARC, who is qualified in flight crew training procedures and is holding a valid type rating on the airplane (or for BITD, class rated on the class of airplane) being simulated; or
   ii. A flight operations inspector of CARC who is qualified in flight crew training procedures assisted by a Type Rating Instructor, holding a valid type rating on the airplane (or for BITD, class rated on the class of airplane) being simulated; or, exceptionally,
   iii. A person designated by CARC who is qualified in flight crew training procedures and is holding a valid type rating on the airplane (or for BITD, class rated on the class of airplane) being simulated and sufficiently experienced to assist the technical team. This person should fly out at least part of the functions and subjective test profiles.

   Where a designee is used as a substitute for one of CARC inspectors, the other person shall be a properly qualified inspector of CARC.

   For an FTD level 1 and FNPT Type I, one suitably qualified Inspector may combine the functions in a. and b. above.

   For a BITD this team consists of an Inspector from CARC.

2.2 Additionally the following persons should be present:

a. For FFS, FTD and FNPT a type or class rated Training Captain from the FSTD operator or main FSTD users.

b. For all types, sufficient FSTD support staff to assist with the running of tests and operation of the instructor's station.

2.3 On a case-by-case basis, when an FFS is being evaluated, CARC may reduce the evaluation team to CARC flight inspector supported by a type rated training captain from a main flight simulator user for evaluation of a specific flight simulator of a specific FSTD operator, provided:

a. This composition is not being used prior to the second re-current evaluation;

b. Such an evaluation will be followed by an evaluation with a full CARC evaluation team;

c. CARC flight inspector will perform some spot checks in the area of objective testing;

d. No major change or upgrading has been applied since the directly preceding evaluation;

e. No re-location of the FSTD has taken place since the last evaluation;

f. A system is established enabling CARC to monitor and analyze the status of the FSTD on a continuous basis;

g. The FSTD hardware and software has been working reliably for the previous years. This should be reflected in the number and kind of (technical log) discrepancies and the results of the quality system audits.

AC No. 2 to JCAR- FSTD A.015 (explanatory material)
FSTD Evaluations
See JCAR–FSTD A.015

1 **General.**

1.1 During initial and re-current FSTD evaluations it will be necessary for CARC to conduct the Objective and Subjective tests described in JCAR-FSTD A.030 and JCAR–FSTD A.035, and detailed in AC No 1 to JCAR-FSTD A.030. There will be occasions when all tests cannot be completed - for example during re-current evaluations on a convertible FSTD - but arrangements should be made for all tests to be completed within a reasonable time.

1.2 Following an evaluation, it is possible that a number of defects may be identified. Generally these defects should be rectified and CARC notified of such action within 30 days. Serious defects, which affect flight crew training, testing and checking, could result in an immediate downgrading of the Qualification Level, or if any defect remains unattended without good reason for period greater than 30 days, subsequent downgrading may occur or the FSTD Qualification could be revoked.

2 **Initial Evaluations.**

2.1 **Objective Testing.**

2.1.1 Objective Testing is centered around the QTG. Before testing can begin on an initial evaluation the acceptability of the validation tests contained in the QTG should be agreed with CARC well in advance of the evaluation date to ensure that the FSTD time especially devoted to the running of some of the tests by CARC is not wasted. The acceptability of all tests depends upon their content, accuracy, completeness and recency of the results.

2.1.2 Much of the time allocated to Objective Tests depends upon the speed of the automatic and manual systems set up to run each test and whether or not special equipment is required. CARC will not necessarily warn the FSTD operator of the sample validations tests which will be run on the day of the evaluation, unless special equipment is required. It should be remembered that the FSTD cannot be used for Subjective Tests whilst part of the QTG is being run.

Therefore sufficient time (at least 8 consecutive hours) should be set aside for the examination and running of the QTG. A useful explanation of how the validation tests should be run is contained in the 'RAeS Airplane Flight Simulator Evaluation Handbook' produced in support of the ICAO Manual of Criteria for the Qualification of Flight Simulators and JCAR–FSTD A.

2.2 **Subjective Testing.**

2.2.1 The Subjective Tests for the evaluation can be found in AC No 1 to JCAR-FSTD A.030, and a suggested Subjective Test Profile is described in sub-paragraph 4.6 below.

2.2.2 Essentially one working day is required for the Subjective Test routine, which effectively denies use of the FSTD for any other purpose.

2.3 **Conclusion.**

2.3.1 To ensure adequate coverage of Subjective and Objective Tests and to allow for cost effective rectification and re-test before departure of the inspection team, adequate time (up to three consecutive days) should be dedicated to an initial evaluation of an FSTD.

3 **Recurrent Evaluations.**

3.1 **Objective Testing.**

3.1.1 During re-current evaluations, CARC will wish to see evidence of the successful running of the QTG between evaluations. CARC will select a number of tests to be run during the evaluation, including those that may be cause for concern. Again adequate notification would be given when special equipment is required for the test.

3.1.2 Essentially the time taken to run the Objective Tests depends upon the need for special equipment, if any, and the test system, and the FSTD cannot be used for Subjective Tests or other functions whilst testing is in progress. For a modern FSTD incorporating an automatic test system, four (4) hours would normally be required. FSTDs that rely upon Manual Testing may require a longer period of time.

3.2 **Subjective Testing.**

3.2.1 Essentially the same subjective test routine should be flown as per the profile described in subparagraph 4.6 below with a selection of the subjective tests taken from AC No 1 to JCAR- FSTD A.030.

3.2.2 Normally, the time taken for recurrent Subjective Testing is about four (4) hours, and the FSTD cannot perform other functions during this time.

3.3 **Conclusion.**

3.3.1 To ensure adequate coverage of Subjective and Objective Tests during a re-current evaluation, a total of 8 hours should be allocated, (4 hours for a BITD). However, it should be remembered that any FSTD deficiency that arises during the evaluation could necessitate the extension of the evaluation period.

3.3.2 In the case of a BITD, the re-current evaluation may be conducted by one suitably qualified Flight operations Inspector only, in conjunction with the visit of any Facility or inspection of any Flight Training Organization, using the BITD.

4 **Functions and Subjective Tests - Suggested Test Routine.**

4.1 During initial and re-current evaluations of an FSTD, CARC will conduct a series of Functions and Subjective Tests that together with the Objective Tests complete the comparison of the FSTD with the type or class of airplane.

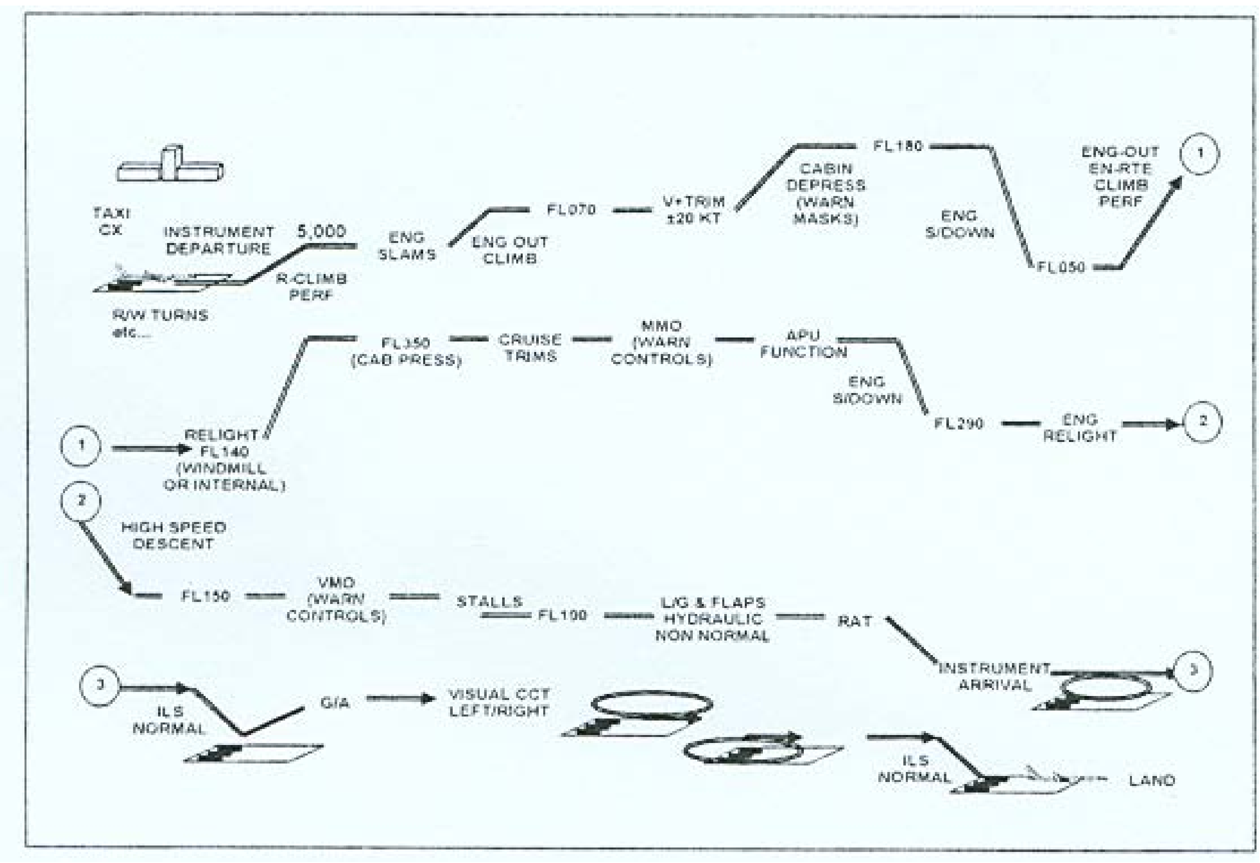
4.2 Where as functions tests verify the acceptability of the simulated airplane systems and their integration, Subjective Tests verify the fitness of the FSTD in relation to training, checking and testing tasks.

4.3 The FSTD should provide adequate flexibility to permit the accomplishment of the desired/required tasks while maintaining an adequate perception by the flight crew that they are operating in a real airplane environment. Additionally, the Instructor Operating Station (IOS) should not present an unnecessary distraction from observing the activities of the flight crew whilst providing adequate facilities for the tasks.

4.4 Section 1 of JCAR– FSTD A sets out the requirements, and the ACs in Section 2 the means of compliance for qualification. However, it is important that both CARC and the FSTD operator understand what to expect from the routine of FSTD Functions and Subjective Tests. It should be remembered that part of the Subjective Tests routine for an FSTD should involve an uninterrupted fly-out (except for FTD level 1) comparable with the duration of typical training sessions in addition to assessment of flight freeze and repositioning. An example of such a profile is to be found in sub-paragraph 4.6 (4.7 for BITD) below. (A useful explanation of Functions and Subjective Tests and an example of Subjective Test routine check-list may be found in the RAeS Airplane Flight Simulator Evaluation Handbook) produced in support of the ICAO Manual of Criteria for the Qualification of Flight Simulators and JCAR–FSTD A.

4.5 Reserved.

4.6 Typical Test Profile for a FSTD A.



Note:

(1) The Typical Test Profile (approximately 2 hours) should be flown at airplane masses at, or close to, the maximum allowable mass for the ambient atmospheric conditions. Those ambient conditions should be varied from Standard Atmosphere to test the validity of the limits of temperature and pressure likely to be required in the practical use of the FSTD. Visual exercises only apply to FSTDs fitted with a visual system.

(2) Flight with AFCS.

(3) Manual handling qualities are purely generic and should not provide negative training.

4.7 Typical Subjective Test Profile for BITDs (approximately 2 hours) - items and altitudes as applicable:

- Instrument departure, rate of climb, climb performance.
- Level-off at 4 000 ft.
- Fail engine (if applicable).
- Engine out climb to 6 000 ft (if applicable).
- Engine out cruise performance (if applicable), restart engine.
- All engine cruise performance with different power settings.
- Descent to 2000 ft.
- All engine performance with different configurations, followed by ILS approach.
- All engine go-around.
- Non-precision approach.
- Go-around with engine failure (if applicable).
- Engine out ILS approach (if applicable).
- Go-around engine out (if applicable).
- Non precision approach engine out (if applicable), followed by go-around.
- Restart engine (if applicable).
- Climb to 4000 ft.

- Maneuvering:
    - Normal turns left and right.
    - Steep turns left and right.
    - Acceleration and deceleration within operational range.
    - Approaching to stall in different configurations.
    - Recovery from spiral dive.
    - Auto flight performance (if applicable).
    - System malfunctions.
    - Approach.

AC to JCAR-FSTD A.020 (acceptable means of compliance)
Validity of FSTD Qualification
See JCAR-FSTD A.020

1. **Prerequisites.**

1.1 On a case-by-case basis, CARC may grant an extended validity of a FSTD qualification in excess of 12 months up to a maximum of 24 months, to a specific FSTD operator for a specific FSTD, provided:

a. An initial and at least one re-current successful evaluation have been performed on this FSTD by CARC;

b. The FSTD operator has got a satisfactory record of successful regulatory FSTD evaluations over a period of at least 3 years;

c. The FSTD operator has established and successfully maintained a Quality System for at least 3 years;

d CARC performs a formal audit of the FSTD operator's Quality System every calendar year;

e. An accountable person of the FSTD operator with FSTD and training experience acceptable to CARC (such as a type rated training captain), reviews the regular reruns of the QTG and conducts the relevant function and subjective tests every 12 months;

f. A report detailing the results of the QTG rerun tests and function and subjective evaluation will be signed and submitted by the accountable person described under subparagraph (e) above to CARC.

2. **Prerogative of CARC.**

CARC reserves the right to perform FSTD evaluations whenever it deems it necessary.

AC No.1 to JCAR-FSTD A.025 (acceptable means of compliance)
Quality System
See JCAR– FSTD A.025

1. **Introduction.**

1.1 In order to show compliance with JCAR– FSTD A.025, an FSTD operator should establish his Quality System in accordance with the instructions and information contained in the following paragraphs.

2 **General.**

2.1 **Terminology.**

a. The terms used in the context of the requirement for an FSTD operator's Quality System have the following meanings:

i. **Accountable Manager***:* The person acceptable to CARC who has corporate authority for ensuring that all necessary activities can be financed and carried out to the standard required by CARC, and any additional requirements defined by the FSTD operator.

ii. **Quality Assurance**: All those planned and systematic actions necessary to provide adequate confidence that specified performance, functions and characteristics satisfy given requirements.

iii. **Quality Manager**: The manager, acceptable to CARC, responsible for the management of the Quality System, monitoring function and requesting corrective actions.

2.2 **Quality Policy.**

2.2.1 An FSTD operator should establish a formal written Quality Policy Statement that is a commitment by the Accountable Manager as to what the Quality System is intended to achieve. The Quality Policy should reflect the achievement and continued compliance with JCAR– FSTD A together with any additional standards specified by the FSTD operator.

2.2.2 The Accountable Manager is an essential part of the FSTD qualification holder's organization. With regard to the above terminology, the term 'Accountable Manager' is intended to mean the Chief Executive / President / Managing Director/General Manager etc. of the FSTD operator's organization, who by virtue of his position has overall responsibility (including financial) for managing the organization.

2.2.3 The Accountable Manager will have overall responsibility for the FSTD qualification holder's Quality System including the frequency, format and structure of the internal management evaluation activities as prescribed in paragraph 4.9 below.

2.3 **Purpose of the Quality System.**

2.3.1 The Quality System should enable the FSTD operator to monitor compliance with JCAR–FSTD A, and any other standards specified by that FSTD operator, or CARC, to ensure correct maintenance and performance of the device.

2.4 **Quality Manager.**

2.4.1 The primary role of the Quality Manager is to verify, by monitoring activity in the fields of FSTD qualification, that the standards required by CARC, and any additional requirements defined by the FSTD operator, are being carried out under the supervision of the relevant Manager.

2.4.2 The Quality Manager should be responsible for ensuring that the Quality Assurance Program is properly established, implemented and maintained.

2.4.3 The Quality Manager should:

a. Have direct access to the Accountable Manager;

b. Have access to all parts of the FSTD operator's and, as necessary, any sub-contractor's organization.

2.4.4 The posts of the Accountable Manager and the Quality Manager may be combined by FSTD operators whose structure and size may not justify the separation of those two posts. However, in this event, Quality Audits should be conducted by independent personnel.

3 Quality System.

3.1 Introduction.

3.1.1 The FSTD operator's Quality System should ensure compliance with FSTD qualification requirements, standards and procedures.

3.1.2 The FSTD operator should specify the structure of the Quality System.

3.1.3 The Quality System should be structured according to the size and complexity of the organization to be monitored.

3.2 Scope.

3.2.1 As a minimum, the Quality System should address the following:

a. The provision of JCAR–FSTD A.

b. The FSTD operator's additional standards and procedures.

c. The FSTD operator's Quality Policy.

d. The FSTD operator's organizational structure.

e. Responsibility for the development, establishment and management of the Quality System.

f. Documentation, including manuals, reports and records.

g. Quality Procedures.

h. Quality Assurance Program.

i. The provision of adequate financial, material and human resources.

j. Training requirements for the various functions in the organization.

3.2.2 The Quality System should include a feedback system to the Accountable Manager to ensure that corrective actions are both identified and promptly addressed. The feedback system should also specify who is required to rectify discrepancies and non-compliance in each particular case, and the procedure to be followed if corrective action is not completed within an appropriate timescale.

3.3 **Relevant Documentation.**

Relevant documentation should include the following:

a. Quality Policy.

b. Terminology.

c. Reference to specified FSTD technical standards.

d. A description of the organization.

e. The allocation of duties and responsibilities.

f. Qualification procedures to ensure regulatory compliance.

g. The Quality Assurance Program, reflecting:
   i. Schedule of the monitoring process.
   ii. Audit procedure.
   iii. Reporting procedures.
   iv. Follow-up and corrective action procedures.
   v. Recording system.

h. Document control.

4. **Quality Assurance Program.**

4.1 **Introduction.**

4.1.1 The Quality Assurance Program should include all planned and systematic actions necessary to provide confidence that all maintenance is conducted and all performance maintained in accordance with all applicable requirements, standards and procedures.

4.1.2 When establishing a Quality Assurance Program, consideration should, at least, be given to the paragraphs 4.2 to 4.9 below.

4.2 **Quality Inspection.**

4.2.1 The primary purpose of a quality inspection is to observe a particular event/action/document etc., in order to verify whether established procedures and requirements are followed during the accomplishment of that event and whether the required standard is achieved.

4.2.2 Typical subject areas for quality inspections are:
- Actual FSTD operation.
- Maintenance.
- Technical standards.
- Flight simulator safety features.

4.3 **Audit.**

4.3.1 An audit is a systematic and independent comparison of the way in which an activity is being conducted against the way in which the published procedures say it should be conducted.

4.3.2 Audits should include at least the following quality procedures and processes:

a. A statement explaining the scope of the audit.

b. Planning and preparation.

c. Gathering and recording evidence.

d. Analysis of the evidence.

4.3.3 Techniques which contribute to an effective audit are:

a. Interviews or discussions with personnel.

b. A review of published documents.

c. The examination of an adequate sample of records.

d. The witnessing of the activities which make up the operation

e. The preservation of documents and the recording of observations.

4.4 **Auditors.**

4.4.1 An FSTD operator should decide, depending on the complexity and size of the organization, whether to make use of a dedicated audit team or a single auditor. In any event, the auditor or audit team should have relevant FSTD experience.

4.4.2 The responsibilities of the auditors should be clearly defined in the relevant documentation.

4.5 **Auditor's Independence.**

4.5.1 Auditors should not have any day to day involvement in the area of activity which is to be audited. An FSTD operator may, in addition to using the services of full-time dedicated personnel belonging to a separate quality department, undertake the monitoring of specific areas or activities by the use of part-time auditors. Due to the technological complexity of FSTDs, which requires auditors with very specialized knowledge and experience, an FSTD operator may undertake the audit function by the use of part-time personnel from within his own organization or from an external source under the terms of an agreement acceptable to CARC. In all cases the FSTD operator should develop suitable procedures to ensure that persons directly responsible for the activities to be audited are not selected as part of the auditing team. Where external auditors are used, it is essential that any external specialist is familiar with the type of device conducted by the FSTD operator.

4.5.2 The FSTD operator's Quality Assurance Program should identify the persons within the company who have the experience, responsibility and authority to:

a. Perform quality inspections and audits as part of ongoing Quality Assurance.

b. Identify and record any concerns or findings, and the evidence necessary to substantiate such concerns or findings.

c. Initiate or recommend solutions to concerns or findings through designated reporting channels.

d. Verify the implementation of solutions within specific time scales.

e. Report directly to the Quality Manager.

4.6 **Audit Scope.**

4.6.1 FSTD operators are required to monitor compliance with the procedures they have designed to ensure specified performance and functions. In doing so they should as a minimum, and where appropriate, monitor:

a. Organization.

b. Plans and objectives.

c. Maintenance procedures.

d. FSTD Qualification Level.

e. Supervision.

f. FSTD technical status.

g. Manuals, logs, and records.

h. Defect deferral.

i. Personnel training.

j. Airplane modifications management.

4.7 Auditing scheduling.

4.7.1 A Quality Assurance Program should include a defined audit schedule and a periodic review. The schedule should be flexible, and allow unscheduled audits when trends are identified. Follow-up audits should be scheduled when necessary to verify that corrective action was carried out and that it was effective.

4.7.2 An FSTD operator should establish a schedule of audits to be completed during a specified calendar period. All aspects of the operation should be reviewed within every period of 12 months in accordance with the program unless an extension to the audit period is accepted as explained below. An FSTD operator may increase the frequency of audits at his discretion but should not decrease the frequency without the agreement of CARC.

4.7.3 When an FSTD operator defines the audit schedule, significant changes to the management, organization, or technologies should be considered as well as changes to the regulatory requirements.

4.7.4 For FSTD operators whose structure and size may not justify the completion of a complex system of audits, it may be appropriate to develop a Quality Assurance Program that employs a checklist. The checklist should have a supporting schedule that requires completion of all checklist items within a specified time scale, together with a statement acknowledging completion of a periodic review by top management.

4.7.5 Whatever arrangements are made, the FSTD operator retains the ultimate responsibility for the Quality System and especially the completion and follow up of corrective actions.

4.8 Monitoring and Corrective Action.

4.8.1 The aim of monitoring within the Quality System is primarily to investigate and judge its effectiveness and thereby to ensure that defined policy, performance and function standards are continuously complied with. Monitoring activity is based upon quality inspections, audits, corrective action and follow-up. The FSTD operator should establish and publish a quality procedure to monitor regulatory compliance on a continuing basis. This monitoring activity should be aimed at eliminating the causes of unsatisfactory performance.

4.8.2 Any non-compliance identified as a result of monitoring should be communicated to the manager responsible for taking corrective action or, if appropriate, the Accountable Manager. Such non-compliance should be recorded, for the purpose of further investigation, in order to determine the cause and to enable the recommendation of appropriate corrective action.

4.8.3 The Quality Assurance Program should include procedures to ensure that corrective actions are taken in response to findings. These quality procedures should monitor such actions to verify their effectiveness and that they have been completed. Organizational responsibility and accountability for the implementation of corrective actions resides with the department cited in the report identifying the finding. The Accountable Manager will have the ultimate responsibility for resourcing the corrective action and ensuring, through the Quality Manager, that the corrective action has re-established compliance with the standard required by CARC, and any additional requirements defined by the FSTD operator.

4.8.4 Corrective action.

a. Subsequent to the quality inspection/audit, the FSTD operator should establish:
   i. The seriousness of any findings and any need for immediate corrective action.
   ii. Cause of the finding.
   iii. Corrective actions required to ensure that the non-compliance does not recur.
   iv. A schedule for corrective action.
   v. The identification of individuals or departments responsible for implementing corrective action.
   vi. Allocation of resources by the Accountable Manager, where appropriate.

4.8.5 The Quality Manager should:

a. Verify that corrective action is taken by the manager responsible in response to any finding of noncompliance.

b. Verify that corrective action includes the elements outlined in paragraph 4.8.4 above.

c. Monitor the implementation and completion of corrective action.

d. Provide management with an independent assessment of corrective action, implementation and completion.

e. Evaluate the effectiveness of corrective action through the follow-up process.

4.9 **Management Evaluation.**

4.9.1 A management evaluation is a comprehensive, systematic, documented review of the Quality System and procedures by the management, and it should consider:

a. The results of quality inspections, audits and any other indicators.

b. The overall effectiveness of the management organization in achieving stated objectives.

4.9.2 A management evaluation should identify and correct trends, and prevent, where possible, future non-conformities. Conclusions and recommendations made as a result of an evaluation should be submitted in writing to the responsible manager for action. The responsible manager should be an individual who has the authority to resolve issues and take action.

4.9.3 The Accountable Manager should decide upon the frequency, format, and structure of internal management evaluation activities.

4.10 **Recording.**

4.10.1 Accurate, complete, and readily accessible records documenting the results of the Quality Assurance Program should be maintained by the FSTD operator. Records are essential data to enable an FSTD operator to analyze and determine the root causes of non-conformity, so that areas of non-compliance can be identified and addressed.

4.10.2 The following records should be retained for a period of 5 years:

a. Audit schedules.

b. Quality inspection and audit reports.

c. Response to findings.

d. Corrective action reports.

e. Follow-up and closure reports; and

f. Management evaluation reports.

5 Quality Assurance responsibility for sub-contractors.

5.1 Sub-contractors.

5.1.1 FSTD operators may decide to sub-contract out certain activities to external agencies for the provision of services related to areas such as:

a. Maintenance.

b. Manual preparation.

5.1.2 The ultimate responsibility for the product or service provided by the sub-contractor always remains with the FSTD operator. A written agreement should exist between the FSTD operator and the subcontractor clearly defining the services and quality to be provided. The sub-contractor's activities relevant to the agreement should be included in the FSTD operator's Quality Assurance Program.

5.1.3 The FSTD operator should ensure that the sub-contractor has the necessary authorization/approval when required, and commands the resources and competence to undertake the task. If the FSTD operator requires the sub-contractor to conduct activity which exceeds the sub-contractor’s authorization/approval, the FSTD operator is responsible for ensuring that the sub-contractor’s Quality Assurance takes account of such additional requirements.

6 Quality System Training.

6.1 General.

6.1.1 An FSTD operator should establish effective, well planned and resourced quality related briefing for all personnel.

6.1.2 Those responsible for managing the Quality System should receive training covering:

a. An introduction to the concept of the Quality System.

b. Quality management.

c. Concept of Quality Assurance.

d. Quality manuals.

e. Audit techniques.

f. Reporting and recording.

g. The way in which the Quality System will function in the organization.

6.1.3 Time should be provided to train every individual involved in quality management and for briefing the remainder of the employees. The allocation of time and resources should be sufficient for the scope of the training.

6.2 Sources of Training.

6.2.1 Quality management courses are available from the various national or international Standards Institutions, and an FSTD operator should consider whether to offer such courses to those likely to be involved in the management of Quality Systems. FSTD operators with sufficient appropriately qualified staff should consider whether to carry out in-house training.

7. **Standard Measurements for Flight Simulator Quality.**

7.1 **General**.

7.1.1 It is recognized that a Quality System tied to measurement of FSTD performance will probably lead to improving and maintaining training quality. One acceptable means of measuring FSTD performance is entitled “Standard Measurements for Flight Simulator Quality”.

AC No. 2 to JCAR-FSTD A.025
BITD Operator's Quality System
See JCAR-FSTD A.025

1 **Introduction.**

1.1 In order to show compliance with JCAR-FSTD A.025, a BITD operator should establish his Quality System in accordance with the instructions and information contained in the following paragraphs.

2 **Quality Policy.**

2.1 A BITD operator should establish a formal written Quality Policy Statement that is a commitment by the Accountable Manager as to what the Quality System is intended to achieve.

2.2 The Accountable Manager is someone who by virtue of his position has overall authority and responsibility (including financial) for managing the organization.

2.3 The Quality Manager is responsible for the function of the Quality System and requesting corrective actions.

3 **Quality System.**

3.1 The Quality System should enable the BITD operator to monitor compliance with JCAR-FSTD A, and any other standards specified by that BITD operator to ensure correct maintenance and performance of the device.

3.2 A Quality Manager oversees the day-to-day control of quality.

3.3 For a small FSTD operator the position of the Accountable Manager and the Quality Manager may be combined. However, in this event, independent personnel should conduct Quality Audits.

4 **Quality Assurance Program.**

4.1 A Quality Assurance Program together with a statement acknowledging completion of a periodic review by the Accountable Manager should include the following:

4.1.1 A maintenance facility which provides suitable BITD hardware and software test and maintenance capability.

4.1.2 A recording system in the form of a technical log in which defects, deferred defects and development work are listed, interpreted, actioned and reviewed within a specified time scale.

4.1.3 Planned routine maintenance of the BITD and periodic running of the QTG with adequate manning to cover BITD operating periods and routine maintenance work.

4.1.4 A planned audit schedule and a periodic review should be used to verify that corrective action was carried out and that it was effective. The auditor should have adequate knowledge of BITDs and should be acceptable to CARC.

5 **Quality System Training.**

5.1 The Quality Manager should receive appropriate Quality System training and brief other personnel on the procedures.

AC No. 3 to JCAR-FSTD A.025
Installations
See JCAR-FSTD A.025(c)

1 **Introduction.**

1.1 This AC identifies those elements that are expected to be addressed, as a minimum, to ensure that the FSTD installation provides a safe environment for the users and operators of the FSTD under all circumstances.

2 **Expected Elements.**

2.1 Adequate fire/smoke detection, warning and suppression arrangements should be provided to ensure safe passage of personnel from the FSTD.

2.2 Adequate protection should be provided against electrical, mechanical, hydraulic and pneumatic hazards - including those arising from the control loading and motion systems to ensure maximum safety of all personnel in the vicinity of the FSTD.

2.3 Other areas that should be addressed include:

a. A two way communication system that remains operational in the event of a total power failure.

b. Emergency lighting.

c. Escape exits and escape routes.

d. Occupant restraints (seats, seat belts etc.).

e. External warning of motion and access ramp or stairs activity.

f. Danger area markings.

g. Guard rails and gates.

h. Motion and control loading emergency stop controls accessible from either pilot or instructor seats; and

i. A manual or automatic electrical power isolation switch.

AC No. 1 to JCAR-FSTD A.030 (acceptable means of compliance)
FSTDs qualification
See JCAR–FSTD A.030

1 **Introduction.**

1.1 **Purpose**. This AC establishes the criteria that define the performance and documentation requirements for the evaluation of FSTDs used for training, testing and checking of flight crewmembers. These test criteria and methods of compliance were derived from extensive experience of Authorities and the industry.

1.2 **Background.**

1.2.1 The availability of advanced technology has permitted greater use of FSTDs for training, testing and checking of flight crewmembers. The complexity, costs and operating environment of modern aircraft also encourages broader use of advanced simulation. FSTDs can provide more in-depth training than can be accomplished in aircraft and provide a safe and suitable learning environment. Fidelity of modern FSTDs is sufficient to permit pilot assessment with the assurance that the observed behavior will transfer to the aircraft. Fuel conservation and reduction in adverse environmental effects are important by-products of FSTD use.

1.2.2 The final RAeS document, entitled International Standards for the Qualification of Airplane Flight Simulators, dated January 1992 (ISBN 0–903409–98–4), was the core document used to establish the JCAR criteria and also the ICAO Manual of Criteria for the Qualification of Flight Simulators (1995 or as amended).

1.2.3 In showing compliance with JCAR–FSTD A.030, CARC expects account to be taken of the IATA document entitled 'Design and Performance Data Requirements for Flight Simulators' – (1996 or as amended), as appropriate to the Qualification Level sought. In any case early contact with CARC is advised at the initial stage of FSTD build to verify the acceptability of the data.

1.3 **Levels of FSTD qualification**.

Parts 2, and 3 of this AC describe the minimum requirements for qualifying Level A, B, C and D airplane FFS, Level 1 and 2 airplane FTDs, FNPT types I, II and IIMCC and BITDs.

See also Appendix 1 to JCAR-FSTD A.030

1.4 **Terminology.**

Terminology and abbreviations of terms used in this AC are contained in AC to JCAR-FSTD A.005.

1.5 Testing for FSTD qualification.

1.5.1 The FSTD should be assessed in those areas that are essential to completing the flight crew member training, testing and checking process. This includes the FSTDs' longitudinal and lateral directional responses; performance in take-off, climb, cruise, descent, approach, landing; specific operations; control checks; flight deck, flight engineer, and instructor station functions checks; and certain additional requirements depending on the complexity or Qualification Level of the FSTD. The motion and visual systems (where applicable) will be evaluated to ensure their proper operation. Tolerances listed for parameters in the validation tests (Paragraph 2) of this AC are the maximum acceptable for FSTD qualification and should not be confused with FSTD design tolerances.

1.5.2 For FFSs and FTDs the intent is to evaluate the FSTD as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the FSTD will be subjected to validation, and functions and subjective tests listed in Part 2 and 3 of this AC. Validation tests are used to compare objectively FFSs and FTDs with aircraft data to ensure that they agree within specified tolerances. Functions and subjective tests provide a basis for evaluating FSTD capability to perform over a typical training period and to verify correct operation of the FSTD.

1.5.3 For initial qualification of FFSs and FTDs airplane manufacturer's validation flight test data is preferred. Data from other sources may be used, subject to the review and concurrence of CARC.

1.5.4 For FNPTs and BITDs generic data packages can be used. In this case, for an initial evaluation only Correct Trend and Magnitude (CT&M) can be used. The tolerances listed in this AC are applicable for recurrent evaluations and should be applied to ensure the device remains at the standard initially qualified.

For initial qualification testing of FNPTs and BITDs, Validation Data will be used. They may be derived from a specific airplane within the class of airplane the FNPT or BITD is representing or they may be based on information from several airplanes within the class. With the concurrence of CARC, it may be in the form of a manufacturer's previously approved set of Validation Data for the applicable FNPT or BITD. Once the set of data for a specific FNPT or BITD has been accepted and approved by CARC, it will become the Validation Data that will be used as reference for subsequent recurrent evaluations with the application of the stated tolerances.

The substantiation of the set of data used to build the Validation Data should be in the form of an engineering report and shall show that the proposed Validation Data are representative of the airplane or the class of airplane modeled. This report may include flight test data, manufacturer's design data, information from the Airplane Flight Manual (AFM) and Maintenance Manuals, results of approved or commonly accepted simulations or predictive models, recognized theoretical results, information from the public domain, or other sources as deemed necessary by the FSTD manufacturer to substantiate the proposed model.

1.5.5 In the case of new aircraft programs, the aircraft manufacturer's data partially validated by flight test data may be used in the interim qualification of the FSTD. However, the FSTD should be re-evaluated following the release of the manufacturer's approved data. The schedule should be as agreed by CARC, FSTD operator, FSTD manufacturer, and aircraft manufacturer.

1.5.6 FSTD operators seeking initial or upgrade evaluation of a FSTD should be aware that performance and handling data for older aircraft may not be of sufficient quality to meet some of the test standards contained in this AC. In this instance it may be necessary for an operator to acquire additional flight test data.

1.5.7 During FSTD evaluation, if a problem is encountered with a particular validation test, the test may be repeated to ascertain if the problem was caused by test equipment or FSTD operator error. Following this, if the test problem persists, an FSTD operator should be prepared to offer an alternative test.

1.5.8 Validation tests that do not meet the test criteria should be addressed to the satisfaction of CARC.

1.6 Qualification Test Guide (QTG)

1.6.1 The QTG is the primary reference document used for evaluating a FSTD. It contains test results, statements of compliance and other information for the evaluator to assess if the FSTD meets the test criteria described in this AC.

1.6.2 The FSTD operator (in case of a BITD the manufacturer) should submit a QTG that includes:

a. A title page with FSTD operator (in case of a BITD the manufacturer) and CARC signature blocks.

b. A FSTD information page (for each configuration in the case of convertible FSTDs) providing:

i. FSTD operator's FSTD identification number, for a BITD the model and serial number.
ii. Airplane model and series being simulated. For FNPTs and BITDs airplane model or class being simulated.
iii. References to aerodynamic data or sources for aerodynamic model.
iv. References to engine data or sources for engine model.
v. References to flight control data or sources for flight controls model.
vi. Avionic equipment system identification where the revision level affects the training and checking capability of the FSTD.
vii. FSTD model and manufacturer.
viii. Date of FSTD manufacture.
ix. FSTD computer identification.
x. Visual system type and manufacturer (if fitted).
xi. Motion system type and manufacturer (if fitted).

c. Table of contents.

d. List of effective pages and log of test revisions.

e. Listing of all reference and source data.

f. Glossary of terms and symbols used.

g. Statements of Compliance (SOC) with certain requirements. SOC's should refer to sources of information and show compliance rationale to explain how the referenced material is used, applicable mathematical equations and parameter values, and conclusions reached.

h. Recording procedures and required equipment for the validation tests.

I. The following items are required for each validation test:
   - i. Test title. This should be short and definitive, based on the test title referred to in paragraph 2.3 of this AC;
   - ii. Test objective. This should be a brief summary of what the test is intended to demonstrate;
   - iii. Demonstration procedure. This is a brief description of how the objective is to be met;
   - iv. References. These are the airplane data source documents including both the document number and the page or condition number;
   - v. Initial conditions. A full and comprehensive list of the test initial conditions is required;
   - vi. Manual test procedures. Procedures should be sufficient to enable the test to be flown by a qualified pilot, using reference to flight deck instrumentation and without reference to other parts of the QTG or flight test data or other documents;
   - vii. Automatic test procedures (if applicable).
   - viii. Evaluation criteria. Specify the main parameter(s) under scrutiny during the test;
   - ix. Expected result(s). The airplane result, including tolerances and, if necessary, a further definition of the point at which the information was extracted from the source data. For FNPTs and BITDs, the initial validation test result including tolerances is sufficient.

x. Test result. Dated FSTD validation test results obtained by the FSTD operator. Tests run on a computer that is independent of the FSTD are not acceptable. For a BITD the validation test results are normally obtained by the manufacturer;

xi. Source data. Copy of the airplane source data, clearly marked with the document, page number, issuing authority, and the test number and title as specified in sub-Para (i) above. Computer generated displays of flight test data over plotted with FSTD data are insufficient on their own for this requirement.

xii. Comparison of results: An acceptable means of easily comparing FSTD test results with the validation data.

xiii. The preferred method is over plotting. The FSTD operator's FSTD test results should be recorded on a multi-channel recorder, line printer, electronic capture and display or other appropriate recording media acceptable to CARC. FSTD results should be labeled using terminology common to airplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing cross plotting or other acceptable means. Airplane data documents included in the QTG may be photographically reduced only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution.

Incremental scales on graphical presentations should provide resolution necessary for evaluation of the parameters shown in paragraph 2. The test guide will provide the documented proof of compliance with the FSTD validation tests in the tables in paragraph 2. For tests involving time histories, flight test data sheets, FSTD test results should be clearly marked with appropriate reference points to ensure an accurate comparison between the FSTD and airplane with respect to time. FSTD operators using line printers to record time histories should clearly mark that information taken from line printer data output for cross plotting on the airplane data. The cross plotting of the FSTD operator's FSTD data to airplane data is essential to verify FSTD performance in each test. The evaluation serves to validate the FSTD operator's FSTD test results.

j. A copy of the version of the primary reference document as agreed with CARC and used in the initial evaluation should be included.

1.7 **Configuration control**. A configuration control system should be established and maintained to ensure the continued integrity of the hardware and software as originally qualified.

1.8 **Procedures for initial FSTD qualification.**

1.8.1 The request for evaluation should reference the QTG and also include a statement that the FSTD operator has thoroughly tested the FSTD and that it meets the criteria described in this document except as noted in the application form. The FSTD operator - for a BITD the manufacturer - should further certify that all the QTG checks, for the requested Qualification Level, have been achieved and that the FSTD is representative of the respective airplane or, for FNPTs and BITDs representative of the respective class of airplane.

1.8.2 A copy of the FSTD operator’s or BITD manufacturer's QTG, marked with test results, should accompany the request. Any QTG deficiencies raised by CARC should be addressed prior to the start of the on-site evaluation.

1.8.3 The FSTD operator may elect to accomplish the QTG validation tests while the FSTD is at the manufacturer’s facility. Tests at the manufacturer’s facility should be accomplished at the latest practical time prior to disassembly and shipment. The FSTD operator should then validate FSTD performance at the final location by repeating at least one-third of the validation tests in the QTG and submitting those tests to CARC. After review of these tests, CARC will schedule an initial evaluation. The QTG should be clearly annotated to indicate when and where each test was accomplished. This may not be applicable for BITDs that would normally undergo initial qualification at the manufacturer’s facility.

1.9 **FSTD recurrent qualification basis.**

1.9.1 Following satisfactory completion of the initial evaluation and qualification tests, a periodic check system should be established to ensure that FSTDs continue to maintain their initially qualified performance, functions and other characteristics.

1.9.2 The FSTD operator should run the complete QTG, which includes validation, functions & subjective tests, between each annual evaluation by CARC. As a minimum, the QTG tests should be run progressively in at least four approximately equal 3 monthly blocks on an annual cycle. Each block of QTG tests should be chosen to provide coverage of the different types of validation, functions & subjective tests. Results shall be dated and retained in order to satisfy both the FSTD operator as well as CARC that the FSTD standards are being maintained. It is not acceptable that the complete QTG is run just prior to the annual evaluation.

2 FSTD Validation Tests.

2.1 General.

2.1.1 FSTD performance and system operation should be objectively evaluated by comparing the results of tests conducted in the FSTD with airplane data unless specifically noted otherwise. To facilitate the validation of the FSTD, an appropriate recording device acceptable to CARC should be used to record each validation test result. These recordings should then be compared to the approved validation data.

2.1.2 Certain tests in this AC are not necessarily based upon validation data with specific tolerances. However, these tests are included here for completeness, and the required criteria should be fulfilled instead of meeting a specific tolerance.

2.1.3 The FSTD MQTG should describe clearly and distinctly how the FSTD will be set up and operated for each test. Use of a driver program designed to accomplish the tests automatically is encouraged. Overall integrated testing of the FSTD should be accomplished to assure that the total FSTD system meets the prescribed standards.

Historically, the tests provided in the QTG to support FSTD qualification have become increasingly fragmented. During the development of the ICAO Manual of Criteria for the Qualification of Flight Simulators, 1993 by a RAeS Working Group, the following text was inserted:

"It is not the intent, nor is it acceptable, to test each Flight Simulator subsystem independently. Overall Integrated Testing of the Flight Simulator should be accomplished to assure that the total Flight Simulator system meets the prescribed standards.

"This text was developed to ensure that the overall testing philosophy within a QTG fulfilled the original intent of validating the FSTD as a whole whether the testing was carried out automatically or manually.

To ensure compliance with this intent, QTGs should contain explanatory material which clearly indicates how each test (or group of tests) is constructed and how the automatic test system is controlling the test e.g. which parameters are driven, free, locked and the use of closed and open loop drivers.

A test procedure with explicit and detailed steps for completion of each test must also be provided. Such information should greatly assist with the review of a QTG that involves an understanding of how each test was constructed in addition to the checking of the actual results

A manual test procedure with explicit and detailed steps for completion of each test should also be provided.

2.1.4 Submittals for approval of data other than flight test should include an explanation of validity with respect to available flight test information. Tests and tolerances in this paragraph should be included in the FSTD MQTG.

For FFS devices representing airplanes certificated after January 2002 the MQTG should be supported by a Validation Data Roadmap (VDR) as described in Appendix 2 to AC No. 1 to JCAR-FSTD A.030. Data providers are encouraged to supply a VDR for older airplanes.

For FFS devices representing airplanes certificated prior to January 1992, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the MQTG where flight test data are unavailable or unsuitable for a specific test. For such a test, alternative data should be submitted to CARC for approval.

2.1.5 The table of FSTD Validation Tests in this AC indicates the required tests. Unless noted otherwise, FSTD tests should represent airplane performance and handling qualities at operating weights and centers of gravity (cg) positions typical of normal operation.

For FFS devices, if a test is supported by airplane data at one extreme weight or cg, another test supported by airplane data at mid-conditions or as close as possible to the other extreme should be included. Certain tests, which are relevant only at one extreme weight or cg condition, need not be repeated at the other extreme. Tests of handling qualities should include validation of augmentation devices.

Although FTDs are not designed for the purpose of training and testing of flight handling skills, it will be necessary, particularly for FTD Level 2 to include tests which ensure stability and repeatability of the generic flight package. These tests are also indicated in the tables.

2.1.6 For the testing of Computer Controlled Airplane (CCA) FSTDs, flight test data are required for both the normal (N) and non-normal (NN) control states, as applicable to the airplane simulated and, as indicated in the validation requirements of this paragraph. Tests in the non-normal state should always include the least augmented state.

Tests for other levels of control state degradation may be required as detailed by CARC at the time of definition of a set of specific airplane tests for FSTD data. Where applicable, flight test data should record:

a. Pilot controller deflections or electronically generated inputs including location of input; and

b. Flight control surface positions unless test results are not affected by, or are independent of, surface positions.

2.1.7 The recording requirements of (2.1.6 a and b) above apply to both normal and non-normal states. All tests in the table of validation tests require test results in the normal control state unless specifically noted otherwise in the comments section following the computer controlled airplane designation (CCA). However, if the test results are independent of control state, non-normal control data may be substituted.

2.1.8 Where non-normal control states are required, test data should be provided for one or more non-normal control states including the least augmented state.

2.1.9 Where normal, non-normal or other degraded control states are not applicable to the airplane being simulated, appropriate rationales should be included in the airplane manufacturer's validation data roadmap (VDR), which is described in Appendix 2 to AC No. 1 to JCAR-FSTD A.030.

2.2 **Test requirements.**

2.2.1 The ground and flight tests required for qualification are listed in the table of FSTD Validation Tests. Computer generated FSTD test results should be provided for each test. The results should be produced on an appropriate recording device acceptable to CARC. Time histories are required unless otherwise indicated in the table of validation tests.

2.2.2 Approved validation data that exhibit rapid variations of the measured parameters may require engineering judgment when making assessments of FSTD validity. Such judgment should not be limited to a single parameter. All relevant parameters related to a given maneuver or flight condition should be provided to allow overall interpretation. When it is difficult or impossible to match FSTD to airplane data or approved validation data throughout a time history, differences should be justified by providing a comparison of other related variables for the condition being assessed.

2.2.2.1 Parameters, tolerances, and flight conditions. The table of FSTD validation tests in paragraph 2.3 below describes the parameters, tolerances, and flight conditions for FSTD validation. When two tolerance values are given for a parameter, the less restrictive may be used unless indicated otherwise.

Where tolerances are expressed as a percentage:

- For parameters that have units of percent, or parameters normally displayed in the cockpit in units of percent (e.g. N1, N2, engine torque or power), then a percentage tolerance will be interpreted as an absolute tolerance unless otherwise specified (i.e. for an observation of 50% N1 and a tolerance of 5%, the acceptable range shall be from 45% to 55%).

- For parameters not displayed in units of percent, a tolerance expressed only as a percentage will be interpreted as the percentage of the current reference value of that parameter during the test, except for parameters varying around a zero value for which a minimum absolute value should be agreed with the CARC If a flight condition or operating condition is shown which does not apply to the qualification level sought, it should be disregarded. FSTD results should be labeled using the tolerances and units specified.

2.2.2.2 Flight condition verification. When comparing the parameters listed to those of the airplane, sufficient data should also be provided to verify the correct flight condition. For example, to show the control force is within ± 2.2 da N (5 pounds) in a static stability test, data to show correct airspeed, power, thrust or torque, airplane configuration, altitude, and other appropriate datum identification parameters should also be given. If comparing short period dynamics on a FSTD, normal acceleration may be used to establish a match to the airplane, but airspeed, altitude, control input, airplane configuration, and other appropriate data should also be given. All airspeed values should be assumed to be calibrated unless annotated otherwise and like values used for comparison.

2.2.2.3 Where the tolerances have been replaced by ‘Correct Trend and Magnitude’ (CT&M), the FSTD should be tested and assessed as representative of the airplane or class of airplane to the satisfaction of CARC. To facilitate future evaluations, sufficient parameters should be recorded to establish a reference. For the initial qualification of FNPTs and BITDs no tolerances are to be applied and the use of CT&M is to be assumed throughout.

2.2.2.4 Flight conditions. The flight conditions are specified as follows:

a. Ground-on ground, independent of airplane configuration.
b. Take-off - gear down with flaps in any certified takeoff position.
c. Second segment climb – gear up with flaps in any certified take off position.
d. Clean – flaps and gear up.
e. Cruise – clean configuration at cruise altitude and airspeed.
f. Approach – gear up or down with flaps at any normal approach positions as recommended by the airplane manufacturer.
g. Landing – gear down with flaps in any certified landing position.

2.3 Table of FSTD Validation Tests

2.3.1 A number of tests within the QTG have had their requirements reduced to 'Correct Trend and Magnitude' (CT&M) for initial evaluations thereby avoiding the need for specific Flight Test Data. Where CT&M is used it is strongly recommended that an automatic recording system be used to 'foot print' the baseline results thereby avoiding the effects of possible divergent subjective opinions on recurrent evaluation.

However, the use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. It is imperative that the specific characteristics are present, and incorrect effects would be unacceptable.

2.3.2 In all cases the tests are intended for use in recurrent evaluations at least to ensure repeatability.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
															It is accepted that tests and associated tolerances will only apply to a Level 1 FTD if that system or flight condition is simulated.
a	**TAXY**														
	(1) Minimum Radius Turn.	± 0.9 m (3 ft) or ± 20% of airplane turn radius.	Ground	CT&M	✓	✓	✓								Plot both main and nose gear turning loci. Data for no brakes and the minimum thrust required maintaining a steady turn except for airplanes requiring asymmetric thrust or braking to turn.
	(2) Rate of Turn vs. Nose wheel Steering Angle (NWA).	± 10% or ± 2°/s turn rate.	Ground	CT&M	✓	✓	✓								Tests for a minimum of two speeds, greater than minimum turning radius speed, with a spread of at least 5 kts groundspeed
b	**TAKE-OFF**														
															Note-All commonly used take-off flap settings should be demonstrated

															at least once either in minimum un-stick speed (1b3), normal take-off (1b4), and critical engine failure on take-off (1b5) or cross wind take-off (1b6).
	(1) Ground Acceleration Time and Distance.	± 5% or ±1.5 s time and ± 5% or ± 61 m (200 ft) distance	Take-off		✓	✓	✓	C T & M	✓						Acceleration time and distance should be recorded for a minimum of 80% of the total time from brake release to VR. May be combined with normal takeoff (1b4) or rejected takeoff (1b7). Plotted data should be shown using appropriate scales for each portion of the maneuver. For FTD's test limited to time only

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
					✓	✓	✓		✓						
	(2) Minimum Control Speed, ground (VMCG) aerodynamic controls only per applicable airworthiness requirement or alternative engine inoperative test to demonstrate ground control characteristics.	± 25% of maximum airplane lateral deviation or ± 1.5 m (5 ft) For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) rudder pedal force	Take-off	C T & M	✓	✓	✓								Engine failure speed should be within ± 1 kt of airplane engine failure speed. Engine thrust decay should be that resulting from the mathematical model for the engine variant applicable to the flight simulator under test. If the modeled engine variant is not the same as the airplane manufacturers' flight test engine, then a further test may be run with the same initial conditions using the thrust from the flight test data as the driving parameter. If a V_{MCG} test is not available an acceptable alternative is a flight test snap engine deceleration to idle at a speed between V1 and V1-10 kts, followed by control of heading using aerodynamic control only and recovery should be achieved with the main gear on the ground. To ensure only aerodynamic control, nose wheel steering should be disabled (i.e., catered) or the nose wheel held slightly off the ground

AC No. 1 to JCAR-FSTD A.030 (*continue*)

1. PERFORMANCE				FSTD LEVEL												COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD			
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.		
	(3) Minimum Un-stick Speed (V_{MU}) or equivalent test to demonstrate early rotation take off characteristics.	± 3 kts airspeed ± 1.5º pitch angle	Take-off	C T & M	✓	✓	✓									V_{MU} is defined as the minimum speed at which the last main landing gear leaves the ground. Main landing gear strut compression or equivalent air/ ground signal should be recorded. If a V_{MU} test is not available, alternative acceptable flight tests are a constant high attitude take-off run through main gear liftoff, or an early rotation take-off. Record time history data from 10 kts before start of rotation until at least 5 seconds after the occurrence of main gear lift-off.
	(4) Normal Take-off.	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 6 m (20 ft) height For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Take-off	C T & M	✓	✓	✓									Data required for near maximum certificated take-off weight at mid centre of gravity and light take-off weight at an AFT centre of gravity. If the airplane has more than one certificated take-off configuration, a different configuration should be used for each weight. Record take-off profile from brake release to at least 61 m (200 ft) AGL. May be used for ground acceleration time and distance (1b1). Plotted data should be shown using appropriate scales for each portion of the maneuver.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				**FSTD LEVEL**											**COMMENTS**
				FFS				**FTD**		**FNPT**			**BITD**		
No	**Tests**	**Tolerance**	**Flight Conditions**	**A**	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(5) Critical Engine Failure on Takeoff	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 6 m (20 ft) height ± 2º bank and side slip angle ± 3° heading angle For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10% or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force	Take-off	C T & M	✓	✓	✓								Record take-off profile to at least 61 m (200 ft) AGL. Engine failure speed should be within ± 3 kts of airplane data. Test at near maximum take-off weight.
	(6) Crosswind Takeoff	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 6 m (20 ft) height ± 2º bank and side slip angle ± 3° heading Correct trends at airspeeds below 40 kts for rudder/pedal and heading. For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10% or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force	Take-off	C T & M	✓	✓	✓								Record take-off profile from brake release to at least 61 m (200 ft) AGL. Requires test data, including wind profile, for a crosswind component of at least 60% of the AFM value measured at 10m (33 ft) above the runway.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(7) Rejected Takeoff	± 5% time or ± 1.5 s ± 7.5% distance or ± 76 m (250 ft)	Take-off	C T & M	✓	✓	✓								Record near maximum take-off weight. Speed for reject should be at least 80% of V_1. Auto brakes will be used where applicable. Maximum braking effort, auto or manual. Time and distance should be recorded from brake release to a full stop.
	(8) Dynamic Engine Failure after Take-off.	± 20% or ± 2°/s body angular rates	Take-off	C T & M	✓	✓	✓								Engine failure speed should be within ± 3 kts of airplane data. Engine failure may be a snap deceleration to idle. Record hands off from 5 sec before engine failure to + 5 sec or 30 deg banks, whichever occurs first. Note: for safety considerations, airplane flight test may be performed out of ground effect at a safe altitude, but with correct airplane configuration and airspeed. CCA: Test in normal AND Non-normal Control state.
c	**CLIMB**														
	(1) Normal Climb All engines operating	± 3 kts airspeed ± 5% or ± 0·5 m/s (100 ft/min) R/C	Clean or specified climb configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Flight test data or airplane performance manual data may be used. Record at nominal climb speed and mid initial climb altitude. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft). For FTD's may be a Snapshot test

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				**FSTD LEVEL**											**COMMENTS**
				FFS				**FTD**		**FNPT**			**BITD**		
No	**Tests**	**Tolerance**	**Flight Conditions**	**A**	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(2) One Engine Inoperative Second Segment Climb	± 3 kts airspeed ± 5% or ± 0.5 m/s (100 ft/min) R/C but not less than AFM values.	2nd Segment Climb for FNPTs and BITDs Gear up and Take-off Flaps		✓	✓	✓	C T & M	✓	✓	✓	✓	C T & M	✓	Flight test data or airplane performance manual data may be used. Record at nominal climb speed. Flight simulator performance to be recorded over an interval of at least 300m (1 000 ft). Test at WAT (Weight, Altitude, or Temperature) limiting condition. For FTD's may be a Snapshot test
	(3) One Engine Inoperative En route Climb.	± 10% time ± 10% distance ± 10% fuel used	Clean	✓	✓	✓	✓	C T & M	✓						Flight test data or airplane performance manual data may be used. Test for at least a 1 550 m (5 000 ft) segment.
	(4) One Engine Inoperative Approach Climb for airplanes with icing accountability if required by the flight manual for this phase of flight.	± 3 kts airspeed ± 5% or ± 0.5 m/s (100 ft/min) R/C but not less than AFM values	Approach			✓	✓								Flight test data or airplane performance manual data may be used. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft). Test near maximum certificated landing weight as may be applicable to an approach in icing conditions. Airplane should be configured with all anti ice and de-ice systems operating normally, gear up and go-around flap. All icing accountability considerations, in accordance with the flight manual for an approach in icing conditions, should be applied

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
d	**CRUISE/DESCENT**														
	(1) Level Flight Acceleration	± 5% time	Cruise	C T & M	✓	✓	✓	✓	✓						Minimum of 50 kts. increase using maximum continuous thrust rating or equivalent. For very small airplanes, speed change may be reduced to 80% of operational speed range
	(2) Level Flight Deceleration	± 5% time	Cruise	C T & M	✓	✓	✓	✓	✓						Minimum of 50 kts. decrease using idle power. For very small airplanes, speed change may be reduced to 80% of operational speed range
	(3) Cruise Performance	± 0.05 EPR or ± 5% N1 or ± 5% torque ± 5% fuel flow	Cruise	✓	✓	✓	✓	✓	✓						May be a single snapshot showing instantaneous fuel flow or a minimum of two consecutive snapshots with a spread of at least 3 minutes in steady flight.
	(4) Idle Descent	± 3 kts airspeed ± 5% or ± 1·0 m/s (200 ft/min) R/D	Clean	✓	✓	✓	✓								Idle power stabilized descent at normal descent speed at mid altitude. Flight simulator performance to be recorded over an interval of at least 300 m (1 000 ft).
	(5) Emergency Descent	± 5 kts airspeed ± 5% or ± 1·5 m/s (300 ft/min) R/D	As per AFM	✓	✓	✓	✓								Stabilized descent to be conducted with speed brakes extended if applicable, at mid altitude and near VMO or according to emergency descent procedure. Flight simulator performance to be recorded over an interval of at least 900 m (3 000 ft).

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
e	STOPPING														
	(1) Deceleration Time and Distance, Manual Wheel Brakes, Dry Runway, No Reverse Thrust.	± 5% or ±1.5 s time. For distances up to 1 220 m (4 000 ft) ± 61 m (200 ft) or ± 10%, whichever is the smaller. For distances greater than 1 220 m (4000 ft) ± 5% distance.	Landing	C T & M	✓	✓	✓								Time and Distance should be recorded for at least 80% of the total time from touchdown to a full stop. Data required for medium and near maximum certificated landing weight. Engineering data may be used for the medium weight condition. Brake system pressure should be recorded.
	(2) Deceleration Time and Distance, Reverse Thrust No Wheel Brakes, Dry Runway.	± 5% or ±1.5 s time and the smaller of ± 10% or ± 61 m (200 ft) of distance.	Landing	C T & M	✓	✓	✓								Time and distance should be recorded for at least 80% of the total time from initiation of reverse thrust to full thrust reverser minimum operating speed. Data required for medium and near maximum certificated landing weights. Engineering data may be used for the medium weight condition.
	(3) Stopping Distance, Wheel Brakes, Wet Runway.	± 10% or ± 61 m (200 ft) distance	Landing			✓	✓								Either flight test or manufacturers performance manual data should be used where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients are an acceptable alternative.
	(4) Stopping Distance, Wheel Brakes, icy Runway.	± 10% or ± 61 m (200 ft) distance	Landing			✓	✓								Either flight test or manufacturer’s performance manual data should be used where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

1. PERFORMANCE				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
f	ENGINES														
	(1) Acceleration	± 10% Ti or ± 0·25s ± 10% Tt	Approach or Landing	CT&M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ti = Total time from initial throttle movement until a 10% response of a critical engine parameter. Tt = Total time from initial throttle movement to 90% of go around power. Critical engine parameter should be a measure of power (N1, N2, EPR, etc). Plot from flight idle to go around power for a rapid throttle movement. FTD, FNPT and BITD only: CT&M acceptable.
	(2) Deceleration	± 10% TI or ± 0·25s ± 10% Tt	Ground	CT&M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ti = Total time from initial throttle movement Ti = Total time from initial throttle movement until a 10% response of a critical engine parameter. Tt = Total time from initial throttle movement to 90% decay of maximum take-off power. Plot from maximum take-off power to idle for a rapid throttle movement. FTD, FNPT and BITD only: CT&M acceptable.

AC No. 1 to JCAR-FSTD A.030 (*continue*)

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
a	STATIC CONTROL CHECKS														
															NOTE: Pitch, roll and yaw controller position vs. force or time shall be measured at the control. An alternative method would be to instrument the FSTD in an equivalent manner to the flight test airplane. The force and position data from this instrumentation can be directly recorded and matched to the airplane data. Such a permanent installation could be used without any time for installation of external devices. CCA: Testing of position versus force is not applicable if forces are generated solely by use of airplane hardware in the FSTD.
	(1) Pitch Controller Position vs. Force and Surface Position Calibration.	± 0.9 daN (2 lbs) breakout. ± 2.2 daN (5 lbs) or ± 10% force. ± 2º elevator angle	Ground	✓	✓	✓	✓	C T & M	✓						Uninterrupted control sweep to stops. Should be validated (where possible) with in-flight data from tests such as longitudinal static stability, stalls, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.
	Column Position vs. Force only.	± 2.2 daN (5 lbs) or ± 10% Force.	Cruise or Approach							✓	✓	✓	C T & M	✓	FNPT 1 and BITD: Control forces and travel shall broadly correspond to that of the replicated class of airplane
	(2) Roll Controller Position vs. Force and Surface Position Calibration.	± 0.9 daN (2 lbs) breakout ± 1.3 daN (3 lbs) or ± 10% force ± 2º aileron angle ± 3º spoiler angle	Ground	✓	✓	✓	✓	C T & M	✓						Uninterrupted control sweep to stops. Should be validated with in-flight data from tests such as engine out trims, steady state sideslips, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				**FSTD LEVEL**											**COMMENTS**
				FFS				**FTD**		**FNPT**			**BITD**		
No	**Tests**	**Tolerance**	**Flight Conditions**	**A**	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	Wheel Position vs. Force only.	± 1.3 daN (3 lbs) or ± 10% Force	Cruise or Approach							✓	✓	✓	C T & M	✓	FNPT 1 and BITD: Control forces and travel shall broadly correspond to that of the replicated class of airplane
	(3) Rudder Pedal Position vs. Force and Surface Position Calibration.	± 2.2 daN (5 lbs) breakout ± 2.2 daN (5 lbs) or ± 10% force ± 2º rudder angle	Ground	✓	✓	✓	✓	C T & M	✓						Uninterrupted control sweep to stops. Should be validated with in flight data from tests such as engine out trims, steady state sideslips, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures
	Pedal Position vs. Force only	± 2.2 daN (5 lbs) or ± 10% Force.	Cruise or Approach							✓	✓	✓	C T & M	✓	FNPT 1 and BITD: Control forces and travel shall broadly correspond to that of the replicated class of airplane
	(4) Nose wheel Steering Controller Force and Position Calibration.	± 0.9 daN (2 lbs) breakout ± 1.3 daN (3 lbs) or ± 10% force ± 2º NWA	Ground	C T & M	✓	✓	✓								Uninterrupted control sweep to stops
	(5) Rudder Pedal Steering Calibration.	± 2º NWA	Ground	C T & M	✓	✓	✓								Uninterrupted control sweep to stops
	(6) Pitch Trim Indicator vs. Surface Position Calibration	± 0.5º trim angle.	Ground	✓	✓	✓	✓								Purpose of test is to compare flight simulator against design data or equivalent
		±1° of trim angle	Ground					✓	✓	✓	✓	✓	C T & M	✓	BITD: Only applicable if appropriate trim settings are available, e.g. data from the AFM.
	(7) Pitch Trim Rate	± 10% or ± 0.5 deg/s trim rate (°/s)	Ground and approach	✓	✓	✓	✓	✓	✓						Trim rate to be checked at pilot primary induced trim rate (ground) and autopilot or pilot primary trim rate in flight at go-around flight conditions.

AC No. 1 to JCAR-FSTD A.030 (*continue*)

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(8) Alignment of Cockpit Throttle Lever vs. Selected Engine Parameter.	± 5º of TLA or ± 3% N1 or ± 0·03 EPR or ± 3% torque For propeller-driven airplanes, where the propeller levers do not have angular travel, a tolerance of ± 2 cm (± 0.8 in) applies.	Ground	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Simultaneous recording for all engines. The tolerances apply against airplane data and between engines. For airplanes with throttle detents, all detents to be presented. In the case of propeller-driven airplanes, if an additional lever, usually referred to as the propeller lever, is present, it should also be checked. Where these levers do not have angular travel a tolerance of ± 2 cm (± 0.8 inches) applies. May be a series of Snapshot tests
	(9) Brake Pedal Position vs. Force and Brake System Pressure Calibration.	± 2.2 daN (5 lbs) or ± 10% force. ± 1.0 MPa (150 psi) or ± 10% brake system pressure.	Ground	CT&M	✓	✓	✓								Flight simulator computer output results may be used to show compliance. Relate the hydraulic system pressure to pedal position in a ground static test.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
b	**DYNAMIC CONTROL CHECKS**														
															Tests 2b1, 2b2, and 2b3 are not applicable if dynamic response is generated solely by use of airplane hardware in the flight simulator. Power setting may be that required for level flight unless otherwise specified
	(1) Pitch Control.	<u>For under damped systems</u>: ± 10% of time from 90% of initial displacement (Ad) to first zero crossing and ± 10(n+1)% of period thereafter ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) <u>For over damped systems:</u> ± 10% of time from 90% of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d)	Take-off, Cruise, and Landing			✓	✓								Data should be for normal control displacements in both directions (approximately 25% to 50% full throw or approximately 25% to 50% of maximum allowable pitch controller deflection for flight conditions limited by the maneuvering load envelope). Tolerances apply against the absolute values of each period (considered independently). n = The sequential period of a full oscillation. Refer to paragraph 2.4.1

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(2) Roll Control.	For under damped systems: ± 10% of time from 90% of initial displacement (Ad) to first zero crossing and ± 10(n+1) % of period thereafter. ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) For over damped systems: ± 10% of time from 90% of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d).	Take-off, Cruise, and Landing			✓	✓								Data should be for normal control displacement (approximately 25% to 50% of full throw or approximately 25% to 50% of maximum allowable roll controller deflection for flight conditions limited by the maneuvering load envelope). Refer to paragraph 2.4.1

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(3) Yaw Control.	<u>For under damped systems</u>: ± 10% of time from 90% of initial displacement (Ad) to first zero crossing and ± 10(n+1) % of period thereafter. ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) <u>For over damped systems:</u> ± 10% of time from 90% of initial displacement (A_d) to 10 % of initial displacement (0·1 A_d).	Take-off, Cruise, and Landing			✓	✓								Data should be for normal displacement (Approximately 25% to 50% of full throw). Refer to paragraph 2.4.1

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(4) Small Control Inputs - pitch.	± 0·15 °/s body pitch rate or ± 20% of peak body pitch rate applied throughout the time history.	Approach or Landing			✓	✓								Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s pitch rate). Test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state.
	(5) Small Control Inputs - roll	± 0·15 °/s body roll rate or ± 20% of peak body roll rate applied throughout the time history	Approach or Landing			✓	✓								Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s roll rate). Test in one direction. For airplanes that exhibit non symmetrical behavior, test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL												COMMENTS
				FFS				FTD		FNPT			BITD			
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(6) Small Control Inputs – yaw	± 0·15 °/s body yaw rate or ± 20% of peak body yaw rate applied throughout the time history	Approach or Landing			✓	✓								Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s yaw rate). Test in one direction. For airplanes that exhibit non-symmetrical behavior, test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state.
c	**LONGITUDINAL**														Power setting may be that required for level flight unless otherwise specified.
	(1) Power Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitudes. ± 1.5º or ± 20% pitch angle	Approach	✓	✓	✓	✓	C T & M	✓		✓	✓			Power change from thrust for approach or level flight to maximum continuous or go-around power. Time history of uncontrolled free response for a time increment equal to at least 5 sec before initiation of the power change to completion of the power change + 15 sec. CCA: Test in Normal AND Non-normal Control state.
	Power Change Force	± 2.2 daN (5 lbs) or ± 10% Force	Approach							✓	✓	✓	C T & M	✓	For an FNPT I and a BITD the power change force test only is acceptable.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(2) Flap Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitudes. ± 1.5º or ± 20% pitch angle	Take-off Through initial flap retraction and approach to landing	✓	✓	✓	✓	C T & M	✓		✓	✓			Time history of uncontrolled free response for a time increment equal to at least 5 sec before initiation of the reconfiguration change to completion of the reconfiguration change + 15 sec. CCA: Test in Normal and Non-normal Control state.
	Flap Change Force	± 2.2 daN (5 lbs) or ± 10% Force								✓	✓	✓	C T & M	✓	For an FNPT I and a BITD the flap change force test only is acceptable.
	(3) Spoiler / Speed brake Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1.5 º or ± 20% pitch angle	Cruise	✓	✓	✓	✓	C T & M	✓		✓	✓			Time history of uncontrolled free response for a time increment equal to at least 5 sec before initiation of the reconfiguration change to completion of the reconfiguration change + 15 sec. Results required for both extension and retraction. CCA: Test in Normal AND Non-normal Control state.
	(4) Gear Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1.5º or ± 20% pitch angle For FNPTs and BITDs, ± 2º or ± 20% pitch angle	Takeoff (retraction) and Approach (extension)	✓	✓	✓	✓	C T & M	✓		✓	✓			Time history of uncontrolled free response for a time increment equal to at least 5 sec before initiation of the configuration change to completion of the reconfiguration change + 15 sec. CCA: Test in Normal AND Non-normal Control state.
	Gear Change Force	± 2.2 daN (5 lbs) or ± 20% Force.	Take-off and Approach							✓	✓	✓	C T & M	✓	For an FNPT I and a BITD the gear change force test only is acceptable.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(5) Longitudinal Trim	± 1º elevator ± 0·5º stabilizer ± 1º pitch angle ± 5% net thrust or equivalent	Cruise, Approach and Landing	✓	✓	✓	✓	C T & M	✓						Steady-state wings level trim with thrust for level flight. May be a series of snapshot tests. CCA: Test in Normal OR Non-normal Control state.
		± 2 deg Pitch Control (Elevator & Stabilizer) ± 2 deg Pitch ± 5% Power or Equivalent	Cruise, Approach							✓	✓	✓	C T & M	✓	May be a series of Snapshot tests. FNPT I and BITD may use equivalent stick and trim controllers.
	(6) Longitudinal Maneuvering Stability (Stick Force /g).	± 2.2 daN (5 lbs) or ± 10% pitch controller Force Alternative method: ± 1º or ± 10% change of elevator	Cruise, Approach and Landing	✓	✓	✓	✓				✓	✓	C T & M	✓	Continuous time history data or a series of snapshot tests may be used. Test up to approximately 30º of bank for approach and landing configurations. Test up to approximately 45º of bank for the cruise configuration. Force tolerance not applicable if forces are generated solely by the use of airplane hardware in the FSTD. Alternative method applies to airplanes which do not exhibit stick-force-per-g characteristics. CCA: Test in Normal AND Non-normal Control state as applicable.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(7) Longitudinal Static Stability.	± 2.2 daN (5 lbs) or ± 10% pitch controller force. Alternative method: ± 1° or ± 10% change of elevator	Approach	✓	✓	✓	✓			C T & M	✓	✓	C T & M	✓	Data for at least two speeds above and two speeds below trim speed. May be a series of snapshot tests. Force tolerance not applicable if forces are generated solely by the use of airplane hardware in the FSTD. Alternative method applies to airplanes which do not exhibit speed stability characteristics. CCA: Test in Normal OR Non-normal Control state as applicable
	(8) Stall Characteristics.	± 3 kts airspeed for initial buffet, stall warning, and stall speeds. For airplanes with reversible flight control systems (for FS only): ± 10% or ± 2·2 daN (5 lb) column force (prior to g-break only)	2nd Segment Climb and Approach or Landing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Wings-level (1 g) stall entry with thrust at or near idle power. Time history data should be shown to include full stall and initiation of recovery. Stall warning signal should be recorded and should occur in the proper relation to stall. FSTDs for airplanes exhibiting a sudden pitch attitude change or ‘g break’ should demonstrate this characteristic. CCA: Test in Normal and Non-normal Control state. FNPT and BITD: Test need only determine the actuation of the stall warning device only

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(9) Phugoid Dynamics.	± 10% period. ± 10% time to ½ or double amplitude or ± 0.02 of damping ratio.	Cruise	✓	✓	✓	✓				✓	✓			Test should include 3 full cycles or that necessary to determine time to ½ or double amplitude, whichever is less. CCA: Test in Non-normal Control state.
		± 10% Period with representative damping	Cruise							✓			C T & M	✓	Test should include at least 3 full cycles. Time history recommended.
	(10) Short Period Dynamics.	± 1.5º pitch angle or ± 2º/s pitch rate. ± 0.1 g normal acceleration.	Cruise	✓	✓	✓	✓				✓	✓			CCA: Test in Normal AND Non-normal Control state.
d	LATERAL DIRECTIONAL														Power setting may be that required for level flight unless otherwise specified.
	(1) Minimum Control Speed, Air (VMCA or VMCL), per Applicable Airworthiness Standard or Low Speed Engine Inoperative Handling Characteristics in the Air.	± 3 kts airspeed	Take-off or Landing (whichever is most critical in The airplane)	C T & M	✓	✓	✓	C T & M	✓	C T & M	C T & M	C T & M	C T & M	C T & M	Minimum speed may be defined by a performance or control limit which prevents demonstration of VMC or VMCL in the conventional manner. Take-off thrust should be set on the operating engine(s). Time history or snapshot data may be used CCA: Test in Normal OR Non-normal Control state. FNPT and BITD: It is important that there exists a realistic speed relationship between Vmca and Vs for all configurations and in particular the most critical full-power engine-out take-off configurations.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(2) Roll Response (Rate).	± 10% or ± 2º/sec roll rate FS only: For airplanes with reversible flight control systems: ± 10% or ± 1·3 daN (3 lb) roll controller force.	Cruise and Approach or Landing	✓	✓	✓	✓	C T & M	✓	✓	✓	✓	C T & M	✓	Test with normal roll control displacement (about 30% of maximum control wheel). May be combined with step input of flight deck roll controller test (2d3).
	(3) Step Input of Cockpit Roll Controller (or Roll Overshoot).	± 10% or ± 2º bank angle	Approach or Landing	✓	✓	✓	✓				✓	✓			With wings level, apply a step roll control input using approximately one-third of roll controller travel. At approximately 20° to 30° bank, abruptly return the roll controller to neutral and allow at least 10 seconds of airplane free response. May be combined with roll response (rate) test (2d2). CCA: Test in Normal AND Non-normal Control state.
	(4) Spiral Stability.	Correct trend and ± 2º or ± 10% bank angle in 20 seconds If alternate test is used: correct trend and ± 2° aileron.	Cruise and Approach or Landing	✓	✓	✓	✓	C T & M	✓	C T & M	✓	✓	C T & M	✓	Airplane data averaged from multiple tests may be used. Test for both directions. As an alternative test, show lateral control required to maintain a steady turn with a bank angle of approximately 30°. CCA: Test in Non-normal Control state.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(5) Engine Inoperative Trim.	± 1º rudder angle or ± 1º tab angle or equivalent pedal. ± 2º sideslip angle.	2nd Segment Climb and Approach or Landing	✓	✓	✓	✓	CT&M	✓		✓	✓			Test should be performed in a manner similar to that for which a pilot is trained to trim an engine failure condition. 2nd segment climb test should be at take-off thrust. Approach or landing test should be at thrust for level flight. May be snapshot tests.
	(6) Rudder Response.	± 2º/s or ± 10% yaw rate	Approach or Landing	✓	✓	✓	✓								Test with stability augmentation ON and OFF.
		± 2 deg/sec or ± 10% yaw rate or heading change								CT&M	✓	✓	CT&M	✓	Test with a step input at approximately 25% of full rudder pedal throw. CCA: Test in Normal AND Non-normal Control state.
	(7) Dutch Roll (Yaw Damper OFF).	± 0.5 s or ± 10% of period. ± 10% of time to ½ or double amplitude or ± 0.02 of damping ratio. ± 20% or ± 1 s of time difference between peaks of bank and sideslip	Cruise and Approach or Landing	✓	✓	✓	✓			CT&M	CT&M	CT&M			Test for at least 6 cycles with stability augmentation OFF. CCA: Test in Non-normal Control state

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(8) Steady State Side slip.	For a given rudder position: ± 2º bank angle ± 1º sideslip angle ± 10% or ± 2º aileron ± 10% or ± 5º spoiler or equivalent roll controller position or force For FFSs representing aircraft with reversible flight control systems: ±10% or ±1·3 daN (3 lb) wheel force ±10% or ±2·2 daN (5 lb) rudder pedal force.	Approach or Landing	✓	✓	✓	✓			C T & M	✓	✓	C T & M	✓	May be a series of snapshot tests using at least two rudder positions (in each direction for propeller driven airplanes) one of which should be near maximum allowable rudder. For FNPT and BITD a roll controller position tolerance of ± 10% or ± 5º applies instead of the aileron tolerance. For a BITD the force tolerance shall be CT&M.
e	LANDINGS														
	(1) Normal Landing	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 3 m (10 ft) or ± 10% of height For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Landing	C T & M	✓	✓	✓								Test from a minimum of 61 m (200 ft) AGL to nose wheel touch- down. Two tests should be shown, including two normal landing flaps (if applicable) one of which should be near maximum certificated landing weight, the other at light or medium weight CCA: Test in Normal AND Non-normal Control state if applicable.

AC No. 1 to JCAR-FSTD A.030 (*continue*)

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(2) Minimum Flap Landing.	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 3 m (10 ft) or ± 10% of height For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Minimum Certified Landing Flap Configuration		✓	✓	✓								Test from a minimum of 61 m (200 ft) AGL to nose wheel touchdown. Test at near maximum landing weight.
	(3) Crosswind Landing.	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 3 m (10 ft) or ± 10% height ± 2º bank angle ± 2º sideslip angle ± 3° heading angle For airplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10% or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force.	Landing		✓	✓	✓								Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed. Requires test data, including wind profile, for a crosswind component of at least 60% of AFM value measured at 10m (33 ft) above the runway.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(4) One Engine Inoperative Landing.	± 3 kts airspeed ± 1.5º pitch angle ± 1.5º AOA ± 3 m (10 ft) or ± 10% height ± 2º bank angle ± 2º sideslip angle ± 3° heading angle	Landing		✓	✓	✓								Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed.
	(5) Autopilot Landing (if applicable).	± 1.5 m (5 ft) flare height. ± 0.5 s or ± 10%Tf. ± 0.7 m/s (140ft/min) R/D at touchdown. ± 3 m (10 ft) lateral deviation during rollout.	Landing		✓	✓	✓								If autopilot provides rollout guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. Time of autopilot flare mode engage and main gear touchdown should be noted. This test is not a substitute for the ground effects test requirement. T_f = Duration of Flare.
	(6) All engine autopilot Go Around.	± 3 kts airspeed ± 1.5° pitch angle ± 1.5° AOA	As per AFM		✓	✓	✓								Normal all engine autopilot go around should be demonstrated (if applicable) at medium weight. CCA: Test in Normal AND Non-normal
	(7) One-Engine inoperative Go around	± 3 kts airspeed ±1·5° pitch angle ±1·5° AOA ± 2° bank angle ± 2° sideslip angle	As per AFM		✓	✓	✓								Engine inoperative go-around required near maximum certificated landing weight with critical engine(s) inoperative. Provide one test with autopilot (if applicable) and one without autopilot. CCA: Non-autopilot test to be conducted in Non-normal mode.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(8) Directional Control (Rudder Effectiveness) with Reverse Thrust symmetric).	± 5 kts airspeed ± 2°/s yaw rate	Landing		✓	✓	✓								Apply rudder pedal input in both directions using full reverse thrust until reaching full thrust reverser minimum operating speed.
	(9) Directional Control (Rudder Effectiveness) with Reverser Thrust asymmetric)	± 5 kts airspeed ± 3° heading angle	Landing		✓	✓	✓								With full reverse thrust on the operating engine(s), maintain heading with rudder pedal input until maximum rudder pedal input or thrust reverser minimum operating speed is reached.
F	GROUND EFFECT														
	(1) A Test to demonstrate Ground Effect.	± 1º elevator ± 0·5º stabilizer angle. ± 5% net thrust or equivalent. ± 1º AOA ± 1.5 m (5 ft) or ± 10% height ± 3 kts airspeed ± 1º pitch angle	Landing		✓	✓	✓								See Paragraph 2.4.2. A rationale should be provided with justification of results. CCA: Test in Normal or Non-normal control state.
g	WIND SHEAR														
	(1) Four Tests, two take-off and two landing with one of each conducted in still air and the other with Wind Shear active to demonstrate Wind Shear models.	None	Take-off and Landing			✓	✓								Wind shear models are required which provide training in the specific skills required for recognition of wind shear phenomena and execution of recovery maneuvers

AC No. 1 to JCAR-FSTD A.030 (*continue)*

<table>
<tr><th colspan="4">2. HANDLING QUALITIES</th><th colspan="11">FSTD LEVEL</th><th rowspan="3">COMMENTS</th></tr>
<tr><th rowspan="2">No</th><th rowspan="2">Tests</th><th rowspan="2">Tolerance</th><th rowspan="2">Flight Conditions</th><th colspan="4">FFS</th><th colspan="2">FTD</th><th colspan="3">FNPT</th><th colspan="2">BITD</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>Init</th><th>Rec.</th><th>I</th><th>II</th><th>MCC</th><th>Init</th><th>Rec.</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Wind shear models should be representative of measured or accident derived winds, but may be simplifications which ensure repeatable encounters. For example, models may consist of independent variable winds in multiple simultaneous components. Wind models should be available for the following critical phases of flight:

(1) Prior to take-off rotation
(2) At lift-off
(3) During initial climb
(4) Short final approach

The United States Federal Aviation Administration (FAA) Wind shear Training Aid, wind models from the Royal Aerospace Establishment (RAE), the United States Joint Aerodrome Weather studies (JAWS) Project or other recognized sources may be implemented and should be supported and properly referenced in the QTG. Wind models from alternate sources may also be used if supported by airplane related data and such data are properly supported and referenced in the QTG. Use of alternate data should be coordinated with the CARC prior to submittal of the QTG for approval.</td></tr>
</table>

AC No. 1 to JCAR-FSTD A.030 (*continue)*

2. HANDLING QUALITIES				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
h	**FLIGHT AND MANOEUVRE ENVELOPE PROTECTION FUNCTIONS**														
															This paragraph is only applicable to Computer-controlled airplanes. Time history results of response to control inputs during entry into each envelope protection function (i.e., with normal and degraded control states if function is different) are required. Set thrust as required to reach the envelope protection function
	(1) Over speed	± 5 kts airspeed	Cruise	✓	✓	✓	✓	✓	✓						
	(2) Minimum Speed.	± 3 kts airspeed	Take-off, Cruise and Approach or Landing												
	(3) Load Factor	± 0.1 g	Take-off, Cruise	✓	✓	✓	✓	✓	✓						
	(4) Pitch Angle	± 1.5º pitch angle	Cruise, Approach	✓	✓	✓	✓	✓	✓						
	(5) Bank Angle	± 2º or ± 10% bank angle	Approach	✓	✓	✓	✓	✓	✓						
	(6) Angle of Attack	± 1.5º AOA	Second Segment Climb and Approach or Landing	✓	✓	✓	✓	✓	✓						

AC No. 1 to JCAR-FSTD A.030 (*continue)*

3. MOTION SYSTEM				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
a	Frequency response	As specified by the applicant for flight simulator qualification	Not Applicable	✓	✓	✓	✓								Appropriate test to demonstrate frequency response required. See also AC No. 1 to JCAR-FSTD A.030 Para 2.4.3.2
b	Leg Balance	As specified by the applicant for flight simulator qualification	Not Applicable	✓	✓	✓	✓								Appropriate test to demonstrate leg balance required See also AC No. 1 to JCAR-FSTD A.030 Para 2.4.3.2
c	Turn-around check	As specified by the applicant for flight simulator qualification	Not Applicable	✓	✓	✓	✓								Appropriate test to demonstrate turn-around required. See also AC No. 1 to JCAR-FSTD A.030 Para 2.4.3.2
d	Motion effects														Refer to AC No 1 to JCAR-FSTD A.030 3.3(n) subjective testing
e	Motion System repeatability	± 0·05g actual platform linear accelerations	None			✓	✓								Ensure that motion system hardware and software (in normal flight simulator operating mode) continue to perform as originally qualified. Performance changes from the original baseline can be readily identified with this information. See AC No. 1 to JCAR-FSTD A.030 Para 2.4.3.4
f	Motion cueing Performance signature	None	Ground and flight	✓	✓	✓	✓								For a given set of flight simulation critical maneuvers record the relevant motion variables. These tests should be run with the motion buffet module disabled. See AC No. 1 to JCAR-FSTD A.030 Para 2.4.3.3

AC No. 1 to JCAR-FSTD A.030 (*continue)*

3. MOTION SYSTEM				**FSTD LEVEL**											**COMMENTS**
				FFS				**FTD**		**FNPT**			**BITD**		
No	**Tests**	**Tolerance**	**Flight Conditions**	**A**	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
g	Characteristic motion vibrations	None	Ground and flight												The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. For atmospheric disturbance testing, general purpose disturbance models that approximate demonstrable flight test data are acceptable. Principally, the flight simulator results should exhibit the overall appearance and trends of the airplane plots, with at least some of the frequency "spikes" being present within 1 or 2 Hz of the airplane data. See AC No. 1 to JCAR-FSTD A.030 para2.4.3.5
	The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed at the flight deck where applicable by airplane type:														
	(1) Thrust effects with brakes set	N/A	Ground				✓								Test should be conducted at maximum possible thrust with brakes set.
	(2) Landing gear extended buffet	N/A	Flight				✓								Test condition should be for a normal operational speed and not at the gear limiting speed.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

3. MOTION SYSTEM				**FSTD LEVEL**											**COMMENTS**
				FFS				**FTD**		**FNPT**			**BITD**		
No	**Tests**	**Tolerance**	**Flight Conditions**	**A**	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
	(3) Flaps extended buffet	N/A	Flight				✓								Test condition should be for a normal operational speed and not at the flap limiting speed
	(4) Speed brake deployed buffet	N/A	Flight				✓								
	(5) Approach-to-stall buffet	N/A	Flight				✓								Test condition should be approach-to-stall. Post-stall characteristics are not required.
	(6) High speed or Mach buffet	N/A	Flight				✓								Test condition should be for high speed maneuver buffet/wind-up-turn or alternatively Mach buffet
	(7) In flight vibrations	N/A	Flight (clean configuration)				✓								Test should be conducted to be representative of in-flight vibrations for propeller driven airplanes

AC No. 1 to JCAR-FSTD A.030 (*continue)*

4. VISUAL SYSTEM				FSTD LEVEL											COMMENTS
				FFS				FTD		FNPT			BITD		
No	Tests	Tolerance	Flight Conditions	A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
a	SYSTEM RESPONSE TIME														
	(1) Transport Delay	150 milliseconds or less after controller movement.	Pitch, roll and yaw			✓	✓								One separate test is required in each axis. [See Appendix 5 to AC FSTD A.030]() FNPT I and BITD only the instrument response time apply.
		300 milliseconds or less after controller movement.		✓	✓			✓	✓	✓	✓	✓	✓	✓	
	or														
	(2) Latency	- 150 milliseconds or less after controller movement.	Take-off, Cruise, and Approach or Landing			✓	✓								One test is required in each axis (pitch, roll, yaw) for each of the 3 conditions compared with airplane data for a similar input. The visual scene or test pattern used during the response testing shall be representative of the required system capacities to meet the daylight, twilight (dusk/dawn) and night visual capability as applicable. FS only: Response tests should be confirmed in daylight, twilight and night settings as applicable. FNPT I and BITD only the instrument response time applies
		- 300 milliseconds or less after controller movement		✓	✓			✓	✓	✓	✓	✓	✓	✓	

AC No. 1 to JCAR-FSTD A.030 (*continue)*

4. VISUAL SYSTEM				**FSTD LEVEL**											**COMMENTS**
No	**Tests**	**Tolerance**	**Flight Conditions**	**FFS**				**FTD**		**FNPT**			**BITD**		
				A	**B**	**C**	**D**	**Init**	**Rec.**	**I**	**II**	**MCC**	**Init**	**Rec.**	
b	DISPLAY SYSTEM TESTS														
	(1) (a) Continuous collimated cross cockpit visual field of view	Continuous, cross cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view. Horizontal FOV: Not less than a total of 176 measured degrees (including not less than ±88 measured degrees either side of the centre of the design eye point). Vertical FOV: Not less than a total of 36 measured degrees from the pilot's and co-pilot's eye point	Not Applicable			✓	✓								Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in a Statement of Compliance.
	(b) Continuous collimated visual field of view	Continuous, minimum collimated visual field of view providing each pilot with 45 degrees horizontal and 30 degrees vertical field of view	Not Applicable	✓	✓										30 degrees vertical field of view may be insufficient to meet the requirements of AC No. 1 to JCAR-FSTD A.030 Table 2.3 paragraph 4.c (visual ground segment)

AC No. 1 to JCAR-FSTD A.030 (*continue)*

4. VISUAL SYSTEM				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(2) System geometry	5° even angular spacing within ± 1° as measured from either pilot eye-point, and within 1·5° for adjacent squares.	Not Applicable	✓	✓	✓	✓								System geometry should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares with light points at the intersections. The operator should demonstrate that the angular spacing of any chosen 5° square and the relative spacing of adjacent squares are within the stated tolerances. The intent of this test is to demonstrate local linearity of the displayed image at either pilot eye-point
	(3) Surface Contrast Ratio	Not less than 5:1	Not Applicable			✓	✓								Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, 5 per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1° spot photometer. This value should have a minimum brightness of 7 cd/m2 (2 foot lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Note. During contrast ratio testing, simulator aft-cab and flight deck ambient light levels should be zero

AC No. 1 to JCAR-FSTD A.030 (*continue)*

4. VISUAL SYSTEM				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(4) High light Brightness	Not less than 20 cd/m2 (6 ft-lamberts) on the display	Not Applicable			✓	✓								Highlight brightness should be measured by maintaining the full test pattern described in paragraph 4.b 3) above, superimposing a highlight on the centre white square of each channel and measuring the brightness using the 1° spot photometer. Light points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable
	(5) Vernier Resolution	Not greater than 2 arc minutes	Not Applicable			✓	✓								Vernier resolution should be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eye-point. The eye will subtend two arc minutes (arc tan (4/6 876)x60) when positioned on a 3 degree glide slope, 6 876 ft slant range from the centrally located threshold of a black runway surface painted with white threshold bars that are 16 ft wide with 4-ft gaps in-between. This should be confirmed by calculations in a statement of compliance.
	(6) Light point Size	Not greater than 5 arc minutes	Not Applicable			✓	✓								Light point size should be measured using a test pattern consisting of a centrally located single row of light points reduced in length until modulation is just discernible in each visual channel. A row of 48 lights will form a 4° angle or less.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

4. VISUAL SYSTEM				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
	(7) Light point Contrast Ratio	Not less than 10:1	Not Applicable	✓	✓										Light point contrast ratio should be measured using a test pattern demonstrating a 1° area filled with light points (i.e. light point modulation just discernible) and should be compared to the adjacent background. Note. During contrast ratio testing, simulator aft-cab and flight deck ambient light levels should be zero.
		Not less than 25:1				✓		✓							
c	VISUAL GROUND SEGMENT	Near end. The lights computed to be visible should be visible in the FSTD. Far end: ± 20% of the computed VGS	Trimmed in the landing Configuration at 30 m (100 ft) wheel height above touchdown zone elevation on glide slope at a RVR setting of 300 m (1000 ft) or 350m (1200ft)	✓	✓	✓	✓				✓	✓			Visual Ground Segment. This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. Those items include RVR, glide slope (G/S) and localizer modeling accuracy (location and slope) for an ILS, For a given weight, configuration and speed representative of a point within the airplane's operational envelope for a normal approach and landing. If non-homogenous fog is used, the vertical variation in horizontal visibility should be described and be included in the slant range visibility calculation used in the VGS computation. FNPT: If a generic airplane is used as the basic model, a generic cut-off angle of 15 deg. is assumed as an ideal.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

5. SOUND SYSTEMS				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
															All tests in this section should be presented using a un weighted 1/3-octave band format from band 17 to 42 (50 Hz to 16 kHz). A minimum 20 second average should be taken at the location corresponding to the airplane data set. The airplane and flight simulator results should be produced using comparable data analysis techniques
															See AC FSTD A.030 Para 2.4.5
a	TURBO-JET AEROPLANES														
	(1) Ready for engine start	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to engine start. The APU should be on if appropriate
	(2) All engines at idle	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off.
	(3) All engines at Maximum allowable thrust with brakes set	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off.
	(4) Climb	± 5 dB per 1/3 octave band	En-route climb				✓								Medium altitude
	(5) Cruise	± 5 dB per 1/3 octave band	Cruise				✓								Normal cruise configuration
	(6) Speed brake/ spoilers extended (as appropriate)	± 5 dB per 1/3 octave band	Cruise				✓								Normal and constant speed brake deflection for descent at a constant airspeed and power setting
	(7) Initial approach	± 5 dB per 1/3 octave band	Approach				✓								Constant airspeed, gear up, flaps/slats as appropriate
	(8) Final approach	± 5 dB per 1/3 octave band	Landing				✓								Constant airspeed, gear down, full flaps.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

5. SOUND SYSTEMS				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
b	PROPELLER AEROPLANES														
	(1) Ready for engine start	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to engine start. The APU should be on if appropriate.
	(2) All propellers feathered	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off.
	(3) Ground idle or equivalent	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off
	(4) Flight idle or equivalent	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off
	(5) All engines at Maximum allowable power with brakes set	± 5 dB per 1/3 octave band	Ground				✓								Normal condition prior to take-off.
	(6) Climb	± 5 dB per 1/3 octave band	En-route climb				✓								Medium altitude
	(7) Cruise	± 5 dB per 1/3 octave band	Cruise				✓								Normal cruise configuration.
	(8) Initial approach	± 5 dB per 1/3 octave band	Approach				✓								Constant airspeed, gear up, flaps extended as appropriate, RPM as per operating manual
	(9) Final approach	± 5 dB per 1/3 octave band	Landing				✓								Constant airspeed, gear down, full flaps, RPM as per operating manual
c	SPECIAL CASES	± 5 dB per 1/3 octave band					✓								Special cases identified as particularly significant to the pilot, important in training, or unique to a specific airplane type or variant.

AC No. 1 to JCAR-FSTD A.030 (*continue)*

5. SOUND SYSTEMS				FSTD LEVEL											COMMENTS
No	Tests	Tolerance	Flight Conditions	FFS				FTD		FNPT			BITD		
				A	B	C	D	Init	Rec.	I	II	MCC	Init	Rec.	
d	FLIGHT SIMULATOR BACKGROUND NOISE	Initial evaluation: not applicable. Recurrent evaluation: ± 3dB per 1/3 octave band compared to initial evaluation					✓								Results of the background noise at initial qualification should be included in the QTG document and approved by CARC. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. Refer to AC FSTD A.030 Para 2.4.5.6. The measurements are to be made with the simulation running, the sound muted and a dead cockpit
e	FREQUENCY RESPONSE	Initial evaluation: not applicable. Recurrent evaluation: cannot exceed ± 5 dB on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓	✓								Only required if the results are to be used during recurrent evaluations according to AC FSTD A.030 Para 2.4.5.7. The results shall be acknowledged by CARC at initial qualification

AC No.1 to JCAR-FSTD A.030 ***(continued)***

2.4 **Information for Validation Tests.**

2.4.1 **Control dynamics.**

2.4.1.1 General.

The characteristics of an aircraft flight control system have a major effect on handling qualities. A significant consideration in pilot acceptability of an aircraft is the 'feel' provided through the flight controls. Considerable effort is expended on aircraft feel system design so that pilots will be comfortable and will consider the aircraft desirable to fly. In order for a FSTD to be representative, it too should present the pilot with the proper feel that of the aircraft being simulated. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the FSTD to actual aircraft measurements in the relevant configurations.

a. Recordings such as free response to a pulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, the dynamic properties can only be estimated since the true inputs and responses are also only estimated. Therefore, it is imperative that the best possible data be collected since close matching of the FSTD control loading system to the aircraft systems is essential. The required dynamic control checks are indicated in paragraph 2.3-2b (1) to (3) of the table of FSTD validation tests.

b. For initial and upgrade evaluations, it is required that control dynamics characteristics be measured at and recorded directly from the flight controls. This procedure is usually accomplished by measuring the free response of the controls using a step input or pulse input to excite the system. The procedure should be accomplished in relevant flight conditions and configurations.

c. For airplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs (if applicable) are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some airplanes, take-off, 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 should be submitted as justification for ground tests or for eliminating a configuration. For FSTDs requiring static and dynamic tests at the controls, special test fixtures will not be required during initial and upgrade evaluations if the MQTG shows both test fixture results and the results of an alternate approach, such as computer plots which were produced concurrently and show satisfactory agreement. Repeat of the alternate method during the initial evaluation would then satisfy this test requirement.

2.4.1.2 Control dynamics evaluation.

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 FSTD control loading, criteria are needed that will clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for under damped, critically damped, and over damped systems. In the case of an under damped system with very light damping, the system may be quantified in terms of frequency and damping. In critically damped or over damped systems, the frequency and damping are not readily measured from a response time history. Therefore, some other measurement should be used.

Tests to verify that control feel dynamics represent the airplane should show that the dynamic damping cycles (free response of the controls) match that of the airplane within specified tolerances. The method of evaluating the response and the tolerance to be applied is described in the under damped and critically damped cases are as follows:

a. Under damped Response.

1. 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 non-uniform periods in the response. Each period will be independently compared with the respective period of the airplane control system and, consequently, will enjoy the full tolerance specified for that period.

2. The damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots become questionable. Only those overshoots larger than 5% of the total initial displacement should be considered. The residual band, labeled T (Ad) in Figure 1 is ± 5% of the initial displacement amplitude Ad from the steady state value of the oscillation. Only oscillations outside the residual band are considered significant. When comparing FSTD data to airplane data, the process should begin by overlaying or aligning the FSTD and airplane steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. The FSTD should 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 below.

b. Critically damped and over damped response. Due to the nature of critically damped and over damped responses (no overshoots); the time to reach 90% of the steady state (neutral point) value should be the same as the airplane within ± 10%. Figure 2 illustrates the procedure.

c. Special considerations. Control systems, which exhibit characteristics other than classical over damped or under damped responses should meet specified tolerances. In addition, special consideration should be given to ensure that significant trends are maintained.

2.4.1.3 Tolerances. The following table summarizes the tolerances, T. See figures 1 and 2 for an illustration of the referenced measurements:

$T (P_0)$	$\pm$ 10% of P_0
$T (P_1)$	$\pm$ 20% of P_1
$T (P_2)$	$\pm$ 30% of P_2
$T (P_n)$	$\pm$ 10(n+1) % of P_n
$T (A_n)$	$\pm$ 10% of A_1
$T (A_d)$	$\pm$ 5% of A_d = residual band
Significant overshoots	First overshoot and ± 1 subsequent overshoots

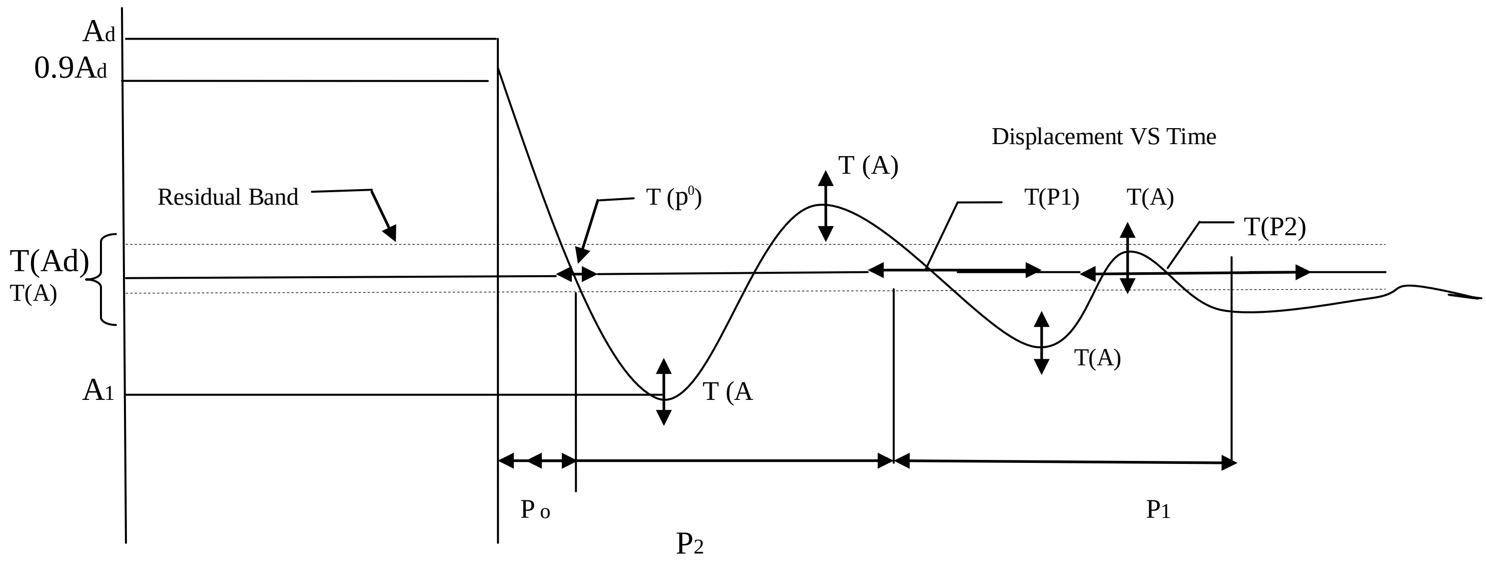


Figure 2: Under damped step response

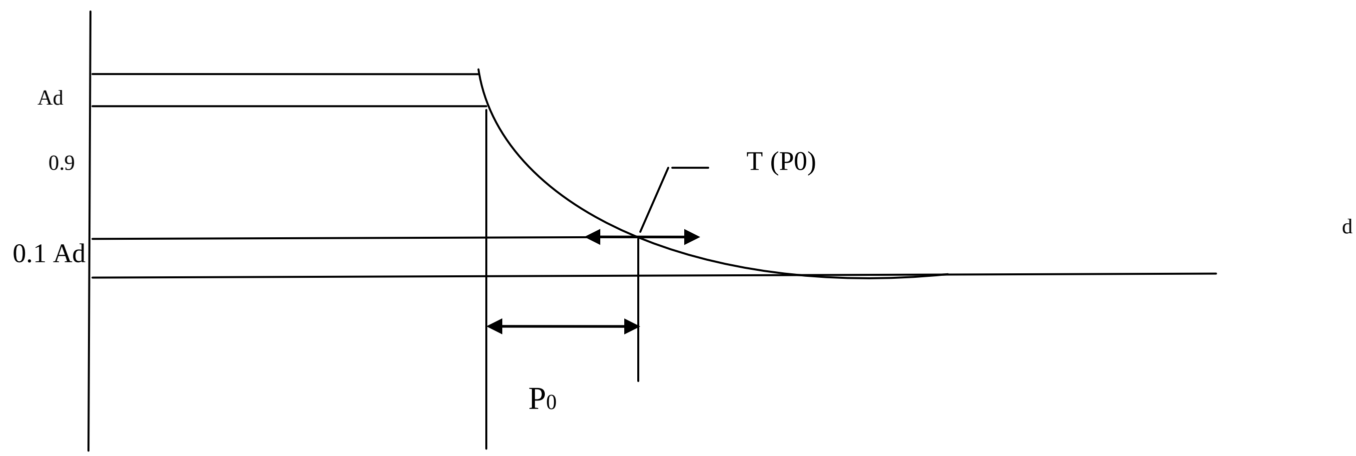


Figure 2: Critically damped step response

2.4.1.4 Alternate method for control dynamics evaluation.

An alternate means for validating control dynamics for aircraft with hydraulically powered flight controls and artificial feel systems is by the measurement of control force and rate of movement. For each axis of pitch, roll, and yaw, the control should be forced to its maximum extreme position for the following distinct rates.

These tests should be conducted at typical flight and ground conditions:

a. Static test - Slowly move the control such that approximately 100 seconds are required to achieve a full sweep. A full sweep is defined as movement of the controller from neutral to the stop, usually aft or right stop, then to the opposite stop, then to the neutral position.

b. Slow dynamic test - Achieve a full sweep in approximately 10 seconds.

c. Fast dynamic test - Achieve a full sweep in approximately 4 seconds.

Note: Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lbs)

2.4.1.5 Tolerances.

1. Static test, see paragraph 2.3 - 2.a (1), (2), and (3) of the table of FSTD validation tests.

2. Dynamic test ± 0.9 daN (2 lbs) or ± 10% on dynamic increment above static test.

CARC is open to alternative means such as the one described above. Such alternatives should, however, be justified and appropriate to the application. For example, the method described here may not apply to all manufacturers’ systems and certainly not to airplanes with reversible control systems. Hence, each case should be considered on its own merit on an ad hoc basis. Should CARC find that alternative methods do not result in satisfactory performance, and then more conventionally accepted methods should be used.

2.4.2 **Ground Effect.**

2.4.2.1 For a FSTD to be used for take-off and landing it should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for FSTD validation should be indicative of these changes.

A dedicated test should be provided which will validate the aerodynamic ground effect characteristics.

The selection of the test method and procedures to validate ground effect is at the option of the organization performing the flight tests; however, the flight test should be performed with enough duration near the ground to validate sufficiently the ground-effect model.

2.4.2.2 Acceptable tests for validation of ground effect include:

a. Level fly-bys. The level fly-bys should be conducted at a minimum of three altitudes within the ground effect, including one at no more than 10% of the wingspan above the ground, one each at approximately 30% and 50% of the wingspan where height refers to main gear tire above the ground. In addition, one level-flight trim condition should be conducted out of ground effect, e.g. at 150% of wingspan.

b. Shallow approach landing. The shallow approach landing should be performed at a glide slope of approximately one degree with negligible pilot activity until flare. If other methods are proposed, a rationale should be provided to conclude that the tests performed validate the ground-effect model.

2.4.2.3 The lateral-directional characteristics are also altered by ground effect. For example, because of changes in lift, roll damping is affected. The change in roll damping will affect other dynamic modes usually evaluated for FSTD validation. In fact, Dutch roll dynamics, spiral stability, and roll-rate for a given lateral control input are altered by ground effect. Steady heading sideslips will also be affected. These effects should be accounted for in the FSTD modeling.

Several tests such as 'crosswind landing', 'one engine inoperative lands', and 'engine failure on take-off' serve to validate lateral-directional ground effect since portions of them are accomplished whilst transiting heights at which ground effect is an important factor.

2.4.3 **Motion System.**

2.4.3.1 General.

a. Pilots use continuous information signals to regulate the state of the airplane. In concert with the instruments and outside-world visual information, whole-body motion feedback is essential in assisting the pilot to control the airplane's dynamics, particularly in the presence of external disturbances. The motion system should therefore meet basic objective performance criteria, as well as being subjectively tuned at the pilot's seat position to represent the linear and angular accelerations of the airplane during a prescribed minimum set of maneuvers and conditions. Moreover, the response of the motion cueing system should be repeatable.

b. The objective validation tests presented in this paragraph are intended to qualify the FSTD motion cueing system from a mechanical performance standpoint. Additionally, the list of motion effects provides a representative sample of dynamic conditions that should be present in the FSTD. A list of representative training-critical maneuvers that should be recorded during initial qualification (but without tolerance) to indicate the FSTD motion cueing performance signature has been added to this document. These are intended to help to improve the overall standard of FSTD motion cueing.

2.4.3.2 Motion System Checks.

The intent of tests as described in the table of FSTD validation tests, paragraph 2.3 - 3.a, frequency response, 3.b leg balance, and 3.c, turn-around check, is to demonstrate the performance of the motion system hardware, and to check the integrity of the motion set-up with regard to calibration and wear. These tests are independent of the motion cueing software and should be considered as robotic tests.

2.4.3.3 Motion Cueing Performance Signature.

a. Background. The intent of this test is to provide quantitative time history records of motion system response to a selected set of automated QTG maneuvers during initial qualification. This is not intended to be a comparison of the motion platform accelerations against the flight test recorded accelerations (i.e. not to be compared against airplane cueing). This information describes a minimum set of maneuvers and a guideline for determining the FSTD's motion footprint. If over time there is a change to the initially certified motion software load or motion hardware then these baseline tests should be rerun.

b. List of tests. Table 1 delineates those tests that are important to pilot motion cueing and are general tests applicable to all types of airplanes and thus the motion cueing performance signature should be run for initial qualification. These tests can be run at any time deemed acceptable to CARC prior to or during the initial qualification. The tests in table 2 are also significant to pilot motion cues but are provided for information only. These tests are not required to be run.

c. Priority. A priority (X) is given to each of these maneuvers, with the intent of placing greater importance on those maneuvers that directly influence pilot perception and control of the airplane motions. For the maneuvers designated with a priority in the tables below, the FSTD motion cueing system should have a high tilt co-ordination gain, high rotational gain, and high correlation with respect to the airplane simulation model.

d. Data Recording. The minimum list of parameters provided should allow for the determination of the FSTD's motion cueing performance signature for the initial qualification. The following parameters are recommended as being acceptable to perform such a function:

1. Flight model acceleration and rotational rate commands at the pilot reference point;
2. Motion actuators position;
3. Actual platform position;
4. Actual platform acceleration at pilot reference point.

2.4.3.4 Motion System Repeatability.

The intent of this test is to ensure that the motion system software and motion system hardware have not degraded or changed over time. This diagnostic test should be run during recurrent checks in lieu of the robotic tests. This will allow an improved ability to determine changes in the software or determine degradation in the hardware that have adversely affected the training value of the motion as was accepted during the initial qualification. The following information delineates the methodology that should be used for this test.

a. Conditions:
   1. One test case on-ground: to be determined by the operator;
   2. One test case In-flight: to be determined by the operator.

b. Input: The inputs should be such that both rotational accelerations / rates and linear accelerations are inserted before the transfer from airplane centre of gravity to pilot reference point with a minimum amplitude of 5deg/sec/sec, 10deg/sec and 0·3g respectively to provide adequate analysis of the output.

c. Recommended output:
   1. Actual platform linear accelerations; the output will comprise accelerations due to both the linear and rotational motion acceleration;
   2. Motion actuators position.

No.	Associated validation test	Maneuver	Priority	Comments
1	1b4	Take-off rotation (V_r to V_2)	X	Pitch attitude due to initial climb should dominate over cab tilt due to longitudinal acceleration
2	1b5	Engine failure between V_1 and V_r	X	
3	2e6	Pitch change during go-around	X	
4	2c2 & 2c4	Configuration changes	X	
5	2c1	Power change dynamics	X	Resulting effects of power changes
6	2e1	Landing flare	X	
7	2e1	Touchdown bump	X	

Table 1 – Tests required for initial qualification

No.	Associated validation test	Maneuver	Priority	Comments
8	1a2	Taxi (including acceleration, turns, braking), with presence of ground rumble	X	
9	1b4	Brake release and initial acceleration	X	
10	1b1 & 3g	Ground rumble on runway, acceleration during takeoff, scuffing, runway lights and surface discontinuities	X	Scuffing and velocity cues are given priority
11	1b2 & 1b7	Engine failure prior to V1 (RTO)	X	Lateral and directional cues are given priority
12	1c1	Steady-state climb	X	
13	1d1& 1d2	Level flight acceleration and deceleration	X	
14	2c6	Turns	X	
15	1b8	Engine failures	X	
16	2c8	Stall characteristics	X	
17		System failures	X	Priority depending on the type of system failure and airplane type (e.g. flight controls failures, rapid decompression, inadvertent thrust reverser deployment)
18	2g1 & 2e3	Wind shear/crosswind landing	X	Influence on vibrations and on attitude control
19	1e1	Deceleration on runway		Including contamination effects

Table 2 – Tests that are significant but are not required to be run

2.4.3.5 Motion vibrations.

a. Presentation of results. The characteristic motion vibrations are a means to verify that the FSTD can reproduce the frequency content of the airplane when flown in specific conditions. The test results should be presented as a Power Spectral Density (PSD) plot with frequencies on the horizontal axis and amplitude on the vertical axis. The airplane data and FSTD data should be presented in the same format with the same scaling. The algorithms used for generating the FSTD data should be the same as those used for the airplane data. If they are not the same then the algorithms used for the FSTD data should be proven to be sufficiently comparable. As a minimum the results along the dominant axes should be presented and a rationale for not presenting the other axes should be provided.

b. Interpretation of results. The overall trend of the PSD plot should be considered while focusing on the dominant frequencies. Less emphasis should be placed on the differences at the high frequency and low amplitude portions of the PSD plot. During the analysis it should be considered that certain structural components of the FSTD have resonant frequencies that are filtered and thus may not appear in the PSD plot. If such filtering is required the notch filter bandwidth should be limited to 1 Hz to ensure that the buffet feel is not adversely affected. In addition, a rationale should be provided to explain that the characteristic motion vibration is not being adversely affected by the filtering. The amplitude should match airplane data as per the description below; however, if for subjective reasons the PSD plot was altered a rationale should be provided to justify the change. If the plot is on a logarithmic scale it may be difficult to interpret the amplitude of the buffet in terms of acceleration. A 1x10-3 grms2/Hz would describe a heavy buffet. On the other hand, a 1x10-6 grms2/Hz buffet is almost not perceivable; but may represent a buffet at low speed. The previous two examples could differ in magnitude by 1 000. On a PSD plot this represents three decades (one decade is a change in order of magnitude of 10; two decades is a change in order of magnitude of 100, etc.).

2.4.4 **Visual System.**

2.4.4.1 Visual Display System.

a. Contrast ratio (daylight systems). Should be demonstrated using a raster drawn test pattern filling the entire visual scene (three or more channels) consisting of a matrix of black and white squares no larger than 5 degrees per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1 degree spot photometer. Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Light point contrast ratio is measured when light point modulation is just discernable compared to the adjacent background. See paragraph 2.3.4.b. (3) and paragraph 2.3.4.b. (7)

b. Highlight brightness test (daylight systems). Should be demonstrated by maintaining the full test pattern described above, the superimposing a highlight on the centre white square of each channel and measure the brightness using the 1 degree spot photometer. Light points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable. See paragraph 2.3.4.b. (4)

c. Resolution (daylight systems) should be demonstrated by a test of objects shown to occupy a visual angle of not greater than the specified value in arc minutes in the visual scene from the pilot's eye point. This should be confirmed by calculations in the statement of compliance. See paragraph 2.3.4.b. (5)

d. Light point size (daylight systems) should be measured in a test pattern consisting of a single row of light points reduced in length until modulation is just discernible. See paragraph 2.3.4.b. (6)

e. Light point size (twilight and night systems) of sufficient resolution so as to enable achievement of visual feature recognition tests according to paragraph 2.3.4.b. (6).

2.4.4.2 Visual ground segment.

(a) Altitude and RVR for the assessment have been selected in order to produce a visual scene that can be readily assessed for accuracy (RVR calibration) and where spatial accuracy (centerline and G/S) of the simulated airplane can be readily determined using approach/runway lighting and flight deck instruments.

(b) The QTG should indicate the source of data, i.e. airport and runway used ILS G/S antenna location (airport and airplane), pilot eye reference point, flight deck cut-off angle, etc., used to make accurately visual ground segment (VGS) scene content calculations.

(c) Automatic positioning of the simulated airplane on the ILS is encouraged. If such positioning is accomplished, diligent care should be taken to ensure the correct spatial position and airplane attitude is achieved. Flying the approach manually or with an installed autopilot should also produce acceptable results.

2.4.5 **Sound System**

2.4.5.1 General. The total sound environment in the airplane is very complex, and changes with atmospheric conditions, airplane configuration, airspeed, altitude, power settings, etc. Thus, flight deck sounds are an important component of the flight deck operational environment and as such provide valuable information to the flight crew. These aural cues can either assist the crew, as an indication of an abnormal situation, or hinder the crew, as a distraction or nuisance. For effective training, the FSTD should provide flight deck sounds that are perceptible to the pilot during normal and abnormal operations, and that are comparable to those of the airplane. Accordingly, the FSTD operator should carefully evaluate background noises in the location being considered. To demonstrate compliance with the sound requirements, the objective or validation tests in this paragraph have been selected to provide a representative sample of normal static conditions typical of those experienced by a pilot.

2.4.5.2 Alternate engine fits. For FSTDs with multiple propulsion configurations any condition listed in paragraph 2.3, the table of FSTD validation tests that is identified by the airplane manufacturer as significantly different, due to a change in engine model should be presented for evaluation as part of the QTG.

2.4.5.3 Data and Data Collection System

(a) Information provided to the FSTD manufacturer should comply with "IATA Flight Simulator Design & Performance Data Requirements", 6th Edition, 2000. This information should contain calibration and frequency response data.

(b) The system used to perform the tests listed in Para. 2.3.5, within the table of FSTD validation tests, should comply with the following standards:

(1) ANSI S1.11-1986 - Specification for octave, half octave and third octave band filter sets;

(2) IEC 1094-4 - 1995 - measurement microphones - type WS2 or better.

2.4.5.4 Headsets. If headsets are used during normal operation of the airplane they should also be used during the FSTD evaluation.

2.4.5.5 Playback equipment. Recordings of the QTG conditions according to paragraph 2.3, table of FSTD validation tests, should be provided during initial evaluations.

2.4.5.6 Background noise.

(a) Background noise is the noise in the FSTD due to the FSTD's cooling and hydraulic systems that is not associated with the airplane, and the extraneous noise from other locations in the building. Background noise can seriously impact the correct simulation of airplane sounds, so the goal should be to keep the background noise below the airplane sounds. In some cases, the sound level of the simulation can be increased to compensate for the background noise. However, this approach is limited by the specified tolerances and by the subjective acceptability of the sound environment to the evaluation pilot.

(b) The acceptability of the background noise levels is dependent upon the normal sound levels in the airplane being represented. Background noise levels that fall below the lines defined by the following points may be acceptable (refer to figure 3):

(1) 70 dB @ 50 Hz;
(2) 55 dB @ 1 000 Hz;
(3) 30 dB @ 16 kHz.

These limits are for un-weighted 1/3 octave band sound levels. Meeting these limits for background noise does not ensure an acceptable FSTD. Airplane sounds, which fall below this limit require careful review and may require lower limits on the background noise.

(c) The background noise measurement may be rerun at the recurrent evaluation as stated in paragraph 2.4.5.8. The tolerances to be applied are that recurrent 1/3 octave band amplitudes cannot exceed ± 3 dB when compared to the initial results.

2.4.5.7 Frequency response - Frequency response plots for each channel should be provided at initial evaluation. These plots may be rerun at the recurrent evaluation as per paragraph 2.4.5.8. The tolerances to be applied are as follows:

(a) Recurrent 1/3 octave band amplitudes cannot exceed ± 5 dB for three consecutive bands when compared to initial results.

(b) The average of the sum of the absolute differences between initial and recurrent results cannot exceed 2 dB (refer table 3).

2.4.5.8 Initial and recurrent evaluations. If recurrent frequency response and FSTD background noise results are within tolerance, respective to initial evaluation results, and the operator can prove that no software or hardware changes have occurred that will affect the airplane cases, then it is not required to rerun those cases during recurrent evaluations.

If airplane cases are rerun during recurrent evaluations then the results may be compared against initial evaluation results rather than airplane master data.

2.4.5.9 Validation testing. Deficiencies in airplane recordings should be considered when applying the specified tolerances to ensure that the simulation is representative of the airplane. Examples of typical deficiencies are:

(a) Variation of data between tail numbers;
(b) Frequency response of microphones;
(c) Repeatability of the measurements;
(d) Extraneous sounds during recordings.

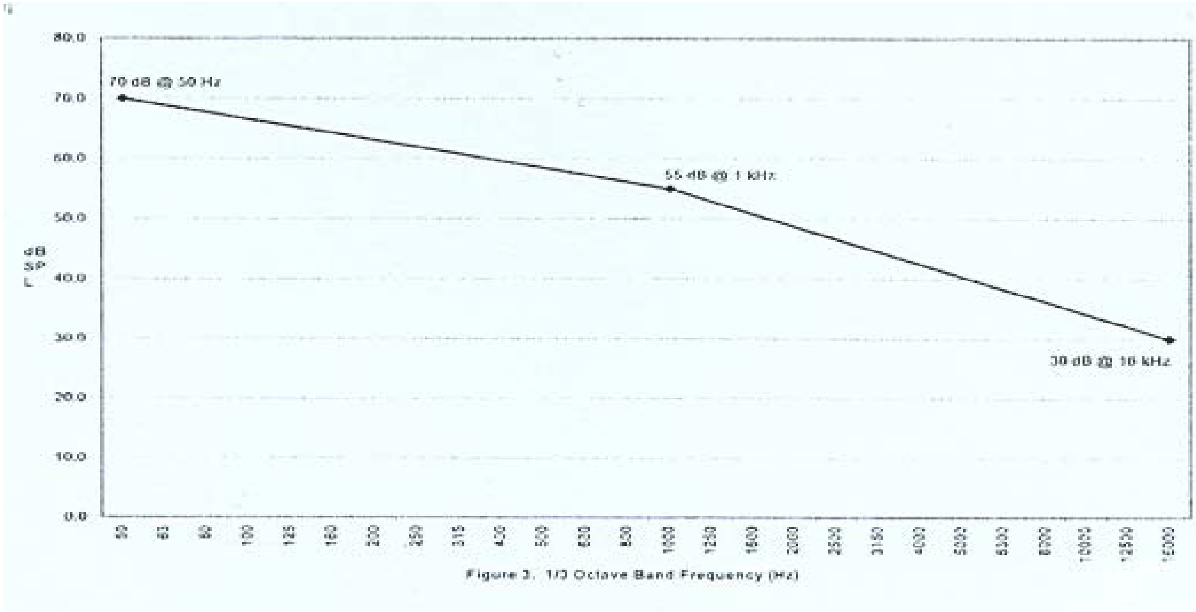


Figure 3. 1/3 Octave Band Frequency (Hz)

Band Centre Freq.	Initial Results (dBSPL)	Recurrent Results (dBSPL)	Absolute Difference
50	75.0	73.8	1.2
63	75.9	75.6	0.3
80	77.1	76.5	0.6
100	78.0	78.3	0.3
125	81.9	81.3	0.6
160	79.8	80.1	0.3
200	83.1	84.9	1.8
250	78.6	78.9	0.3
315	79.5	78.3	1.2
400	80.1	79.5	0.6
500	80.7	79.8	0.9
630	81.9	80.4	1.5
800	73.2	74.1	0.9
1000	79.2	80.1	0.9
1250	80.7	82.8	2.1
1600	81.6	78.6	3.0
2000	76.2	74.4	1.8
2500	79.5	80.7	1.2
3150	80.1	77.1	3.0
4000	78.9	78.6	0.3
5000	80.1	77.1	3.0
6300	80.7	80.4	0.3
8000	84.3	85.5	1.2
10000	81.3	79.8	1.5
12500	80.7	80.1	0.6
16000	71.1	71.1	0.0
		Average	1.1

Table 3 - Example of recurrent frequency response test tolerance

Functions and Subjective Tests

3.1 **Discussion.**

3.1.1 Accurate replication of airplane systems functions will be checked at each flight crewmember position. This includes procedures using the operator's approved manuals; airplane manufacturers approved manuals and checklists. A useful source of guidance for conducting the tests required to establish that the criteria set out in this document are complied with by the flight simulator under evaluation are published in the RAeS Airplane Flight Simulator Evaluation Handbook. Handling qualities, performance, and FSTD systems operation will be subjectively assessed. In order to assure the functions tests are conducted in an efficient and timely manner, operators are encouraged to coordinate with CARC for the evaluation so that any skills, experience or expertise needed by CARC evaluation team are available.

3.1.2 The necessity of functions and subjective tests arises from the need to confirm that the simulation has produced a totally integrated and acceptable replication of the airplane. Unlike the objective tests listed in paragraph 2 above, the subjective testing should cover those areas of the flight envelope which may reasonably be reached by a trainee, even though the FSTD has not been approved for training in that area. Thus it is prudent to examine, for example, the normal and abnormal FSTD performance to ensure that the simulation is representative even though it may not be a requirement for the level of qualification being sought. (Any such subjective assessment of the simulation should include reference to paragraph 2 and 3 above in which the minimum objective standards acceptable for that Qualification Level are defined. In this way it is possible to determine whether simulation is an absolute requirement or just one where an approximation, if provided, has to be checked to confirm that it does not contribute to negative training.)

3.1.3 At the request of CARC, the FSTD may be assessed for a special aspect of an operator's training program during the functions and subjective portion of an evaluation. Such an assessment may include a portion of a Line Oriented Flight Training (LOFT) scenario or special emphasis items in the operator's training program. Unless directly related to a requirement for the current Qualification Level, the results of such an evaluation would not affect the FSTD's current status.

3.1.4 Functions tests will be run in a logical flight sequence at the same time as performance and handling assessments. This also permits real time FSTD running for 2 to 3 hours, without repositioning or flight or position freeze, thereby permitting proof of reliability.

3.2 **Test requirements.**

3.2.1 The ground and flight tests and other checks required for qualification are listed in the table of functions and subjective tests. The table includes maneuvers and procedures to assure that the FSTD functions and performs appropriately for use in pilot training, testing and checking in the maneuvers and procedures normally required of training, testing and checking program.

3.2.2 Maneuvers and procedures are included to address some features of advanced technology airplanes and innovative training programs. For example, ‘high angle of attack maneuvering’ is included to provide an alternative to ‘approach to stalls’. Such an alternative is necessary for airplanes employing flight envelope limiting technology.

3.2.3 All systems functions will be assessed for normal and, where appropriate, alternate operations. Normal, abnormal, and emergency procedures associated with a flight phase will be assessed during the evaluation of maneuvers or events within that flight phase. Systems are listed separately under ‘any flight phase’ to assure appropriate attention to systems checks.

3.2.4 When evaluating functions and subjective tests, the fidelity of simulation required for the highest level of qualification should be very close to the airplane. However, for the lower levels of qualification the degree of fidelity may be reduced in accordance with the criteria contained in paragraph 2 above.

3.2.5 Evaluation of the lower orders of FSTD should be tailored only to the systems and flight conditions which have been simulated. Similarly, many tests will be applicable for automatic flight. Where automatic flight is not possible and pilot manual handling is required, the FSTD shall be at least controllable to permit the conduct of the flight.

3.2.6 Any additional capability provided in excess of the minimum required standards for a particular Qualification Level should be assessed to ensure the absence of any negative impact on the intended training and testing maneuvers.

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Functions and subjective tests

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
a	**PREPARATION FOR FLIGHT**										
	(1) Preflight. Accomplish a functions check of all switches, indicators, systems, and equipment at all crewmembers' and instructors' stations and determine that;										
	(a) the flight deck design and functions are identical to that of the airplane or class of airplane simulated	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(b) design and functions represent those of the simulated class of airplane										✓
b	**SURFACE OPERATIONS (PRE-TAKE-OFF)**										
	(1) Engine Start										
	(a) Normal start	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) Alternate start procedures	✓	✓	✓	✓	✓	✓				
	(c) Abnormal starts and shutdowns (hot start, hung start, tail pipe fire, etc.)	✓	✓	✓	✓	✓	✓				
	(2) Pushback/Power back	✓	✓	✓	✓						
	(3) Taxi										
	(a) Thrust response	✓	✓	✓	✓			✓	✓	✓	
	(b) Power lever friction	✓	✓	✓	✓			✓	✓	✓	
	(c) Ground handling	✓	✓	✓	✓			✓	✓	✓	
	(d) Nose wheel scuffing	✓	✓	✓	✓			✓	✓	✓	
	(e) Brake operation (normal and alternate/emergency)										
	A Brake fade (if applicable)	✓	✓	✓	✓						
	B. Other	✓	✓	✓	✓						
c	**TAKE-OFF**										
	(1) Normal										✓ (1)
	(a) Airplane/engine parameter relationships	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) Acceleration characteristics (motion)	✓	✓	✓	✓						
	(c) Acceleration characteristics (not associated with motion)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(d) Nose wheel and rudder steering	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(e) Crosswind (maximum demonstrated)	✓	✓	✓	✓				✓	✓	
	(f) Special performance (e.g. reduced V1, max de-rate, short field operations)	✓	✓	✓	✓						
	(g) Low visibility take-off	✓	✓	✓	✓				✓	✓	
	(h) Landing gear, wing flap leading edge device operation	✓	✓	✓	✓			✓	✓	✓	✓
	(i) Contaminated runway operation	✓	✓	✓	✓						
	(j) Other	✓	✓	✓	✓						

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No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(2) Abnormal/emergency										
	(a) Rejected	✓	✓	✓	✓					✓	
	(b) Rejected special performance (e.g. reduced V1, max de-rate, short field operations)	✓	✓	✓	✓						
	(c) With failure of most critical engine at most critical point, continued take-off	✓	✓	✓	✓						
	(d) With wind shear	✓	✓	✓	✓						
	(e) Flight control system failures, reconfiguration modes, manual reversion and associated handling	✓	✓	✓	✓						
	(f) Rejected, brake fade	✓	✓	✓	✓						
	(g) Rejected, contaminated runway	✓	✓	✓	✓						
	(h) Other	✓	✓	✓	✓						
d	**CLIMB**										
	(1) Normal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) One or more engines inoperative	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓	✓(2)
	(3) Other	✓	✓	✓	✓	✓	✓				
e	**CRUISE**										
	(1) Performance characteristics (speed vs. power)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) High altitude handling	✓	✓	✓	✓	✓	✓		✓	✓	
	(3) High Mach number handling (Mach tuck, Mach buffet) and recovery (trim change)	✓	✓	✓	✓	✓	✓		✓	✓	
	(4) Over speed warning (in excess of Vmo or Mmo)	✓	✓	✓	✓						
	(5) High IAS handling	✓	✓	✓	✓	✓	✓		✓	✓	
f	**MANOEUVRES**										
	(1) High angle of attack, approach to stalls, stall warning, buffet, and g-break (take-off, cruise, approach, and landing configuration)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Flight envelope protection (high angle of attack, bank limit, over speed, etc)	✓	✓	✓	✓	✓	✓				
	(3) Turns with/without speed brake/spoilers deployed	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(4) Normal and standard rate turns	✓	✓	✓	✓						✓
	(5) Steep turns	✓	✓	✓	✓						✓
	(6) Performance turn	✓	✓	✓	✓						
	(7) In flight engine shutdown and restart (assisted and windmill)	✓	✓	✓	✓	✓	✓			✓	
	(8) Maneuvering with one or more engines inoperative, as appropriate	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓	✓ (2)
	(9) Specific flight characteristics (e.g. direct lift control)	✓	✓	✓	✓	✓	✓				
	(10) Flight control system failures, reconfiguration modes, manual reversion and associated handling	✓	✓	✓	✓	✓	✓			✓	
	(11) Other	✓	✓	✓	✓	✓	✓				

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No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
g	**DESCENT**										
	(1) Normal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Maximum rate (clean and with speed brake, etc)	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(3) With autopilot	✓	✓	✓	✓					✓	
	(4) Flight control system failures, reconfiguration modes, manual reversion and associated handling	✓	✓	✓	✓	✓	✓			✓	
	(5) Other	✓	✓	✓	✓	✓	✓				
h	**INSTRUMENT APPROACHES AND LANDING**										
	Only those instrument approach and landing tests relevant to the simulated airplane type or class should be selected from the following list, where tests should be made with limiting wind Velocities, wind shear and with relevant system failures, including the use of Flight Director.										
	(1) Precision										
	(a) PAR	✓	✓	✓	✓			✓	✓	✓	✓
	(b) CAT I/GBAS (ILS/MLS) published approaches										
	A Manual approach with/without flight director including landing	✓	✓	✓	✓	✓	✓		✓	✓	
	B Autopilot/auto throttle coupled approach and manual landing	✓	✓	✓	✓	✓	✓			✓	
	C Manual approach to DH and G/A all engines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	D Manual one engine out approach to DH and G/A	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓	✓(2)
	E Manual approach controlled with and without flight director to 30 m (100 ft) below CAT I minima	✓	✓	✓	✓						
	(i) with cross-wind (maximum demonstrated)	✓	✓	✓	✓						
	(ii) with wind shear	✓	✓	✓	✓	✓	✓			✓	
	F Autopilot/auto throttle coupled approach, one engine out to DH and G/A	✓	✓	✓	✓	✓	✓			✓	
	G Approach and landing with minimum/standby electrical power										
	(c) CAT II/GBAS (ILS/MLS) published approaches										
	A Autopilot/auto throttle coupled approach to DH and landing	✓	✓	✓	✓	✓	✓				
	B Autopilot/auto throttle coupled approach to DH and G/A	✓	✓	✓	✓	✓	✓				
	C Auto coupled approach to DH and manual G/A	✓	✓	✓	✓	✓	✓				
	D Auto coupled/auto throttle Category II published approach	✓	✓	✓	✓						
	(d) CAT III/GBAS (ILS/MLS) published approaches										
	A Autopilot/auto throttle coupled approach to land and rollout	✓	✓	✓	✓	✓	✓				
	B Autopilot/auto throttle coupled approach to DH/Alert Height and G/A	✓	✓	✓	✓	✓	✓				
	C Autopilot/auto throttle coupled approach to land and rollout with one engine out	✓	✓	✓	✓	✓	✓				
	D Autopilot/auto throttle coupled approach to DH/Alert Height and G/A with one engine out	✓	✓	✓	✓	✓	✓				
	E Autopilot/auto throttle coupled approach (to land or to go around)										
	(i) with generator failure	✓	✓	✓	✓						
	(ii) with 10 knot tail wind	✓	✓	✓	✓						
	(iii) with 10 knot crosswind	✓	✓	✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(2) Non-precision										
	(a) NDB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) VOR, VOR/DME, VOR/TAC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(c) RNAV (GNSS)	✓	✓	✓	✓	✓	✓			✓	
	(d) ILS LLZ (LOC), LLZ(LOC)/BC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(e) ILS offset localizer	✓	✓	✓	✓						
	(f) direction finding facility	✓	✓	✓	✓						
	(g) surveillance radar	✓	✓	✓	✓						
	NOTE: If Standard Operating Procedures are to use autopilot for non-precision approaches then these should be evaluated										
i	**VISUAL APPROACHES (SEGMENT) AND LANDINGS**										
	(1) Maneuvering, normal approach and landing all engines operating with and without visual approach aid guidance	✓	✓	✓	✓				✓	✓	
	(2) Approach and landing with one or more engines inoperative	✓	✓	✓	✓				✓	✓	
	(3) Operation of landing gear, flap/slats and speed brakes (normal and abnormal)	✓	✓	✓	✓						
	(4) Approach and landing with crosswind (max. demonstrated for Flight simulator)	✓	✓	✓	✓				✓	✓	
	(5) Approach to land with wind shear on approach	✓	✓	✓	✓						
	(6) Approach and landing with flight control system failures,(for Flight simulator - reconfiguration modes, manual reversion and associated handling (most significant degradation which is probable)	✓	✓	✓	✓					✓	
	(7) Approach and landing with trim malfunctions										
	(a) longitudinal trim malfunction	✓	✓	✓	✓						
	(b) lateral-directional trim malfunction	✓	✓	✓	✓						
	(8) Approach and landing with standby (minimum) electrical/hydraulic power	✓	✓	✓	✓						
	(9) Approach and landing from circling conditions (circling approach)	✓	✓	✓	✓						
	(10) Approach and landing from visual traffic pattern	✓	✓	✓	✓						
	(11) Approach and landing from non-precision approach	✓	✓	✓	✓						
	(12) Approach and landing from precision approach	✓	✓	✓	✓						
	(13) Approach procedures with vertical guidance (APV), e.g., SBAS	✓	✓	✓	✓						
	(14) Other	✓	✓	✓	✓						
	NOTE: FSTD with visual systems, which permit completing a special approach procedure in accordance with applicable regulations, may be approved for that particular approach procedure.										
j	**MISSED APPROACH**										
	(1) All engines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) One or more engine(s) out	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓	✓ (2)
	(3) With flight control system failures, reconfiguration modes, manual reversion and for flight simulator - associated handling	✓	✓	✓	✓	✓	✓			✓	

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
k	**SURFACE OPERATIONS (POST LANDING)**										
	(1) Landing roll and taxi										
	(a) Spoiler operation	✓	✓	✓	✓	✓	✓		✓	✓	
	(b) Reverse thrust operation	✓	✓	✓	✓	✓	✓		✓	✓	
	(c) Directional control and ground handling, both with and without reverse thrust	✓	✓	✓	✓	✓	✓				
	(d) Reduction of rudder effectiveness with increased reverse thrust (rear pod-mounted engines)	✓	✓	✓	✓						
	(e) Brake and anti-skid operation with dry, wet, and icy condition	✓	✓	✓	✓						
	(f) Brake operation, to include auto-braking system where applicable	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(g) Other	✓	✓	✓	✓	✓	✓				
l	**ANY FLIGHT PHASE**										
	(1) Airplane and power plant systems operation										
	(a) Air conditioning and pressurization (ECS)	✓	✓	✓	✓	✓	✓			✓	
	(b) De-icing/anti-icing	✓	✓	✓	✓	✓	✓		✓	✓	
	(c) Auxiliary power plant/auxiliary power unit (APU)	✓	✓	✓	✓	✓	✓				
	(d) Communications	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(e) Electrical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(f) Fire and smoke detection and suppression	✓	✓	✓	✓	✓	✓			✓	
	(g) Flight controls (primary and secondary)	✓	✓	✓	✓	✓	✓			✓	
	(h) Fuel and oil, hydraulic and pneumatic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(i) Landing gear	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(j) Oxygen	✓	✓	✓	✓	✓	✓			✓	
	(k) Power plant	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(l) Airborne radar	✓	✓	✓	✓	✓	✓				
	(m) Autopilot and Flight Director	✓	✓	✓	✓	✓	✓			✓	
	(n) Collision avoidance systems. (e.g. GPWS,TCAS)	✓	✓	✓	✓	✓	✓				
	(o) Flight control computers including stability and control augmentation	✓	✓	✓	✓	✓	✓				
	(p) Flight display systems	✓	✓	✓	✓	✓	✓				
	(q) Flight management computers	✓	✓	✓	✓	✓	✓				
	(r) Head-up guidance, head-up displays	✓	✓	✓	✓	✓	✓				
	(s) Navigation systems	✓	✓	✓	✓			✓	✓	✓	✓
	(t) Stall warning/avoidance	✓	✓	✓	✓			✓	✓	✓	
	(u) Wind shear avoidance equipment	✓	✓	✓	✓						
	(v) Automatic landing aids	✓	✓	✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(2) Airborne procedures										
	(a) Holding	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) Air hazard avoidance. (traffic, weather)			✓	✓	✓	✓				
	(c) Wind shear			✓	✓	✓	✓				
	(3) Engine shutdown and parking										
	(a) Engine and systems operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(b) Parking brake operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	(4) Other as appropriate including effects of wind	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
m	**VISUAL SYSTEM**										
	(1) Functional test content requirements (Levels C and D) Note—The following is the minimum airport model content requirement to satisfy visual capability tests, and provides suitable visual cues to allow completion of all functions and subjective tests described in this appendix. FSTD operators are encouraged to use the model content described below for the functions and subjective tests. If all of the elements cannot be found at a single real world airport, then additional real world airports may be used. The intent of this visual scene content requirement description is to identify that content required to aid the pilot in making appropriate, timely decisions.										
	(a) two parallel runways and one crossing runway displayed simultaneously; at least two runways should be lit simultaneously			✓	✓						
	(b) runway threshold elevations and locations shall be modeled to provide sufficient correlation with airplane systems (e.g., HGS, GPS, altimeter); slopes in runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eye-point height variation			✓	✓						
	(c) representative airport buildings, structures and lighting			✓	✓						
	(d) one useable gate, set at the appropriate height, for those airplanes that typically operate from terminal gates			✓	✓						
	(e) representative moving and static gate clutter (e.g., other airplanes, power carts, tugs, fuel trucks, additional gates)			✓	✓						
	(f) representative gate/apron markings (e.g., hazard markings, lead-in lines, gate numbering) and lighting			✓	✓						
	(g) representative runway markings, lighting, and signage, including a wind sock that gives appropriate wind cues (h) representative taxiway markings, lighting, and signage necessary for position identification, and to taxi from parking to a designated runway and return to parking; representative, visible taxi route signage shall be provided; a low visibility taxi route (e.g. Surface Movement Guidance Control System, follow-me truck, daylight taxi lights) should also be demonstrated (see next page)			✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(i) representative moving and static ground traffic (e.g., vehicular and airplane)			✓	✓						
	(j) representative depiction of terrain and obstacles within 25 NM of the reference airport			✓	✓						
	(k) representative depiction of significant and identifiable natural and cultural features within 25 NM of the reference airport **Note**—This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation			✓	✓						
	(l) representative moving airborne traffic			✓	✓						
	(m) appropriate approach lighting systems and airfield lighting for a VFR circuit and landing, non-precision approaches and landings, and Category I, II and III precision approaches and landings			✓	✓						
	(n) representative gate docking aids or a marshaller			✓	✓						
	(2) Functional test content requirements (Levels A and B) **Note**—The following is the minimum airport model content requirement to satisfy visual capability tests, and provides suitable visual cues to allow completion of all functions and subjective tests described in this appendix. FSTD operators are encouraged to use the model content described below for the functions and subjective tests.										
	(a) representative airport runways and taxiways	✓	✓					✓	✓	✓	
	(b) runway definition	✓	✓					✓	✓	✓	
	(c) runway surface and markings	✓	✓					✓	✓	✓	
	(d) lighting for the runway in use including runway edge and centerline lighting, visual approach aids and approach lighting of appropriate colors	✓	✓					✓	✓	✓	
	(e) representative taxiway lights	✓	✓								
	(3) Visual scene management										
	(a) Runway and approach lighting intensity for any approach should be set at an intensity representative of that used in training for the visibility set; all visual scene light points should fade into view appropriately	✓	✓	✓	✓						
	(b) The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, and touchdown zone lights on the runway of intended landing should be realistically replicated	✓	✓	✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(4) Visual feature recognition **Note—**Tests 4(a) through 4(g) below contain the minimum distances at which runway features should be visible. Distances are measured from runway threshold to an airplane aligned with the runway on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing										
	(a) Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold	✓	✓	✓	✓				✓	✓	
	(b) Visual Approach Aids lights from 8 km (5 sm) of the runway threshold			✓	✓						
	(c) Visual Approach Aids lights from 5 km (3 sm) of the runway threshold	✓	✓						✓	✓	
	(d) Runway centerline lights and taxiway definition from 5 km (3 sm)	✓	✓	✓	✓				✓	✓	
	(e) Threshold lights and touchdown zone lights from 3 km (2 sm)	✓	✓	✓	✓				✓	✓	
	(f) Runway markings within range of landing lights for night scenes as required by the surface resolution test on day scenes	✓	✓	✓	✓				✓	✓	
	(g) For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner	✓	✓	✓	✓						
	(5) Airport model content (Minimum of three specific airport scenes as defined below;)										
	(a) terminal approach area										
	A accurate portrayal of airport features is to be consistent with published data used for airplane operations			✓	✓						
	B all depicted lights should be checked for appropriate colors, directionality, behavior and spacing (e.g., obstruction lights, edge lights, centre line, touchdown zone, VASI, PAPI, REIL and strobes)			✓	✓						
	C depicted airport lighting should be selectable via controls at the instructor station as required for airplane operation			✓	✓						
	D selectable airport visual scene capability at each model demonstrated for: (i) night (ii) twilight (iii) day			✓	✓						
	E (i) ramps and terminal buildings which correspond to an operator's LOFT and LOS scenarios			✓	✓						
	(ii) terrain- appropriate terrain, geographic and cultural features			✓	✓						
	(iii) dynamic effects - the capability to present multiple ground and air hazards such as another airplane crossing the active runway or converging airborne traffic; hazards should be selectable via controls at the instructor station			✓	✓						
	(iv) illusions - operational visual scenes which portray representative physical relationships known to cause landing illusions, for example short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features **Note** - Illusions may be demonstrated at a generic airport or specific aerodrome			✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(6) Correlation with airplane and associated equipment										
	(a) visual system compatibility with aerodynamic programming	✓	✓	✓	✓				✓	✓	
	(b) Visual cues to assess sink rate and depth perception during landings. Visual cueing sufficient to support changes in approach path by using runway perspective. Changes in visual cues during take-off and approach should not distract the pilot		✓	✓	✓				✓	✓	
	(c) accurate portrayal of environment relating to flight simulator attitudes	✓	✓	✓	✓				✓	✓	
	(d) the visual scene should correlate with integrated airplane systems, where fitted (e.g. terrain, traffic and weather avoidance systems and Head-up Guidance System (HGS))			✓	✓						
	(e) representative visual effects for each visible, own ship, airplane external light		✓	✓	✓						
	(f) the effect of rain removal devices should be provided			✓	✓						
	(7) Scene quality										
	(a) surfaces and textural cues should be free from apparent quantization (aliasing)			✓	✓						
	(b) system capable of portraying full color realistic textural cues			✓	✓						
	(c) the system light points should be free from distracting jitter, smearing or streaking	✓	✓	✓	✓						
	(d) demonstration of occulting through each channel of the system in an operational Scene	✓	✓								
	(e) demonstration of a minimum of ten levels of occulting through each channel of the system in an operational scene			✓	✓						
	(f) system capable of providing focus effects that simulate rain and light point perspective growth			✓	✓						
	(g) system capable of six discrete light step controls (0-5)	✓	✓	✓	✓						
	(8) Environmental effects										
	(a) the displayed scene should correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects			✓	✓						
	(b) Special weather representations which include the sound, motion and visual effects of light, medium and heavy precipitation near a thunderstorm on take-off, approach and landings at and below an altitude of 600 m (2 000 ft) above the aerodrome surface and within a radius of 16 km (10 sm) from the aerodrome			✓	✓						
	(c) in - cloud effects such as variable cloud density, speed cues and ambient changes should be provided			✓	✓						
	(d) the effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene			✓	✓						
	(e) gradual break-out to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 20 ft≤ transition layer ≤200 ft; cloud effects should be checked at and below a height of 600 m (2 000 ft) above the aerodrome and within a radius of 16 km (10 sm) from the airport			✓	✓						
	(f) Visibility and RVR measured in terms of distance. Visibility/RVR should be checked at and below a height of 600 m (2 000 ft) above the aerodrome and within a radius of 16 km (10 sm.) from the airport	✓	✓	✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(g) Patchy fog giving the effect of variable RVR Note – Patchy fog is sometimes referred to as patchy RVR.			✓	✓						
	(h) effects of fog on aerodrome lighting such as halos and defocus			✓	✓						
	(i) effect of own ship lighting in reduced visibility, such as reflected glare, to include landing lights, strobes, and beacons			✓	✓						
	(j) wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway should be selectable from the instructor station			✓	✓						
	(9) Instructor controls of:										
	(a) Environmental effects, e.g. cloud base, cloud effects, cloud density, visibility in kilometers/statute miles and RVR in meters/feet	✓	✓	✓	✓				✓	✓	
	(b) Airport/aerodrome selection	✓	✓	✓	✓			✓	✓	✓	
	(c) Airport/aerodrome lighting including variable intensity where appropriate	✓	✓	✓	✓				✓(4)	✓(4)	
	(d) Dynamic effects including ground and flight traffic	✓	✓	✓	✓						
	(10) Night visual scene capability	✓	✓	✓	✓						
	(11) Twilight visual scene capability			✓	✓						
	(12) Daylight visual scene capability			✓	✓						
n	**MOTION EFFECTS**										
	The following specific motion effects are required to indicate the threshold at which a flight crewmember should recognize an event or situation. Where applicable below, flight simulator pitch, side loading and directional control characteristics should be representative of the airplane as a function of airplane type:										
	(1) Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centerline lights and taxiway characteristics (a) After the airplane has been pre-set to the takeoff position and then released, taxi at various speeds, first with a smooth runway, and note the general characteristics of the simulated runway rumble effects of oleo deflections. Next repeat the maneuver with a runway roughness of 50%, then finally with maximum roughness. The associated motion vibrations should be affected by ground speed and runway roughness. If time permits, different gross weights can also be selected as this may also affect the associated vibrations depending on airplane type. The associated motion effects for the above tests should also include an assessment of the effects of centerline lights, surface discontinuities of uneven runways, and various taxiway characteristics	*	✓	✓	✓						
	(2) Buffets on the ground due to spoiler/speed brake extension and thrust (a) Perform a normal landing and use ground spoilers and reverse thrust – either individually or in combination with each other – to decelerate the simulated airplane. Do not use wheel braking so that only the buffet due to the ground spoilers and thrust reversers is felt.	*	✓	✓	✓						

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(3) Bumps associated with the landing gear (a) Perform a normal take-off paying special attention to the bumps that could be perceptible due to maximum oleo extension after lift-off. When the landing gear is extended or retracted, motion bumps could be felt when the gear locks into position	*	✓	✓	✓						
	(4) Buffet during extension and retraction of landing gear (a) Operate the landing gear. Check that the motion cues of the buffet experienced are reasonably representative of the actual airplane	*	✓	✓	✓						
	(5) Buffet in the air due to flap and spoiler/speed brake extension and approach to stall buffet (a) First perform an approach and extend the flaps and slats, especially with airspeeds deliberately in excess of the normal approach speeds. In cruise configuration verify the buffets associated with the spoiler/speed brake extension. The above effects could also be verified with different combinations of speed brake/flap/gear settings to assess the interaction effects	*	✓	✓	✓						
	(6) Approach to stall buffet (a) Conduct an approach-to-stall with engines at idle and a deceleration of 1 knot/second. Check that the motion cues of the buffet, including the level of buffet increase with decreasing speed, are reasonably representative of the actual airplane	*	✓	✓	✓						
	(7) Touchdown cues for main and nose gear (a) Fly several normal approaches with various rates of descent. Check that the motion cues of the touchdown bump for each descent rate are reasonably representative of the actual airplane	*	✓	✓	✓						
	(8) Nose wheel scuffing (a) Taxi the simulated airplane at various ground speeds and manipulate the nose wheel steering to cause yaw rates to develop which cause the nose wheel to vibrate against the ground ("scuffing"). Evaluate the speed/nose wheel combination needed to produce scuffing and check that the resultant vibrations are reasonably representative of the actual airplane	*	✓	✓	✓						
	(9) Thrust effect with brakes set (a) With the simulated airplane set with the brakes on at the take-off point, increase the engine power until buffet is experienced and evaluates its characteristics. This effect is most discernible with wing mounted engines. Confirm that the buffet increases appropriately with increasing engine thrust	*	✓	✓	✓						

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No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
	(10) Mach and maneuver buffet (a) With the simulated airplane trimmed in 1 g flight while at high altitude, increase the engine power such that the Mach number exceeds the documented value at which Mach buffet is experienced. Check that the buffet begins at the same Mach number as it does in the airplane (for the same configuration) and that buffet levels are a reasonable representation of the actual airplane. In the case of some airplanes ,maneuver buffet could also be verified for the same effects. Maneuver buffet can occur during turning flight at conditions greater than 1 g, particularly at higher altitudes	*	✓	✓	✓						
	(11) Tire failure dynamics (a) Dependent on airplane type, a single tire failure may not necessarily be noticed by the pilot and therefore there should not be any special motion effect. There may possibly be some sound and/or vibration associated with the actual tire losing pressure. With a multiple tire failure selected on the same side the pilot may notice some yawing which should require the use of the rudder to maintain control of the airplane			✓	✓						
	(12) Engine malfunction and engine damage (a) The characteristics of an engine malfunction as stipulated in the malfunction definition document for the particular FSTD should describe the special motion effects felt by the pilot. The associated engine instruments should also vary according to the nature of the malfunction	*	✓	✓	✓						
	(13) Tail strikes and pod strikes (a) Tail-strikes can be checked by over-rotation of the airplane at a speed below Vr whilst performing a takeoff. The effects can also be verified during a landing. The motion effect should be felt as a noticeable bump. If the tail strike affects the airplane's angular rates, the cueing provided by the motion system should have an associated effect.	*	✓	✓	✓						
	(b) Excessive banking of the airplane during its take-off/landing roll can cause a pod strike. The motion effect should be felt as a noticeable bump. If the pod strike affects the airplane's angular rates, the cueing provided by the motion system should have an associated effect	*	✓	✓	✓						
o	**SOUND SYSTEM**										
	(1) The following checks should be performed during a normal flight profile with motion										
	(a) precipitation			✓	✓						
	(b) rain removal equipment			✓	✓						
	(c) significant airplane noises perceptible to the pilot during normal operations, such as engine, flaps, gear, spoiler extension/retraction, thrust reverser to a comparable level of that found in the airplane	✓	✓	✓	✓				✓	✓	
	(d) abnormal operations for which there are associated sound cues including, but not limited to, engine malfunctions, landing gear/tire malfunctions, tail and engine pod strike and pressurization malfunction			✓	✓						
	(e) sound of a crash when the flight simulator is landed in excess of limitations			✓	✓						
	(f) significant engine/propeller noise perceptible to pilot during normal operations							✓	✓	✓	✓

AC No.1 to JCAR-FSTD A.030 *(continued)*

No.	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS				FTD		FNPT			BITD
		A	B	C	D	1	2	I	II	MCC	
p	**SPECIAL EFFECTS**										
	(1) Braking Dynamics (a) Representative brake failure dynamics (including antiskid) and decreased brake efficiency due to high brake temperatures based on airplane related data. These representations should be realistic enough to cause pilot identification of the problem and implementation of appropriate procedures. FSTD pitch, side-loading and directional control characteristics should be representative of the airplane			✓	✓						
	(2) Effects of Airframe and Engine Icing (a) See Appendix 1 to JCAR FSTD A.030 par 2.1(t).			✓	✓						
	NOTE- For Level 'A', an asterisk (*****) denotes that the appropriate effect is required to be present.										
	NOTE -It is accepted that tests will only apply to FTD Level 1 if that system and flight condition is simulated. It is intended that the tests listed below should be conducted in automatic flight. Where automatic flight is not possible and pilot manual handling is required, the FTD shall be at least controllable to permit the conduct of the flight.										

Notes

General: Motion and buffet cues will only be applicable to FSTD equipped with an appropriate motion system:

(1) Takeoff characteristics sufficient to commence the airborne exercises

(2) For FNPT 1 and BITD only if multi-engine

(3) Only trim change required

(4) For FNPT, variable intensity airport lighting not required

Appendix 1 to AC No. 1 to JCAR-FSTD A.030 (interpretative material)
Validation Test Tolerances

1 **Background.**

1.1 The tolerances listed in AC No. 1 of JCAR-FSTD A.030 are designed to be a measure of quality of match using flight-test data as a reference.

1.2 There are many reasons, however, why a particular test may not fully comply with the prescribed tolerances:

(a) Flight-test is subject to many sources of potential error, e.g. instrumentation errors and atmospheric disturbance during data collection;

(b) Data that exhibit rapid variation or noise may also be difficult to match;

(c) Engineering simulator data and other calculated data may exhibit errors due to a variety of potential differences discussed below.

1.3 When applying tolerances to any test, good engineering judgment should be applied. Where a test clearly falls outside the prescribed tolerance(s) for no apparent reasons, then it should be judged to have failed.

1.4 The use of non-flight-test data as reference data was in the past quite small, and thus these tolerances were used for all tests. The inclusion of this type of data as a validation source has rapidly expanded, and will probably continue to expand.

1.5 When engineering simulator data are used, the basis for their use is that the reference data are produced using the same simulation models as used in the equivalent flight training simulator; i.e., the two sets of results should be ‘essentially’ similar. The use of flight-test based tolerances may undermine the basis for using engineering simulator data, because an essential match is needed to demonstrate proper implementation of the data package.

1.6 There are, of course, reasons why the results from the two sources can be expected to differ:

(a) Hardware (avionics units and flight controls);

(b) Iteration rates;

(c) Execution order;

(d) Integration methods;

(e) Processor architecture;

(f) Digital drift:
(1) Interpolation methods;
(2) Data handling differences;
(3) Auto-test trims tolerances, etc.

1.7 Any differences should, however, be small and the reasons for any differences, other than those listed above, should be clearly explained.

1.8 Historically, engineering simulation data were used only to demonstrate compliance with certain extra modeling features:

(a) Flight test data could not reasonably be made available;

(b) Data from engineering simulations made up only a small portion of the overall validation data set;

(c) Key areas were validated against flight-test data.

1.9 The current rapid increase in the use and projected use of engineering simulation data is an important issue because:

(a) Flight-test data are often not available due to sound technical reasons;

(b) Alternative technical solutions are being advanced;

(c) Cost is an ever-present issue.

1.10 Guidelines are therefore needed for the application of tolerances to engineering-simulator-generated validation data.

2 Non-Flight-Test Tolerances.

2.1 Where engineering simulator data or other non-flight-test data are used as an allowable form of reference validation data for the objective tests listed in the table of validation tests, the match obtained between the reference data and the FSTD results should be very close. It is not possible to define a precise set of tolerances as the reasons for other than an exact match will vary depending upon a number of factors discussed in paragraph one of this appendix.

2.2 As guidance, unless a rationale justifies a significant variation between the reference data and the FSTD results, 20% of the corresponding ‘flight-test’ tolerances would be appropriate.

2.3 For this guideline (20% of flight-test tolerances) to be applicable, the data provider should supply a well-documented mathematical model and testing procedure that enables an exact replication of their engineering simulation results.

Appendix 2 to AC No.1 to JCAR-FSTD A.030
Validation Data Roadmap

1 **General.**

1.1 Airplane manufacturers or other sources of data should supply a validation data roadmap (VDR) document as part of the data package. A VDR document contains guidance material from the airplane validation data supplier recommending the best possible sources of data to be used as validation data in the QTG. A VDR is of special value in the cases of requests for 'interim' qualification; requests for qualification of simulations of airplanes certificated prior to 1992, and for qualification of alternate engine or avionics fits (see Appendices 3 and 4 of this AC). A VDR should be submitted to CARC as early as possible in the planning stages for any FSTD planned for qualification to the standards contained herein. CARC is the final authority to approve the data to be used as validation material for the QTG.

1.2 The validation data roadmap should clearly identify (in matrix format) sources of data for all required tests. It should also provide guidance regarding the validity of these data for a specific engine type and thrust rating configuration and the revision levels of all avionics affecting airplane handling qualities and performance. The document should include rationale or explanation in cases where data or parameters are missing, engineering simulation data are to be used, flight test methods require explanation, etc., together with a brief narrative describing the cause/effect of any deviation from data requirements. Additionally, the document should make reference to other appropriate sources of validation data (e.g., sound and vibration data documents).

1.3 Table 1, below, depicts a generic roadmap matrix identifying sources of validation data for an abbreviated list of tests. A complete matrix should address all test conditions.

1.4 Additionally, two examples of 'rationale pages' are presented in Appendix F of the IATA Flight Simulator Design & Performance Data Requirements document. These illustrate the type of airplane and avionics configuration information and descriptive engineering rationale used to describe data anomalies, provide alternative data, or provide an acceptable basis to CARC for obtaining deviations from QTG validation requirements.

ICAO or IATA #	Test Description	CCA Mode*1	Validation Source: Aircraft Flight Test Data *2	Validation Source: Engineering Simulator Data (DEF-73 Engines)	Validation Document: Aerodynamics POM Doc. # xxx123, Rev. A	Flight Controls POM Doc. # xxx456, NEW	Ground Handling POM Doc. # xxx789, Rev. B	Propulsion POM Doc. # xxx321, Rev. C	Integrated POM Doc. # xxx654, Rev. A	Appendix to this VDR Doc. # xxx987, NEW	Comments
	Notes: 1. Only one page is shown; and some test conditions were deleted for brevity; 2. Relevant regulatory material should be consulted and all applicable tests addressed; 3. Validation source, document and comments provided herein are for reference only and do not constitute approval for use										D71 = Engine Type: DEF-71, Thrust Rating: 71.5K D73 = Engine Type: DEF-73, Thrust Rating: 73K **BOLD** upper case denotes primary validation source Lower case denotes alternate validation source R = Rationale included in the VDR Appendix
1.a.1	Minimum Radius Turn		X				D71				
1.a.2	Rate of Turn vs. Nosewheel Angle (2 speeds)		X				D71				
1.b.1	Ground Acceleration Time and Distance		X				d73		D73		Primary data contained in IPOM
1.b.2	Minimum Control Speed, Ground (Vmcg)		x	X	d71					D73	See engineering rationale for test data in VDR
1.b.3	Minimum Unstick Speed (Vmu)		X		D71						
1.b.4	Normal Takeoff		X		d73				D73		Primary data contained in IPOM
1.b.5	Critical Engine Failure on Takeoff		X		d71					D73	Alternate engine thrust rating flight test data in VDR
1.b.6	Crosswind Takeoff		X		d71					D73	Alternate engine thrust rating flight test data in VDR
1.b.7	Rejected Takeoff		X		D71					R	Test procedure anomaly; see rationale
1.b.8	Dynamic Engine Failure After Takeoff			X						D73	No flight test data available; see rationale
1.c.1	Normal Climb - All Engine		X		d71				D71		Primary data contained in IPOM
1.c.2	Climb - Engine-Out, Second Segment		X		d71					D73	Alternate engine thrust rating flight test data in VDR
1.c.3	Climb - Engine-Out, Enroute		X		d71					D73	AFM data available (73K)
1.c.4	Engine-Out Approach Climb		X		D71						
1.c.5.a	Level Flight Acceleration		x	X	d73					D73	Eng sim data w/ modified EEC accel rate in VDR
1.c.5.b	Level Flight Deceleration		x	X	d73					D73	Eng sim data w/ modified EEC decel rate in VDR
1.d.1	Cruise Performance		X		D71						
1.e.1.a	Stopping Time & Distance (Wheel Brakes / Light weight)			X	D71					d73	No flight test data available; see rationale
1.e.1.b	Stopping Time & Distance (Wheel Brakes / Med weight)		X	x	D71					d73	
1.e.1.c	Stopping Time & Distance (Wheel Brakes / Heavy weight		X	x	D71					d73	
1.e.2.a	Stopping Time & Distance (Reverse Thrust / Light weight)		X	x	D71					d73	
1.e.2.b	Stopping Time & Distance (Reverse Thrust / Med weight)			X	d71					D73	No flight test data available; see rationale

Appendix 3 to AC No.1 to JCAR-FSTD 1A.030

Data Requirements for Alternate Engines - Approval Guidelines (Applicable to FFS only)

1 **Background.**

1.1 For a new airplane type, the majority of flight validation data are collected on the first airplane configuration with a 'baseline' engine type. These data are then used to validate all FSTDs representing that airplane type.

1.2 In the case of FSTDs representing an airplane with engines of a different type than the baseline, or a different thrust rating than that of previously validated configurations, additional flight test validation data may be needed.

1.3 When a FSTD with additional and/or alternate engine fits is to be qualified, the QTG should contain tests against flight test validation data for selected cases where engine differences are expected to be significant.

2 Approval Guidelines for validating alternate Engine Fits.

2.1 The following guidelines apply to FSTDs representing airplanes with an alternate engine fit; or, with more than one engine type or thrust rating.

2.2 Validation tests can be segmented into those that are dependent on engine type or thrust rating and those that are not.

2.3 For tests that are independent of engine type or thrust rating, the QTG can be based on validation data from any engine fit. Tests in this category should be clearly identified.

2.4 For tests which are affected by engine type, the QTG should contain selected engine-specific flight test data sufficient to validate that particular airplane-engine configuration. These effects may be due to engine dynamic characteristics, thrust levels and/or engine-related airplane configuration changes. This category is primarily characterized by differences between different engine manufacturers' products, but also includes differences due to significant engine design changes from a previously flight-validated configuration within a single engine type. See Table 1 below for a list of acceptable tests.

2.5 For those cases where the engine type is the same, but the thrust rating exceeds that of a previously flight-validated configuration by five percent (5%) or more, or is significantly less than the lowest previously validated rating (a decrease of fifteen percent (15%) or more), the QTG should contain selected engine specific flight test data sufficient to validate the alternate thrust level. See Table 1 below for a list of acceptable tests. However, if an airplane manufacturer, qualified as a validation data supplier under the guidelines of AC nos1 and 2 to JCAR-FSTD A.030(c)(1), shows that a thrust increase greater than 5% will not significantly change the airplane's flight characteristics, and then flight validation data are not needed.

2.6 No additional flight test data are required for thrust ratings which are not significantly different from that of the baseline or other applicable flight-validated engine-airframe configuration (i.e., less than 5% above or 15% below), except as noted in paragraphs 2.7 and 2.8, below. As an example, for a configuration validated with 50,000 pound-thrust-rated engines, no additional flight validation data are required for ratings between 42,500 and 52,500 lbs. If multiple engine ratings are tested concurrently, only test data for the highest rating are needed.

2.7 Throttle calibration data (i.e., commanded power setting parameter versus throttle position) should be provided to validate all alternate engine types, and engine thrust ratings which are higher or lower than a previously validated engine. Data from a test airplane or engineering test bench are acceptable, provided the correct engine controller (both hardware and software) is used.

2.8 The validation data described in paragraphs 2.4 through 2.7 above should be based on flight test data, except as noted in those paragraphs, or where other data are specifically allowed within AC No. 1 to JCAR-FSTD 1A.030(c)(1). However, if certification of the flight characteristics of the airplane with a new thrust rating (regardless of percentage change) does require certification flight testing with a comprehensive stability and control flight instrumentation package, then the conditions in table 1 below should be obtained from flight testing and presented in the QTG. Conversely, flight test data other than throttle calibration as described above are not required if the new thrust rating is certified on the airplane without need for a comprehensive stability and control flight instrumentation package.

2.9 As a supplement to the engine-specific flight tests of table 1 below and baseline engine-independent tests, additional engine-specific engineering validation data should be provided in the QTG, as appropriate, to facilitate running the entire QTG with the alternate engine configuration. The specific validation tests to be supported by engineering simulation data should be agreed with CARC well in advance of FSTD evaluation.

2.10 A matrix or 'roadmap' should be provided with the QTG indicating the appropriate validation data source for each test (see Appendix 2 of this AC). The following flight test conditions (one per test number) are appropriate and should be sufficient to validate implementation of alternate engine fits in a FSTD.

<table>
<tr><th>Test Number</th><th colspan="2">Test Description</th><th>Alternate Engine Type</th><th>Alternate Thrust Rating [2]</th></tr>
<tr><td>1.b.1, 4</td><td colspan="2">Normal take-off/ground acceleration time & distance</td><td>X</td><td>X</td></tr>
<tr><td>1.b.2</td><td colspan="2">V_{mcg}, if performed for airplane certification</td><td>X</td><td>X</td></tr>
<tr><td>1.b.5</td><td>Engine-out take-off</td><td rowspan="2">Either test may be performed</td><td rowspan="2">X</td><td rowspan="2"></td></tr>
<tr><td>1.b.8</td><td>Dynamic engine failure after take-off</td></tr>
<tr><td>1.b.7</td><td colspan="2">Rejected take-off if performed for airplane certification</td><td>X</td><td></td></tr>
<tr><td>1.d.3</td><td colspan="2">Cruise performance</td><td>X</td><td></td></tr>
<tr><td>1.f.1, 2</td><td colspan="2">Engine acceleration and deceleration</td><td>X</td><td>X</td></tr>
<tr><td>2.a.8</td><td colspan="2">Throttle calibration [1]</td><td>X</td><td>X</td></tr>
<tr><td>2.c.1</td><td colspan="2">Power change dynamics (acceleration)</td><td>X</td><td>X</td></tr>
<tr><td>2.d.1</td><td colspan="2">V_{mca} if performed for airplane certification</td><td>X</td><td>X</td></tr>
<tr><td>2.d.5</td><td colspan="2">Engine inoperative trim</td><td>X</td><td>X</td></tr>
<tr><td>2.e.1</td><td colspan="2">Normal landing</td><td>X</td><td></td></tr>
</table>

1 Should be provided for all changes in engine type or thrust rating (see paragraph 2.7, above).

2 See paragraphs 2.5 through 2.8 above for a definition of applicable thrust ratings.

Note: this table does not take in to consideration additional configuration settings and control laws.

Table 1: Alternate Engine Validation Flight Tests

Appendix 4 to AC No.1 to JCAR-FSTD A.030
Data Requirements for Alternate Avionics (Flight-related Computers & Controllers) – Approval Guidelines

1. **Background.**

1.1 For a new airplane type, the majority of flight validation data are collected on the first airplane configuration with a 'baseline' flight-related avionics ship-set (see paragraph 2.2, below). These data are then used to validate all FSTDs representing that airplane type.

1.2 In the case of FSTDs representing an airplane with avionics of a different hardware design than the baseline, or a different software revision than that of previously validated configurations, additional validation data may be required.

1.3 When a FSTD with additional and/or alternate avionics configurations is to be qualified, the QTG should contain tests against validation data for selected cases where avionics differences are expected to be significant.

2. **Approval Guidelines for Validating Alternate Avionics.**

2.1 The following guidelines apply to FSTDs representing airplanes with a revised, or more than one, avionics configuration.

2.2 The airplane avionics can be segmented into those systems or components that can significantly affect the QTG results and those that cannot. The following avionics are examples of those for which hardware design changes or software revision updates may lead to significant differences relative to the baseline avionics configuration: Flight control computers and controllers for engines, autopilot, braking system, nose wheel steering system, high lift system, and landing gear system. Related avionics such as stall warning and augmentation systems should also be considered. The airplane manufacturer should identify for each validation test, which avionics systems, if changed, could affect test results.

2.3 The baseline validation data should be based on flight test data, except where other data are specifically allowed (see AC No.1 and 2 to JCAR-FSTD A.030(c) (1)).

2.4 For changes to an avionics system or component that cannot affect MQTG validation test results, the QTG test can be based on validation data from the previously validated avionics configuration.

2.5 For changes to an avionics system or component that could affect an QTG validation test, but where that test is not affected by this particular change (e.g., the avionics change is a BITE update or a modification in a different flight phase), the QTG test can be based on validation data from the previously-validated avionics configuration. The airplane manufacturer should clearly state that this avionics change does not affect the test.

2.6 For an avionics change which affects some tests in the QTG, but where no new functionality is added and the impact of the avionics change on airplane response is a small, well-understood effect, the QTG may be based on validation data from the previously-validated avionics configuration. This should be supplemented with avionics-specific validation data from the airplane manufacturer's engineering simulation, generated with the revised avionics configuration. In such cases, the airplane manufacturer should provide a rationale explaining the nature of the change and its effect on the airplane response.

2.7 For an avionics change that significantly affects some tests in the QTG, especially where new functionality is added, the QTG should be based on validation data from the previously-validated avionics configuration and supplemental avionics-specific flight test data sufficient to validate the alternate avionics revision. However, additional flight validation data may not be needed if the avionics changes were certified without need for testing with a comprehensive flight instrumentation package. The airplane manufacturer should co-ordinate FSTD data requirements in this situation, in advance, with CARC.

2.8 A matrix or 'roadmap' should be provided with the QTG indicating the appropriate validation data source for each test (see Appendix 2 of AC No 1 to JCAR-FSTD 1A.030).

Appendix 5 to AC No.1 to JCAR-FSTD A.030
Transport Delay and Latency Testing Methods

1. **General.**

1.1 The purpose of this appendix is to demonstrate how to determine the introduced transport delay through the FSTD system such that it does not exceed a specific time delay. That is, measure the transport delay from control inputs through the interface, through each of the host computer modules and back through the interface to motion, flight instrument and visual systems, and show that it is no more than the tolerances required in the validation test tables. (For Latency testing methods see Para 2).

1.2 Four specific examples of transport delay are described as follows:

(a) Simulation of classic non-computer controlled aircraft;

(b) Simulation of computer controlled aircraft using real aircraft equipment;

(c) Simulation of computer controlled aircraft using software emulation of aircraft equipment;

(d) Simulation using software avionics or re-hosted instruments.

1.3 Figure 1 illustrates the total transport delay for a non-computer-controlled aircraft, or the classic transport delay test.

1.4 Since there are no aircraft-induced delays for this case, the total transport delay is equivalent to the introduced delay.

1.5 Figure 2 illustrates the transport delay testing method employed on a FSTD that uses the real aircraft controller system.

1.6 To obtain the induced transport delay for the motion, instrument and visual signal, the delay induced by the aircraft controller should be subtracted from the total transport delay. This difference represents the introduced delay.

1.7 Introduced transport delay is measured from the cockpit control input to the reaction of the instruments, and motion and visual systems (See figure 1).

1.8 Alternatively, the control input may be introduced after the aircraft controller system and the introduced transport delay measured directly from the control input to the reaction of the instruments, and FSTD motion and visual systems (See figure 2).

1.9 Figure 3 illustrates the transport delay testing method employed on a FSTD that uses a software emulated aircraft controller system.

1.10 By using the simulated aircraft controller system architecture for the pitch, roll and yaw axes, it is not possible to measure simply the introduced transport delay. Therefore, the signal should be measured directly from the pilot controller. Since in the real aircraft the controller system has an inherent delay as provided by the aircraft manufacturer, the FSTD manufacturer should measure the total transport delay and subtract the inherent delay of the actual aircraft components and ensure that the introduced delay does not exceed the tolerances required in the validation test tables.

1.11 Special measurements for instrument signals for FSTDs using a real aircraft instrument display system, versus a simulated or re-hosted display. For the case of the flight instrument systems, the total transport delay should be measured, and the inherent delay of the actual aircraft components subtracted to ensure that the introduced delay does not exceed the tolerances required in the validation test tables.

1.11.1 Figure 4A illustrates the transport delay procedure without the simulation of aircraft displays. The introduced delay consists of the delay between the control movement and the instrument change on the data bus.

1.11.2 Figure 4B illustrates the modified testing method required to correctly measure introduced delay due to software avionics or re-hosted instruments. The total simulated instrument transport delay is measured and the aircraft delay should be subtracted from this total. This difference represents the introduced delay and shall not exceed the tolerances required in the validation test tables. The inherent delay of the aircraft between the data bus and the displays is indicated as XX m sec (See figure 4A). The display manufacturer shall provide this delay time.

1.12 Recorded signals. The signals recorded to conduct the transport delay calculations should be explained on a schematic block diagram. The FSTD manufacturer should also provide an explanation of why each signal was selected and how they relate to the above descriptions.

1.13 Interpretation of results. It is normal that FSTD results vary over time from test to test. This can easily be explained by a simple factor called 'sampling uncertainty.' All FSTDs run at a specific rate where all modules are executed sequentially in the host computer. The flight controls input can occur at any time in the iteration, but these data will not be processed before the start of the new iteration. For a FSTD running at 60 Hz a worst-case difference of 16·67 m sec can be expected. Moreover, in some conditions, the host computer and the visual system do not run at the same iteration rate, therefore the output of the host computer to the visual will not always be synchronized.

1.14 The transport delay test should account for the worst case mode of operation of the visual system. The tolerance is as required in the validation test tables and motion response shall occur before the end of the first video scan containing new information.

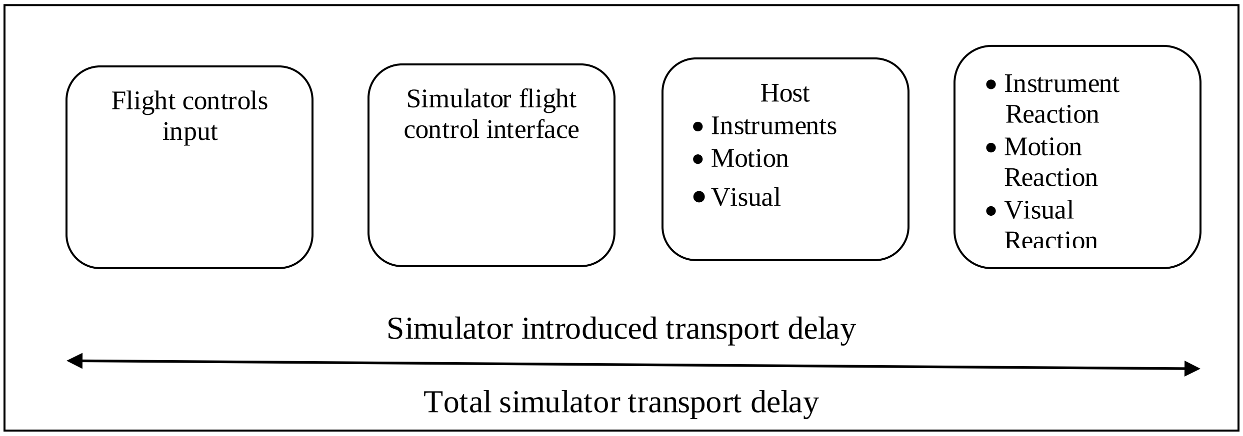

Figure 1: Transport Delay for simulation of classic non-computer controlled aircraft

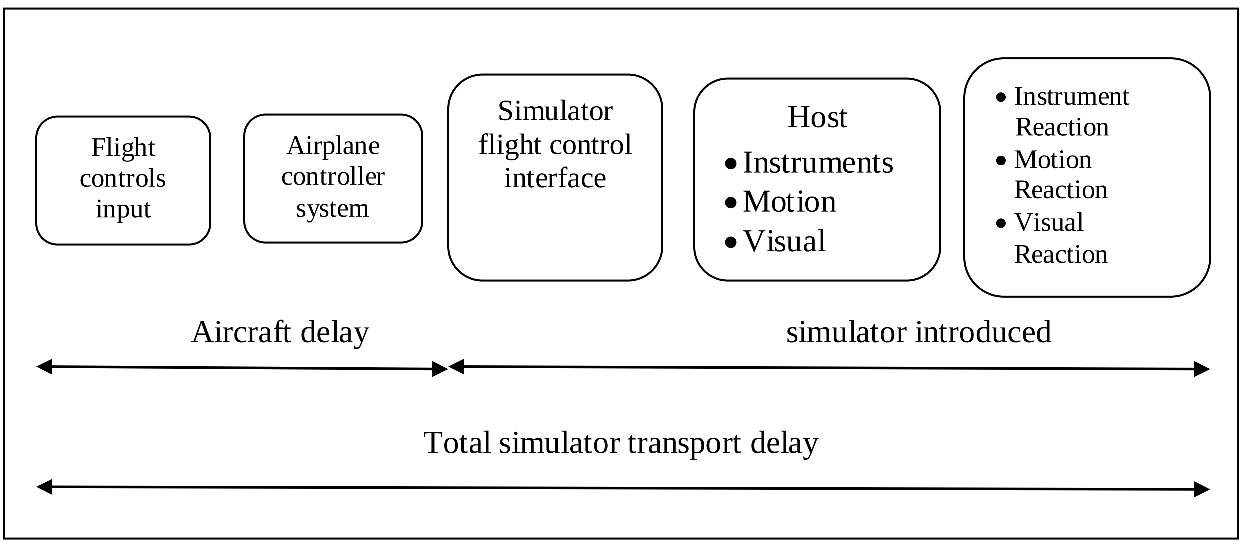

Figure 2: Transport Delay for simulation of computer controlled aircraft using real aircraft equipment

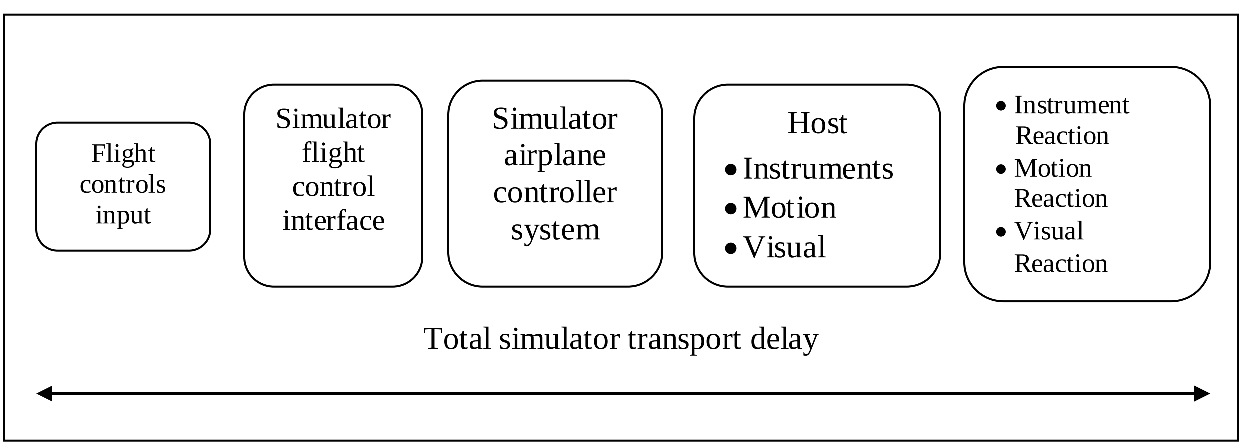

Figure 3: Transport Delay for simulation of computer controlled aircraft using software emulation of aircraft equipment

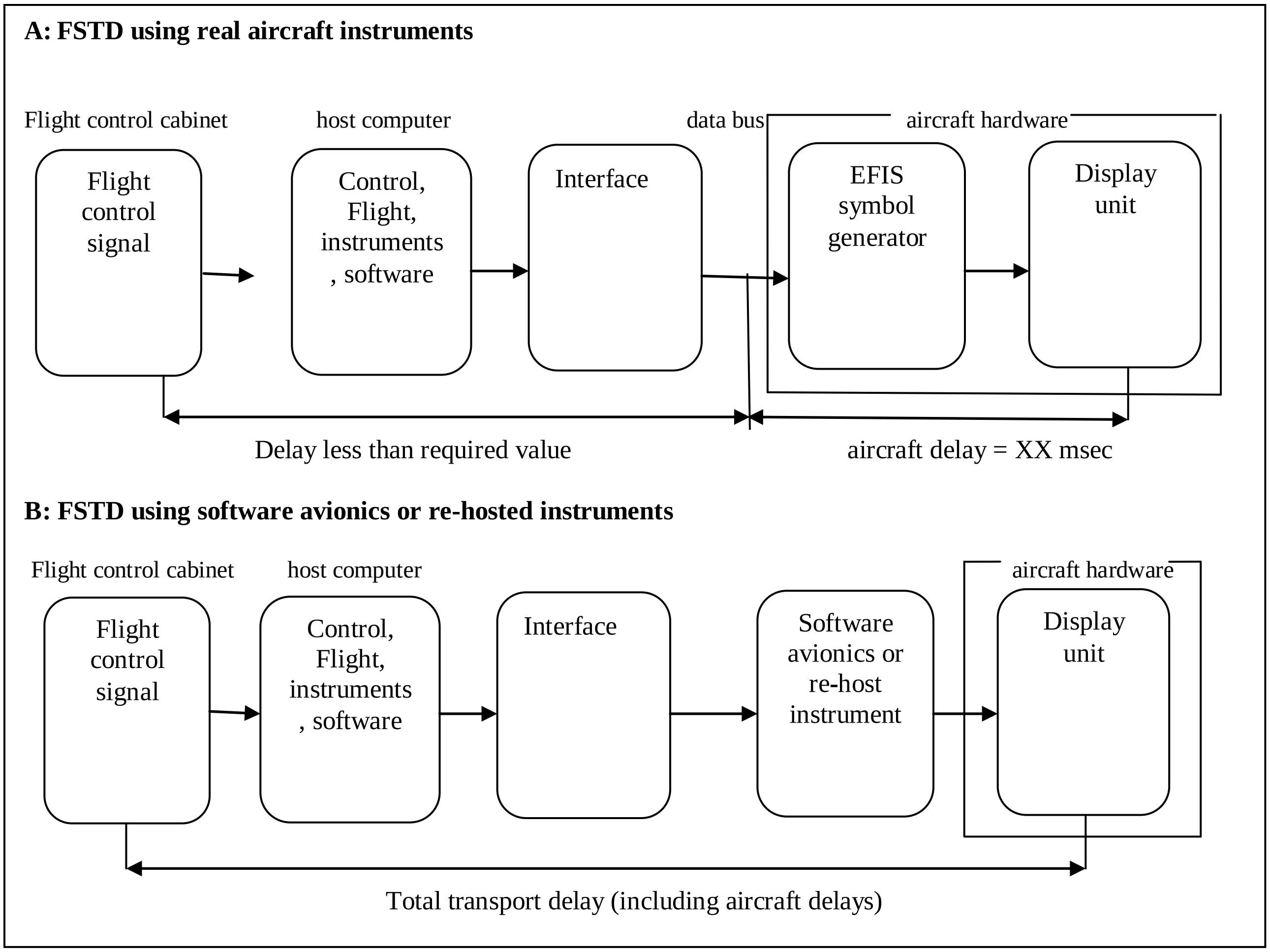

Figure 4A and 4B: Transport delay for simulation of aircraft using real or re-hosted instrument drivers

2. Latency Test Methods.

2.1 The visual system, flight deck instruments and initial motion system response shall respond to abrupt pitch, roll and yaw inputs from the pilot's position within the specified time, but not before the time, when the airplane would respond under the same conditions. The objective of the test is to compare the recorded response of the FSTD to that of the actual airplane data in the take-off, cruise and landing configuration for rapid control inputs in all three rotational axes. The intent is to verify that the FSTD system response does not exceed the specified time (this does not include airplane response time as per the manufacturer's data) and that the motion and visual cues relate to actual airplane responses. For airplane response, acceleration in the appropriate corresponding rotational axis is preferred.

2.2 Interpretation of results. It is normal that FSTD results vary over time from test to test. This can easily be explained by a simple factor called ‘sampling uncertainty.’ All FSTDs run at a specific rate where all modules are executed sequentially in the host computer. The flight controls input can occur at any time in the iteration, but these data will not be processed before the start of the new iteration. For a FSTD running at 60 Hz a worst-case difference of 16·67 m sec can be expected. Moreover, in some conditions, the host computer and the visual system do not run at the same iteration rate, therefore the output of the host computer to the visual will not always be synchronized.

Appendix 6 to AC No.1 to JCAR-FSTD A.030
Recurrent Evaluations - Validation Test Data Presentation

1. **Background.**

1.1 During the initial evaluation of a FSTD the MQTG is created. This is the master document, as amended, to which FSTD recurrent evaluation test results are compared.

1.2 The currently accepted method of presenting recurrent evaluation test results is to provide FSTD results over-plotted with reference data. Test results are carefully reviewed to determine if the test is within the specified tolerances. This can be a time consuming process, particularly when reference data exhibits rapid variations or an apparent anomaly requiring engineering judgment in the application of the tolerances. In these cases the solution is to compare the results to the MQTG. If the recurrent results are the same as those in the MQTG, the test is accepted. Both the FSTD operator and CARC are looking for any change in the FSTD performance since initial qualification.

2. **Recurrent Evaluation Test Results Presentation.**

2.1 To promote a more efficient recurrent evaluation, FSTD operators are encouraged to over-plot recurrent validation test results with MQTG FSTD results recorded during the initial evaluation and as amended. Any change in a validation test will be readily apparent. In addition to plotting recurrent validation test and MQTG results, operators may elect to plot reference data as well.

2.2 There are no suggested tolerances between FSTD recurrent and MQTG validation test results. Investigation of any discrepancy between the MQTG and recurrent FSTD performance is left to the discretion of the FSTD operator and CARC.

2.3 Differences between the two sets of results, other than minor variations attributable to repeatability issues (see Appendix 1 of this AC), which cannot easily be explained, may require investigation.

2.4 The FSTD should still retain the capability to over-plot both automatic and manual validation test results with reference data.

Appendix 7 to AC No.1 to JCAR-FSTD A.030
Applicability of JCAR-STD Amendments to FSTD Data Packages for Existing Airplanes

Except where specifically indicated otherwise within AC No 1 to JCAR-FSTD A.030 Para 2.3, validation data for QTG objective tests are expected to be derived from airplane flight-testing.

Ideally, data packages for all new FSTDs will fully comply with the current standards for qualifying FSTDs.

For types of airplanes first entering into service after the publication of a new amendment of JCAR-FSTD A, the provision of acceptable data to support the FSTD qualification process is a matter of planning and regulatory agreement (see AC No. 1 to JCAR-FSTD A.045 New Airplane FSTD Qualification).

For airplanes certificated prior to the release of the current amendment of JCAR-FSTD A, it may not always be possible to provide the required data for any new or revised objective test cases compared to the previous amendments. After certification, manufacturers do not normally keep flight test airplanes available with the required instrumentation to gather additional data. In the case of flight test data gathered by independent data providers, it is most unlikely that the test airplane will still be available.

Notwithstanding the above discussion, except where other types of data are already acceptable (see, for example, AC Nos 1 and 2 to JCAR-FSTD A.030(c) (1)), the preferred source of validation data is flight test. It is expected that best endeavors will be made by data suppliers to provide the required flight test data. If any flight test data exist (flown during the certification or any other flight test campaigns) that addresses the requirement, these test data should be provided. If any possibility exists to do this flight test during the occasion of a new flight test campaign, this should be done and provided in the data package at the next issue. Where these flight test data are genuinely not available, alternative sources of data may be acceptable using the following hierarchy of preferences:

(a) As defined in Flight test at an alternate but near equivalent condition/configuration.

(b) Data from an audited engineering simulation AC JCAR-FSTD A.005 Para 1.1.e from an acceptable source (for example meets the guidelines laid out in AC No 1 to JCAR-FSTD A.030(c)(1) Para 2), or as used for aircraft certification.

(c) Airplane Performance Data as defined in AC JCAR-FSTD A.005 Para 1.1.b or other approved published sources (e.g., Production flight test schedule) for the following tests:
   i. 1c1 Normal climb, all engines.
   ii. 1c2 one engine inoperative 2nd segment climb.
   iii. 1c3 one engine inoperative en-route climbs.
   iv. 1c4 one engine inoperative approach climbs for airplanes with icing accountability.
   v. 1e3 stopping distance, wheel brakes, wet runway, and test.
   vi. 1e4 stopping distance, wheel brakes, icy runway.

(d) Where no other data is available then, in exceptional circumstances only, the following sources may be acceptable subject to a case-by-case review by CARC taking into consideration the level of qualification sought for the FSTD:
   vii. Unpublished but acceptable sources e.g., calculations, simulations, video or other simple means of flight test analysis or recording.
   viii. Footprint test data from the actual training FSTD requiring qualification validated by NAA appointed pilot subjective assessment.

In certain cases, it may make good engineering sense to provide more than one test to support a particular objective test requirement. An example might be a VMCG test, where the flight test engine and thrust profile do not match the simulated engine. The VMCG test could be run twice, once with the flight test thrust profile as an input and a second time with a fully integrated response to a fuel cut on the simulated engine.

For airplanes certified prior to the date of issue of an amendment, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the MQTG where flight test data are unavailable or unsuitable for a specific test.

For each case, where the preferred data are not available, a rationale should be provided laying out the reasons for the non-compliance and justifying the alternate data and or test(s).

These rationales should be clearly recorded within the Validation Data Road map (VDR) in accordance with and as defined in Appendix 2 to AC No. 1 to JCAR-FSTD A.030.

It should be recognized that there may come a time when there are so little compatible flight test data available that new flight test may be required to be gathered.

Appendix 8 to AC No. 1 to JCAR-FSTD A.030
General technical requirements for FSTD Qualification Levels

This Appendix summarizes the general technical requirements for Flight Simulators levels A, B, C and D, FTD levels 1 and 2, FNPT levels I, II and II MCC, and BITD.

Table 1 – General technical requirements for CARC Level A, B, C and D Full Flight Simulators

Qualification Level	General Technical Requirements
A	**The lowest level of flight simulator technical complexity**.
	An enclosed full-scale replica of the airplane cockpit/flight deck including simulation of all systems, instruments, navigational equipment, communications and caution and warning systems.
	An instructor's station with seat shall be provided. Seats for the flight crewmembers and two seats for inspectors/observers shall also be provided.
	Control forces and displacement characteristics shall correspond to that of the replicated airplane and they shall respond in the same manner as the airplane under the same flight conditions.
	The use of class specific data tailored to the specific airplane type with fidelity sufficient to meet the objective tests, functions and subjective tests is allowed.
	Generic ground effect and ground handling models are permitted.
	Motion, visual and sound systems sufficient to support the training, testing and checking credits sought are required.
	The visual system shall provide at least 45 degrees horizontal and 30 degrees vertical field of view per pilot.
	The response to control inputs shall not be greater than 300 milliseconds more than that experienced on the aircraft
B	**As for Level A plus:**
	Validation flight test data shall be used as the basis for flight and performance and systems characteristics.
	Additionally ground handling and aerodynamics programming to include ground effect reaction and handling characteristics shall be derived from validation flight test data.
C	The second highest level of flight simulator fidelity.
	As for Level B plus:
	A daylight/twilight/night visual system is required with a continuous, cross-cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view.
	A six degrees of freedom motion system shall be provided.
	The sound simulation shall include the sounds of precipitation and other significant airplane noises perceptible to the pilot and shall be able to reproduce the sounds of a crash landing.
	The response to control inputs shall not be greater than 150 milliseconds more than that experienced on the airplane.
	Wind shear simulation shall be provided
D	The highest level of flight simulator fidelity.
	As for Level C plus:
	There shall be complete fidelity of sounds and motion buffets

Table 2 – General technical requirements for CARC Level 1 and 2 FTDs

Qualification Level	General Technical Requirements
1	Type specific with at least 1 system fully represented.
	Enclosed or open flight deck.
	Choice of systems simulated is the responsibility of the organization seeking approval or re approval for the course.
	The airplane system simulated shall comply with the relevant subjective and objective tests relevant to that system.
2	Type specific device with all applicable systems fully represented.
	An enclosed flight deck with an onboard instructor station.
	Type specific or generic flight dynamics (but shall be representative of aircraft performance)
	Primary flight controls which control the flight path and be broadly representative of airplane control characteristics
	Significant sounds
	Control of atmospheric conditions
	Navigation Data Base sufficient to support simulated airplane systems

Table 3A - General technical requirements for CARC Type I FNPTs

Qualification Level	General Technical Requirements
FNPT Type I	A cockpit/flight deck sufficiently enclosed to exclude distraction, which will replicate that of the airplane or class of airplane simulated and in which the navigation equipment, switches and the controls will operate as, and represent those in, that airplane or class of airplane.
	An instructor's station with seat shall be provided and shall provide an adequate view of the crewmembers panels and station
	Effects of aerodynamic changes for various combinations of drag and thrust normally encountered in flight, including the effect of change in airplane attitude, sideslip, altitude, temperature, gross mass, centre of gravity location and configuration
	Complete navigational data for at least 5 different airports with corresponding precision and non-precision approach procedures including current updating within a period of 6 months
	Stall recognition device corresponding to that of the replicated airplane or class of airplane

Table 3B - General technical requirements for CARC Type II FNPTs

Qualification Level	General Technical Requirements
FNPT Type II	As for Type I with the following additions or amendments
	An enclosed flight deck, including the instructor's station
	Crew members' seats shall be provided with sufficient adjustment to allow the occupant to achieve the design eye reference position appropriate to the airplane or class of airplane and for the visual system to be installed to align with that eye position
	Control forces and control travels which respond in the same manner under the same flight conditions as in the airplane or class of airplane being simulated
	Circuit breakers shall function accurately when involved in procedures or malfunctions requiring or involving flight crew response
	Aerodynamic modeling shall reflect: (a) the effects of airframe icing; (b) The rolling moment due to yawing.
	A generic ground handling model shall be provided to enable representative flare and touchdown effects to be produced by the sound and visual systems.
	Systems shall be operative to the extent that it shall be possible to perform all normal, abnormal and emergency operations as may be appropriate to the airplane or class of airplanes being simulated and as required for the training.
	Significant cockpit/flight deck sounds.
	A visual system (night/dusk or day) capable of providing a field-of-view of a minimum of 45 degrees horizontally and 30 degrees vertically, unless restricted by the type of airplane, simultaneously for each pilot. The visual system need not be collimated.
	The responses of the visual system and the flight deck instruments to control inputs shall be closely coupled to provide the integration of the necessary cues.

Table 3C - General technical requirements for CARC Type II MCC FNPTs

Qualification Level	General Technical Requirements
FNPT Type II MCC	For use in Multi-Crew Co-operation (MCC) training - as for Type II with additional instrumentation and indicators as required. For MCC training and operation. Reference AC no. 3 to JCAR-FSTD A.030.

Table 4 - General technical requirements for CARC BITDs

Qualification Level	General Technical Requirements
BITD	A student pilot‘s station that represents a class of airplane sufficiently enclosed to exclude distraction.
	The switches and all the controls shall be of a representative size, shape, location and shall operate as and represent those as in the simulated class of airplane
	In addition to the pilot’s seat, suitable viewing arrangements for the instructor shall be provided allowing an adequate view of the pilot’s panels
	The Control forces, control travel and airplane performance shall be representative of the simulated class of airplane
	Navigation equipment for flights under IFR with representative tolerances. This shall include communication equipment
	Complete navigation database for at least 3 airports with corresponding precision and non precision approach procedures including regular updates
	Engine sound shall be available
	Instructor controls of atmospheric conditions and to set and reset malfunctions relating to flight instruments, navigation aids, flight controls, engine out operations (for multi engine airplanes only).
	Stall recognition device corresponding to that of the simulated class of airplane

AC No. 2 to JCAR-FSTD A.030 (interpretative material)
Guidance on Design and Qualification of Level 'A' Airplane FFSs

1 **Background.**

1.1 When determining the cost effectiveness of any FSTD many factors should be taken into account such as:

(a) Environmental.

(b) Safety.

(c) Accuracy.

(d) Repeatability.

(e) Quality and depth of training.

(f) Weather and crowded airspace.

1.2 The requirements as laid down by the various regulatory bodies for the lowest level of FFS do not appear to have been promoting the anticipated interest in the acquisition of lower cost FFS for the smaller airplanes used by the general aviation community.

1.3 The significant cost drivers associated with the production of any FSTD are:

(a) Type specific data package,

(b) QTG flight test data,

(c) Motion system,

(d) Visual system,

(e) Flight controls and

(f) Aircraft parts.

Note: To attempt to reduce the cost of ownership of CARC Level A FFS, each element has been examined in turn and with a view to relaxing the requirements where possible whilst recognizing the training, checking and testing credits allowed on such a device.

2 **Data package.**

2.1 The cost of collecting specific flight test data sufficient to provide a complete model of the aerodynamics, engines and flight controls can be significant. The use of a class specific data package which could be tailored to represent a specific type of airplane (e.g. PA34 to PA31) is encouraged. This may enable a well-engineered light twin baseline data package to be carefully tuned to adequately represent any one of a range of similar airplanes. Such work including justification and the rationale for the changes would have to be carefully documented and made available for consideration by the CARC as part of the qualification process. Note that for this lower level of FFS, the use of generic ground handling and generic ground effect models is allowed.

2.2 However specific flight test data to meet the needs of each relevant test within the QTG will be required. Recognizing the cost of gathering such data, two points should be borne in mind:

(a) For this class of FFS, much of the flight test information could be gathered by simple means e.g. stopwatch, pencil and paper or video. However comprehensive details of test methods and initial conditions should be presented.

(b) A number of tests within the QTG have had their tolerances reduced to ‘Correct Trend and Magnitude’ (CT&M) thereby avoiding the need for specific flight test data.

(c) The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. Indeed in the class of airplane envisaged, that might take advantage of Level A, it is imperative that the specific characteristics are present, and incorrect effects would be unacceptable (e.g. if the airplane has a weak positive spiral stability, it would not be acceptable for the FFS to exhibit neutral or negative spiral stability).

(d) Where CT&M is used as a tolerance, it is strongly recommended that an automatic recording system be used to ‘footprint’ the baseline results thereby avoiding the effects of possible divergent subjective opinions on recurrent evaluations.

3 **Motion.**

3.1 For Level A FFS, the requirements for both the primary cueing and buffet simulation have been not specified in detail. Traditionally, for primary cueing, emphasis has been laid on the numbers of axes available on the motion system. For this level of FFS, it is felt appropriate that the FFS manufacturer should be allowed to decide on the complexity of the motion system. However, during the evaluation, the motion system will be assessed subjectively to ensure that it is supporting the piloting task, including engine failures, and is, under no circumstances, providing negative cueing.

3.2 Buffet simulation is important to add realism to the overall simulation; for Level A, the effects can be simple but they should be appropriate, in harmony with the sound cues and, under no circumstances, provide negative training.

4 **Visual.**

4.1 Other than field of view (FOV), specific technical criteria for the visual systems are not specified. The emergence of lower cost ‘raster only’ daylight systems is recognized. The adequacy of the performance of the visual system will be determined by its ability to support the flying tasks. e.g. “visual cueing sufficient to support changes in approach path by using runway perspective.”

4.2 The need for collimated visual optics may not always be necessary. A single channel direct viewing system would be acceptable for a FFS of a single crew airplane. (The risk here is that, should the airplane be subsequently upgraded to multi-crew, the non-collimated visual system may be unacceptable.)

4.3 The vertical FOV specified (30°) may be insufficient for certain tasks. Some smaller airplane have large downward viewing angles which cannot be accommodated by the +/–15° vertical FOV. This can lead to two limitations:

(a) At the CAT I all weather operations Decision Height, the appropriate visual ground segment may not be ‘seen’; and

(b) During an approach, where the airplane goes below the ideal approach path, during the subsequent pitch-up to recover, adequate visual reference to make a landing on the runway may be lost.

5 **Flight Controls.**

The specific requirements for flight controls remain unchanged. Because the handling qualities of smaller airplanes are inextricably intertwined with their flight controls, there is little scope for relaxation of the tests and tolerances. It could be argued that with reversible control systems that the on the ground static sweep should in fact be replaced by more representative ‘in air’ testing. It is hoped that lower cost control loading systems would be adequate to fulfill the needs of this level of simulation (i.e. electric).

6 **Airplane Parts.**

As with any level of FSTD, the components used within the flight deck area need not be airplane parts; however, any parts used should be robust enough to endure the training tasks. Moreover, the Level A FFS is type specific, thus all relevant switches, instruments, controls etc. within the simulated area will be required to look and feel ‘as airplane’.

AC No. 3 to JCAR-FSTD A.030 (interpretative material)
Guidance on Design and Qualification of FNPTs
See also JCAR-FSTD A.030

1 **Background.**

1.1 Traditionally training devices used by the ab-initio professional pilot schools have been relatively simple instrument flight-only aids. These devices were loosely based on the particular school's airplane. The performance would be approximately correct in a small number of standard configurations; however the handling characteristics could range from rudimentary to loosely representative. The instrumentation and avionics fit varied between basic and very close to the target airplane. The approval to use such devices as part of a training course was based on a regular subjective evaluation of the equipment and its operator by CARC inspector.

1.2 JCAR-FSTD A introduces two new devices: FNPT I & FNPT II. The FNPT I device is essentially a replacement for the traditional instrument flight ground training device taking advantage of recent technologies and having a more objective design basis. The FNPT II device is the more advanced of the two defined standards and fulfils the wider requirements of the various JCAR-FCL professional pilot training modules up to and including (optionally with additional features) multi-crew co-operation (MCC) training.

1.3 The currently available technologies enable such new devices to have much greater fidelity and lower life-cycle costs than was previously possible. A more objective design basis encourages better understanding and therefore modeling of the airplane systems, handling and performance. These advances combined with the ever upwardly spiraling costs of flying and with the environmental pressures all point towards the need for revised standards.

1.4 The FNPT II device essentially bridges the gap in design complexity between the traditional subjectively created device and the objectively based Level A FFS.

1.5 These new standards are designed to replace the highly subjective design standards and qualification methods with new objective and subjective methods, which ensure that the devices fulfill their intended goals throughout their service lives.

2 Design Standards.

There are two sets of design standards specified within JCAR-FSTD A, FNPT I and FNPT II, the more demanding one of which is FNPT II.

2.1 Simulated Airplane Configuration.

Unlike FFS devices, FNPT I and FNPT II devices are intended to be representative of a class of airplane (although they may in fact be type specific if desired).

The configuration chosen should sensibly represent the airplane or airplanes likely to be used as part of the overall training package. Areas such as general layout, seating, instruments and avionics, control type, control force and position, performance and handling and power plant configuration should be representative of the class of airplane or the airplane itself.

It would be in the interest of all parties to engage in early discussions with CARC to broadly agree a suitable configuration (known as the "designated airplane configuration"). Ideally any such discussion would take place in time to avoid any hold-ups in the design/build/acceptance process thereby ensuring a smooth entry into service.

2.2 The Cockpit/Flight Deck.

The cockpit/flight deck should be representative of the designated airplane configuration. For good training ambiance the cockpit/flight deck should be sufficiently enclosed for FNPT I to exclude any distractions. For an FNPT II the cockpit/flight deck should be fully enclosed. The controls, instruments and avionics controllers should be representative: touch, feel, layout, color and lighting to create a positive learning environment and good transfer of training to the airplane.

2.3 Cockpit/Flight Deck Components.

As with any training device, the components used within the cockpit/flight deck area do not need to be aircraft parts: however, any parts used should be representative of typical training airplanes and should be robust enough to endure the training tasks. With the current state of technology the use of simple CRT monitor based representations and touch screen controls would not be acceptable.

The training tasks envisaged for these devices are such that appropriate layout and feel is very important: i.e. the altimeter sub-scale knob needs to be physically located on the altimeter. The use of CRTs with physical overlays incorporating operational switches/knobs/buttons replicating an airplane instrument panel may be acceptable.

2.4 **Data.**

The data used to model the aerodynamics flight controls and engines should be soundly based on the "designated airplane configuration". It is not acceptable and would not give good training if the models merely represented a few key configurations bearing in mind the extent of the credits available.

Validation data may be derived from a specific airplane within a set of airplanes that the FNPT is intended to represent, or it may be based on information from several airplanes within a set/group/range ("designated airplane configuration"). It is recommended that the intended validation data together with a substantiation report be submitted to CARC for evaluation and approval prior to the commencement of the manufacturing process.

2.4.1 Data Collection and Model Development.

Recognizing the cost of and complexity of flight simulation models, it should be possible to generate generic class "typical" models. Such models should be continuous and vary sensibly throughout the required training flight envelope. A basic requirement for any modeling is the integrity of the mathematical equations and models used to represent the flying qualities and performance of the class of airplane simulated. Data to tune the generic model to represent a more specific airplane can be obtained from many sources without recourse to expensive flight test:

(a) Airplane design data.

(b) Flight and Maintenance Manuals.

(c) Observations on ground and in air.

Data obtained on the ground and in flight can be measured and recorded using a range of simple means such as:

(a) Video.

(b) Pencil and paper.

(c) Stopwatch.

(d) New technologies (i.e. GPS).

Any such data gathering should take place at representative masses and centre's of gravity. Development of such a data package including justification and the rationale for the design and intended performance, the measurement methods and recorded parameters (e.g. mass, c of g, atmospheric conditions) should be carefully documented and available for inspection by CARC as part of the qualification process.

2.5 **Limitations.**

A further possible complication is the strong interaction between the flight control forces and the effects of both the engines and the aerodynamic configuration. For this reason a simple force cueing system in which forces vary not only with position but with configuration (speed, flaps, trim) will be necessary for the FNPT II device. For an FNPT I device a force cueing system may be spring-loaded, but it should be remembered that it is vitally important that negative characteristics would not be acceptable.

It should be remembered however that whilst a simple model may be sufficient for the task, it is vitally important that negative characteristics are not present.

3 **Visual.**

Unless otherwise stated, the visual requirements are as specified for a Level A FFS.

3.1 Other than Field-of-View (FOV) specific technical criteria for the visual systems are not specified. The emergence of lower cost raster only daylight systems is recognized. The adequacy of the performance of the visual system will be determined by its ability to support the flying tasks. e.g. "visual cueing sufficient to support changes in approach path by using runway perspective".

3.2 The need for collimated visual optics is probably not necessary. A single channel direct viewing system (single projector or a monitor for each pilot) would probably be acceptable as no training credits for landing will be available. Distortions due to non-collimation would only become significant during on ground or near to the ground operations.

3.3 The minimum specified vertical FoV of 30 deg may not be sufficient for certain tasks. Where the FNPT does not simulate a particular airplane type, then the design of the out-of-cockpit/flight deck view should be matched to the visual system such that the pilot has a FoV sufficient for the training tasks.

For example during an instrument approach the pilot should be able to see the appropriate visual segment at Decision Height. Additionally where the airplane deviates from the permitted approach path, undue loss of visual reference should not occur during the subsequent correction in pitch.

3.4 There are two methods of establishing latency, which is the relative response of the visual system, cockpit/flight deck instruments and initial motion system response. These should be coupled closely to provide integrated sensory cues.

For a generic FNPT, a Transport Delay test is the only suitable test that demonstrates that the FNPT system does not exceed the permissible delay. If the FNPT is based upon a particular airplane type, either Transport Delay or Latency tests are acceptable. Response time tests check response to abrupt pitch, roll, and yaw inputs at the pilot's position is within the permissible delay, but not before the time when the airplane would respond under the same conditions. Visual scene changes from steady state disturbance should occur within the system dynamic response limit but not before the resultant motion onset.

The test to determine compliance with these requirements should include simultaneously recording the analogue output from the pilot's control column, wheel, and pedals, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the visual system display (including visual system analogue delays), and the output signal to the pilot's attitude indicator or an equivalent test approved by CARC. The test results in a comparison of a recording of the simulator's response with actual airplane response data in the take-off, cruise, and landing configuration.

The intent is to verify that the FNPT system Transport Delays or time lags are less than the permissible delay and that the motion and visual cues relate to actual airplane responses. For airplane response, acceleration in the appropriate rotational axis is preferred.

The Transport Delay test should measure all the delay encountered by a step signal migrating from the pilot's control through the control loading electronics and interfacing through all the simulation software modules in the correct order, using a handshaking protocol, finally through the normal output interfaces to the motion system, to the visual system and instrument displays. A recordable start time for the test should be provided by a pilot flight control input. The test mode should permit normal computation time to be consumed and should not alter the flow of information through the hardware/software system.

The Transport Delay of the system is then the time between control input and the individual hardware responses. It need only be measured once in each axis.

3.5 Care should be taken when using the limited processing power of the lower cost visual systems to concentrate on the key areas which support the intended uses thereby avoiding compromising the visual model by including unnecessary features e.g. moving ground traffic, marshallers. The capacity of the visual model should be directed towards:

(a) Runway surface.

(b) Runway lighting systems.

(c) PAPI/ VASI approach guidance aids.

(d) Approach lighting systems.

(e) Simple taxi way.

(f) Simple large-scale ground features e.g. large bodies of water, big hills.
(g) Basic environmental lighting (night/dusk).

4 **Motion.**

Although motion is not a requirement for either an FNPT I or II, should the operator choose to have one fitted, it will be evaluated to ensure that its contribution to the overall fidelity of the device is positive. Unless otherwise stated in this document, the motion requirements are as specified for a Level A FFS, see AC No 2 to JCAR-FSTD A.030.

5 **Testing / Evaluation.**

To ensure that any device meets its design criteria initially and periodically throughout its life a system of objective and subjective testing will be used. The subjective testing may be similar to that in use in the recent past. The objective testing methodology is drawn from that used currently on FSTD.

The validation tests specified (AC No 1 to JCAR-FSTD A.030 Para. 2.3) can be "flown" by a suitably skilled person and the results recorded manually. Bearing in mind the cost implications, the use of automatic recording (and testing) is encouraged thereby increasing the repeatability of the achieved results.

The tolerances specified are designed to ensure that the device meets its original target criteria year after year. It is therefore important that such target data is carefully derived and values are agreed with CARC in advance of any formal qualification process. For initial qualification, it is highly desirable that the device should meet its design criteria within the listed tolerances, however unlike the tolerances specified for FSTDs, the tolerances contained within this document are specifically intended to be used to ensure repeatability during the life of the device and in particular at each recurrent regulatory inspection.

A number of tests within the QTG have had their tolerances reduced to "Correct Trend and Magnitude" (CT&M) thereby avoiding the need for specific validation data. The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. For such tests, the performance of the device should be appropriate and representative of the simulated designated airplane and should under no circumstances exhibit negative characteristics. Where CT&M is used as a tolerance, it is strongly recommended that an automatic recording system be used to "footprint" the baseline results thereby avoiding the effects of possible divergent subjective opinions during recurrent evaluations.

The subjective tests listed under "Functions and Maneuvers" (AC No 1 to JCAR- FSTD A.030 Para. 3) should be flown out by a suitably qualified and experienced pilot.

Subjective testing will review not only the interaction of all of the systems but the integration of the FNPT with:

(a) Training environment.

(b) Freezes and repositions.

(c) Nav.-aid environment.

(d) Communications.

(e) Weather and visual scene contents.

In parallel with this objective/subjective testing process it is envisaged that suitable maintenance arrangements as part of a Quality Assurance Program shall be in place. Such arrangements will cover routine maintenance, the provision of satisfactory spares holdings and personnel.

6 FNPT Type I.

The design standards, testing and evaluation requirements for the FNPT Type I device are less demanding than those required for a FNPT Type II device. This difference in standard is in line with the reduced JCAR-FCL credits available for this type of device.

7 Additional features.

Any additional features in excess of the minimum design requirements added to an FNPT Type I & II will be subject to evaluation and should meet the appropriate standards in JCAR-FSTD A.

AC No. 4 to JCAR-FSTD A.030 (interpretative material)
Guidance on Design and Qualification of BITDs
See JCAR–FSTD A.030

1 **Background.**

1.1 Traditionally training devices used by the ab-initio pilot schools have been relatively simple instrument flight-only aids. These devices were loosely based on the particular school's airplane. The performance would be approximately correct in a small number of standard configurations; however the handling characteristics could range from rudimentary to loosely representative. The instrumentation and avionics fit varied between basic and very close to the target airplane. The approval to use such devices as part of a training course was based on a regular subjective evaluation of the equipment and its operator by CARC inspector.

1.2 JCAR-FSTD A introduces two new devices, FNPT type I and FNPT type II, where the FNPT I device is essentially a replacement for the traditional instrument flight ground training device taking advantage of recent technologies and having a more objective design basis.

1.3 JCAR-FSTD A sets also the requirements and guidelines for the lowest level of FSTDs by introducing BITDs. It should be clearly understood that a BITD never can replace an FNPT I. The main purpose of a BITD is to replace an old instrument training device that cannot be longer approved either due to poor fidelity or system reliability.

2 **Design Standards.**

2.1 Unlike FFS devices, a BITD is intended to be representative of a class of airplane. The configuration chosen should broadly represent the airplane likely to be used as part of the overall training package. It would be in the interest of all parties to engage in early discussions with CARC to broadly agree a suitable configuration, known as the 'designated airplane configuration'.

2.2 The student pilot station should be broadly representative of the designated airplane configuration and should be sufficiently enclosed to exclude any distractions.

2.3 The main instrument panel in a BITD may be displayed on a CRT. Touch screen or mouse and keyboard operation by the student pilot would not be acceptable for any instrument or system.

2.4 The standards for BITDs were developed for low cost devices and therefore were kept as simple as possible. With advances in technology the higher standards defined for FFSs and FNPTs should be used where economically possible.

3 **Validation Data.**

3.1 The data used to model the aerodynamics and engine(s) should be soundly based on the designated airplane configuration. It is not acceptable if the models merely represent a few key configurations.

3.2 Recognizing the cost and complexity of flight simulation models, it should be possible to generate a generic class typical model. Such models should be continuous and vary sensibly throughout the required training flight envelope. A basic principal for any modeling is the integrity of the mathematical equations and models used to represent the flying qualities and performance of the class of airplane simulated. Data to tune the generic model to represent a more specific airplane can be obtained from many sources without recourse to expensive flight test:

(a) Airplane design date.

(b) Flight and Maintenance Manuals.

(c) Observations on ground and during flight.

Data obtained on ground or in flight can be measured and recorded using a range of simple means such as:

(a) Video.

(b) Pencil and paper.

(c) Stopwatch.

(d) New technologies like GPS etc.

Any such data gathering should take place at representative masses and centers of gravity. Development of such a data package including justification and the rationale for the design and intended performance, the measurement methods and recorded parameters should be carefully documented and available for inspection by CARC as part of the qualification process.

4 **Limitations.**

A force cueing system may be spring-loaded. But it should be remembered that it is vitally important that negative characteristics would not be acceptable.

5 **Testing and Evaluation.**

To ensure that any device meets its design criteria initially and periodically throughout its ‘life’ a system of objective and subjective testing will be used. The subjective testing may be similar to that in use in the recent past. The objective testing methodology is drawn from that used currently on higher level training devices.

The validation tests specified in AC No 1 to JCAR-FSTD A.030, Para. 2.3 can be flown by a suitably skilled person and the results recorded manually. However a print out of the parameters of interest is highly recommended, thereby increasing the repeatability of the achieved results.

The tolerances specified are designated to ensure that the device meets its original target criteria year after year. It is therefore important that such target data is carefully derived and values are agreed with CARC in advance of any formal qualification process. For initial qualification, it is highly desirable that the device meets its design criteria within the listed tolerances, however the tolerances contained in this document are specifically intended to be used to ensure repeatability during the ‘life’ of the device and in particular at each re-current CARC evaluation.

Most of the tests within the QTG had their tolerances reduced to Correct Trend and Magnitude (CT&M). The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. For such tests, the performance of the device should be approximate and representative of the simulated class of airplane and should under no circumstances exhibit negative characteristics. In all these cases it is strongly recommended to print out the baseline results during initial evaluation thereby avoiding the effects of possible divergent subjective opinions during recurrent evaluations.

The subjective tests listed under AC No 1 to JCAR-FSTD A.030, Para. 3, functions and maneuvers, should be flown out by a suitably qualified and experienced pilot. Subjective testing will not only review the interaction of all the applicable systems but the integration of the BITD within a training syllabus, including:

(a) Training environment.

(b) Freezes and repositions.

(c) Nav.-aid environment.

In parallel with this objective and subjective testing process it is envisaged that suitable maintenance arrangements as part of a Quality System are in place. Such arrangements will cover routine maintenance, the provision of satisfactory spares supply and personnel.

6 Guidelines for an Instrument Panel displayed on a Screen

No	Guidelines for an Instrument Panel displayed on a Screen
a	The basic flight instruments shall be displayed and arranged in the usual "T-layout". Instruments shall be displayed very nearly full-size as in the simulated class of airplane. The following instruments shall be displayed so as to be representative for the simulated class of airplane: 1. An attitude indicator with at least 5° and 10° pitch markings, and bank angle markings for 10°, 20°, 30° and 60°. 2. Adjustable altimeter(s) with 20 ft markings. Controls to adjust the QNH shall be located spatially correct at the respective instrument. 3. An airspeed indicator with at least 5 kts markings within a representative speed range and color coding. 4. An HSI or heading indicator with incremental markings each of at least 5°, displayed on a 360° circle. The heading figures shall be radially aligned. Controls to adjust the course or heading bugs shall be located spatially correct at the respective instrument. 5. A vertical speed indicator with 100 fpm markings up to 1 000 fpm and 500 fpm thereafter within a representative range. 6. A turn and bank indicator with incremental markings for a rate of 3° per second turn for left and right turns. The 3° per second rate index shall be inside of the maximum deflection of the indicator. 7. A slip indicator representative of the simulated class of airplane, where a coordinated flight condition is indicated with the ball in centre position. A triangle slip indicator is acceptable if applicable for the simulated class of airplane 8. A magnetic compasses with incremental markings each 10°. 9. Engine instruments as applicable to the simulated class of airplane, with markings for normal ranges, minimum and maximum limits. 10. A suction gauge or instrument pressure gauge, as applicable, with a display as applicable for the simulated class of airplane. 11. A flap position indicator, which displays the current flap setting. This indicator shall be representative of the simulated class of airplane. 12. A pitch trim indicator with a display that shows zero trim and appropriate indices of airplane nose down and nose up trim. 13. A stop watch or digital timer, which allows the readout of seconds and minutes.
b	A communication and navigation panel shall be displayed in a manner that the frequency in use is shown. Controls to select the frequencies and other functions may be located on a central COM/NAV panel or on a separate ergonomically located panel. The NAV equipment shall include ADF, VOR, DME and ILS indicators with the following incremental markings: 1. One-half dot or less for course and glide slope indications on the VOR and ILS display. 2. 5° or less of bearing deviation for ADF and RMI, as applicable. All NAV radios shall be equipped with an aural identification feature. A marker beacon receiver shall also be installed with an optical and aural identification.
c	All instrument displays shall be visible during all flight operation. The instrument system shall be designed to ensure jumping and stepping is not a distraction and to display all changes within the range of the replicated instruments that are equal or greater than the values stated below: 1. Attitude ½° pitch and 1° bank 2. Turn and bank of ¼ standard rate turn 3. IAS 1 kts 4. VSI 20 fpm 5. Altitude 3 ft 6. Heading on HSI ½° 7. Course and Heading on OBS and/or RMI 1° 8. ILS ¼° 9. RPM 25 10. MP ½ inch
d	The update rate of all displays shall be proofed by a SOC. The resolution shall provide an image of the instruments that: 1. Does not appear out of focus. 2. Does not appear to "jump" or "step" to a distracting degree during operation. 3. does not appear with distracting jagged lines or edges

7 **Additional Information.**

Unlike with other FSTDs the manufacturer of a BITD has the responsibility for the initial evaluation of a new BITD model. Because all serial numbers of such a model are automatically qualified, the user approval at the operator's site becomes more important before the course approval is granted.

AC No. 1 to JCAR-FSTD A.030(c) (1) (acceptable means of compliance)
Engineering Simulator Validation Data
See JCAR-FSTD A.030(c) (1)

1. When a fully flight-test validation simulation is modified as a result of changes to the simulated aircraft configuration, a qualified aircraft manufacturer may choose, with the prior agreement of CARC, to supply validation data from an "audited" engineering simulator/simulation to supplement selectively flight test data.

   This arrangement is confined to changes which are incremental in nature and which are both easily understood and well defined.

2. To be qualified to supply engineering simulator validation data, an aircraft manufacturer should:

   (a) Have a proven track record of developing successful data packages.

   (b) Have demonstrated high quality prediction methods through comparisons of predicted and flight test validated data;

   (c) Have an engineering simulator which:
   - has models that run in an integrated manner,
   - uses the same models as released to the training community (which are also used to produce stand/alone proof-of-match and checkout documents),
   - is used to support aircraft development and certification;

   (d) Use the engineering simulation to produce a representative set of integrated proof-of-match cases;

(e) Have an acceptable configuration control system in place covering the engineering simulator and all other relevant engineering simulations.

3. Aircraft manufacturers seeking to take advantage of this alternative arrangement shall contact CARC at the earliest opportunity.

4. For the initial application, each applicant should demonstrate his ability to qualify to the satisfaction of CARC, in accordance with the criteria in this AC and the corresponding AC No. 2 to JCAR-FSTD A.030(c)(1).

AC No. 2 to JCAR-FSTD A.030(c) (1) (interpretative material)
Engineering Simulator Validation Data – Approval Guidelines
See JCAR-FSTD A.030(c) (1)

1. **Background.**

1.1. In the case of fully flight-test validated simulation models of a new or major derivative aircraft; it is likely that these models will become progressively unrepresentative as the aircraft configuration is revised.

1.2. Traditionally as the aircraft configuration has been revised, the simulation models have been revised to reflect changes. In the case of aerodynamic, engine, flight control and ground handling models, this revision process normally results in the collection of additional flight-test data and the subsequent release of new models and validation data.

1.3. The quality of the prediction of simulation models has advanced to the point where differences between the predicted and the flight-test validation models are often quite small.

1.4. The major aircraft manufacturers utilize the same simulation models in their engineering simulations as released to the training community. These simulations vary from physical engineering simulators with and without aircraft hardware to non-real-time workstation based simulations.

2. **Approval Guidelines –for using Engineering Simulator Validation Data.**

2.1. The current system of requiring flight test data as a reference for validating training simulators should continue.

2.2. When a fully flight-test-validated simulation is modified as a result of changes to the simulated aircraft configuration, a qualified aircraft manufacturer may choose, with prior agreement of CARC, to supply validation data from an engineering simulator/simulation to supplement selectively flight test data.

2.3. In cases where data from an engineering simulator is used, the engineering simulation process would have to be audited by CARC.

2.4 In all cases a data package verified to current standards against flight test should be developed for the aircraft "entry-into-service" configuration of the baseline aircraft.

2.5 Where engineering simulator data is used as part of a QTG, an essential match is expected as described in Appendix 1 to JCAR-FSTD A.030.

2.6 In cases where the use of engineering simulator data is envisaged, a complete proposal should be presented to the appropriate regulatory body (ies). Such a proposal would contain evidence of the aircraft manufacturer's past achievements in high fidelity modeling.

2.7 The process will be applicable to "one step" away from a fully flight validated simulation.

2.8 A configuration management process should be maintained, including an audit trail which clearly defines the simulation model changes step by step away from a fully flight validated simulation, so that it would be possible to remove the changes and return to the baseline (flight validated) version.

2.9 CARC will conduct technical reviews of the proposed plan and the subsequent validation data to establish acceptability of the proposal.

2.10 The procedure will be considered complete when an approval statement is issued. This statement will identify acceptable validation data sources.

2.11 To be admissible as an alternative source of validation data an engineering simulator would:

(a) Have to exist as a physical entity, complete with a flight deck representative of the affected class of aircraft, with controls sufficient for manual flight.

(b) Have a visual system; and preferably also a motion system.

(c) Where appropriate, have actual avionics boxes interchangeable with the equivalent software simulations, to support validation of released software.

(d) Have a rigorous configuration control system covering hardware and software.

(e) Have been found to be a high fidelity representation of the aircraft by the pilots of the manufacturers, operators and CARC.

2.12 The precise procedure followed to gain acceptance of engineering simulator data will vary from case to- case between aircraft manufacturers and type of change. Irrespective of the solution proposed, engineering simulations/simulators should conform to the following criteria:

(a) The original (baseline) simulation models should have been fully flight-tested validated.

(b) The models as released by the aircraft manufacturer to the industry for use in training FSTDs should be essentially identical to those used by the aircraft manufacturer in their engineering simulations/simulators.

(c) These engineering simulation/simulators will have been used as part of the aircraft design, development and certification process.

2.13 Training flight simulator(s) utilizing these baseline simulation models should be currently qualified to at least internationally recognized standards such as contained in the ICAO Document 9625, the “Manual of Criteria for the Qualification of Flight Simulators”.

2.14 The type of modifications covered by this alternative procedure will be restricted to those with “well understood effects”:

(a) Software (e.g., flight control computer, autopilot, etc.).

(b) Simple (in aerodynamic terms) geometric revisions (e.g., body length).

(c) Engines – limited to non-propeller-driven aircraft.

(d) Control system gearing/rigging/deflection limits

(e) Brake, tire and steering revisions.

2.15 The manufacturer, who wishes to take advantage of this alternative procedure, is expected to demonstrate a sound engineering basis for his proposed approach. Such analysis would show that the predicted effects of the change(s) were incremental in nature and easily understood and well defined, confirming that additional flight test data were not required. In the event that the predicted effects were not deemed to be sufficiently accurate, it might be necessary to collect a limited set of flight test data to validate the predicted increments.

2.16 Any applications for this procedure will be reviewed by CARC team.

AC to JCAR-FSTD A.035
FFS Approved or Qualified before 1July 2012
See JCAR–FSTD A.035

1 **Introduction.**

1.1 Under previous JCARs rules, FFS may have gained credits in accordance with primary reference documents, which state appropriate technical criteria.

1.2 Reserved.

1.3 It is intended that FFS devices should continue to maintain their Qualification Level and or approval granted prior to the adoption of JCAR–FSTD A in accordance with previous JCARs criteria for the specified period.

2 **Re-categorization.**

These Devices may be of a standard that permits them to be re-categorized as if they were FFS presented for initial qualification.

3 **Equivalent categories AG, BG, CG, DG.**

3.1 FFS that are not re-categorized and that do have an acceptable primary reference document used for their original qualification or approval will gain CARC qualification based upon their original technical Qualification Level or credits which are equivalent to those described in Appendix 1 to JCAR–FSTD A.030. The equivalent qualification will relate to permitted maneuvers in the original qualification or approval document providing that these older FFS continue to meet the original JCAR criteria when evaluated by CARC.

3.2 The letter G will be added to each originally issued Qualification Level to show that the existing Qualification Level deserves its credit under the grandfather right provisions. To comply with the rule, the primary reference document should have meaningful validation, functions and subjective tests criteria, which reasonably cover the performance envelope of the FFS, and in particular the maneuvers for which the equivalent JCAR-FSTD A Qualification Level is given. The minimum acceptable standard is FAA AC 120-40A or equivalent.

4 **Original qualification.**

4.1 FFS that are not re-categorized and that do not have an acceptable primary reference document may continue to enjoy credits for an agreed list of training, testing and checking maneuvers, provided they maintain their performance in accordance with any validation, functions and subjective tests which have been previously established or a list of tests selected from AC No 1 to JCAR-FSTD A.030 by agreement with CARC. Again the tests should relate to the list of maneuvers permitted under the original qualification or approval document.

4.2 The award of credits to an FFS user should be at the discretion of CARC. Current FFS users may retain the credits granted under the previous JCAR criteria.

5 **Grandfather rights summary.**

The following table summarizes the arrangements for FFS approved or qualification and which are not re-categorized:

Primary Reference Document available	CARC equivalent qualification level	Performance criteria
Yes	AG Maximum training, BG testing and checking CG Credits similar DG to A, B, C, D	Perform to the original national validation functions and subjective tests from reference doc.
No	Special Categories Unique list of maneuvers	Original validation, functions and subjective tests or a list of tests selected from AC No 1 to JCAR-FSTD A.030 (by agreement)

AC to JCAR-FSTD A.036
Flight Training Devices Approval or Qualification

See JCAR–FSTD A.036

1 **Introduction.**

1.1 Under previous JCARs rules, FTDs may have gained credits in accordance with primary reference documents which state appropriate technical criteria.

1.2 Reserved.

1.3 It is intended that FTDs should continue to maintain their Qualification Level and or approval granted prior to the adoption of JCAR–FSTD A in accordance with previous JCARs criteria for the specified period.

2 **Re-categorization.**

These Devices may be of a standard which permits them to be re-categorized as if they were FTDs presented for initial qualification.

3 **Original qualification.**

3.1 FTDs that are not re-categorized and that do not have an acceptable primary reference document may continue to enjoy credits for an agreed list of training, testing and checking maneuvers, provided they maintain their performance in accordance with any validation, functions and subjective tests which have been previously established or a list of tests selected from

AC No 1 to JCAR-FSTD A.030 by agreement with CARC. Again these tests should relate to the list of maneuvers permitted under the original qualification or approval document.

3.2 The award of credits to an FTD user should be at the discretion of CARC. Current FTD users may retain the credits granted under the previous JCARs criteria.

AC to JCAR-FSTD A.037
FNPT Approved or Qualification
See JCAR–FSTD A.037

1 **Introduction.**

1.1 Under previous JCAR Rules, Devices or FNPTs may have gained credits in accordance with primary reference documents which state appropriate technical criteria.

1.2 Reserved.

1.3 It is intended that Devices or FNPTs should continue to maintain their Qualification Level and or Approval in accordance with previous JCARs Criteria for the specified period.

2 **Re categorization.**

2.1 These Devices may be of a standard which permits them to be re categorized as if they were FNPTs presented for initial qualification.

3 **Original qualification.**

3.1 FNPTs that are not re categorized may continue to enjoy credits for the period specified for an agreed list of training, testing and checking maneuvers, provided they maintain their performance in accordance with any Validation, Functions and Subjective Tests which have been previously established or a list of tests selected from AC No 1 to JCAR-FSTD A.030 by agreement with CARC. Again these tests should relate to the list of maneuvers permitted under the original qualification or approval document.

3.2 The award of credits to an FTD user should be at the discretion of CARC. Current FTD users may retain the credits granted under the previous JCARs criteria.

AC to JCAR-FSTD A.045 (explanatory material)
New Aircraft FFS/FTD Qualification – Additional Information
See JCAR–FSTD A.045

1 It is usual that aircraft manufacturer's approved final data for performance, handling qualities, systems or avionics will not be available until well after a new or derivative aircraft has entered service. It is often necessary to begin flight crew training and certification several months prior to the entry of the first aircraft into service and consequently it may be necessary to use aircraft manufacturer-provided preliminary data for interim qualification of FSTDs.

2 In recognition of the sequence of events that should occur and the time required for final data to become available, CARC may accept certain partially validated preliminary aircraft and systems data, and early release ('red label') avionics in order to permit the necessary program schedule for training, certification and service introduction.

3 FSTD operators seeking qualification based on preliminary data should, however, consult CARC as soon as it is known that special arrangements will be necessary or as soon as it is clear that the preliminary data will need to be used for FSTD qualification. Aircraft and FSTD manufacturers should also be made aware of the needs and be agreed party to the data plan and FSTD qualification plan. The plan should include periodic meetings to keep the interested parties informed of project status.

4 The precise procedure to be followed to gain CARC acceptance of preliminary data will vary from case to case and between aircraft manufacturers. Each aircraft manufacturer's new aircraft development and test program is designed to suit the needs of the particular project and may not contain the same events or sequence of events as another manufacturer's program or even the same manufacturer's program for a different aircraft. Hence, there cannot be a prescribed invariable procedure for acceptance of preliminary data, but instead there should be a statement describing the final sequence of events, data sources, and validation procedures agreed by the FSTD operator, the aircraft manufacturer, the FSTD manufacturer, and CARC.

NOTE: A description of aircraft manufacturer-provided data needed for flight simulator modeling and validation is to be found in the IATA Document ‘Flight Simulator Design and Performance Data Requirements’ – (Edition 6 2000 or as amended).

5 There should be assurance that the preliminary data are the manufacturer’s best representation of the aircraft and reasonable certainty that final data will not deviate to a large degree from these preliminary, but refined, estimates. Data derived from these predictive or preliminary techniques should be validated by available sources including, at least, the following:

(a) Manufacturer’s engineering report. Such report will explain the predictive method used and illustrating past success of the method on similar projects. For example, the manufacturer could show the application of the method to an earlier aircraft model or predict the characteristics of an earlier model and compare the results to final data for that model.

(b) Early flight tests results. Such data will often be derived from aircraft certification tests, and should be used to maximum advantage for early FSTD validation. Certain critical tests, which would normally be done early in the aircraft certification program, should be included to validate essential pilot training and certification maneuvers. These include cases in which a pilot is expected to cope with an aircraft failure mode including engine failures. The early data available will, however, depend on the aircraft manufacturer’s flight test program design and may not be the same in each case. However it is expected that the flight test program of the aircraft manufacturer include provisions for generation of very early flight tests results for FSTD validation.

6 The use of preliminary data is not indefinite. The aircraft manufacturer’s final data should be available within 6 months after aircraft first ‘service entry’ or as agreed by CARC, the FSTD operator and the aircraft manufacturer, but usually not later than 1 year. In applying for an interim qualification, using preliminary data, the FSTD operator and CARC should agree upon the update program. This will normally specify that the final data update will be installed in the FSTD within a period of 6 months following the final data release unless special conditions exist and a different schedule agreed. The FSTD performance and handling validation would then be based

on data derived from flight test. Initial aircraft systems data should be updated after engineering tests. Final aircraft systems data should also be used for FSTD programming and validation.

7 FSTD avionics should stay essentially in step with aircraft avionics (hardware & software) updates. The permitted time lapse between aircraft and FSTD updates is not a fixed time but should be minimal. It may depend on the magnitude of the update and whether the QTG and pilot training and certification are affected. Permitted differences in aircraft and FSTD avionics versions and the resulting effects on FSTD qualification should be agreed between the FSTD operator and CARC. Consultation with the FSTD manufacturer is desirable throughout the agreement of the qualification process.

8 The following describes an example of the design data and sources which might be used in the development of an interim qualification plan.

(a) The plan should consist of the development of a QTG based upon a mix of flight test and engineering simulation data. For data collected from specific aircraft flight tests or other flights the required designed model and data changes necessary to support an acceptable Proof of Match (POM) should be generated by the aircraft manufacturer.

(b) In order that the two sets of data are properly validated, the aircraft manufacturer should compare their simulation model responses against the flight test data, when driven by the same control inputs and subjected to the same atmospheric conditions as were recorded in the flight test. The model responses should result from a simulation where the following systems are run in an integrated fashion and are consistent with the design data released to the FSTD manufacturer:

(1) Propulsion.
(2) Aerodynamics.
(3) Mass properties.
(4) Flight controls.
(5) Stability augmentation.
(6) Brakes and landing gear.

9 For the qualification of FSTD of new aircraft types, it may be beneficial that the services of a suitably qualified test pilot are used for the purpose of assessing handling qualities and performance evaluation.

NOTE: The Proof of Match should meet the relevant AC No. 1 to JCAR-FSTD A.030 tolerances.

AC No.1 FSTD(A).050 Guidance on upset, stall (including in icing conditions), and qualification of FSTDs

1. Flight Simulation Training Device Standards table of Appendix 1 to FSTD(A).030

1.1 General, h.3:

(1) a suitably qualified pilot should:

(a) hold a type rating qualification for the aeroplane being simulated; and

(b) be familiar with the upset scenarios and associated recovery methods as well as the cues necessary to accomplish the required training objectives;

(2) the statement of compliance (SOC) should also confirm that for each upset scenario, the recovery maneuver can be performed such that the FSTD does not exceed the FSTD training envelope, or when the envelope is exceeded, that the FSTD is within the realms of confidence in the simulation accuracy;

(3) the unrealistic degradation of the FSTD functionality (such as degrading flight control effectiveness) to drive an aeroplane upset is not acceptable unless used purely as a tool for repositioning the FSTD with the pilot out of the loop; and

(4) consideration should be given to flight-envelope-protected aeroplanes as artificially positioning the aeroplane to a specified attitude may incorrectly initialize flight control laws.

1.2 General, s.1:

(1) the FSTD should be evaluated for specific upset recovery maneuvers; a minimum set of maneuvers:

(a) a nose-high wings level aeroplane upset;

(b) a nose-low airplane upset; and

(c) a high bank angle aeroplane upset;

(2) other upset recovery scenarios, as developed by the FSTD operator, should be evaluated in the same manner; and

(3) these evaluations should be made available to the instructor/evaluator.

1.3 General, s.2:

(1) for continuity purposes, the model should remain useable beyond the FSTD
training envelope to the extent to allow completion of the recovery training; and

(2) where known limitations exist in the aerodynamic model for particular stall event maneuvers (such as aeroplane configuration, approach-to-stall entry methods, and limited range for continuity of the modelling), these limitations should be declared in the required SOC.

1.4 General, s.3:

(1) the aerodynamic stall modelling should include degradation of the static/dynamic lateral directional stability;

(2) degradation in control response (pitch, roll, and yaw);

(3) un commanded roll response or roll-off requiring significant control deflection to counter;

(4) apparent randomness or non-repeatability;

(5) changes in pitch stability;

(6) Mach effects; and

(7) stall buffet, as appropriate to the aeroplane type;

(8) as appropriate to the aeroplane type, the model should be capable of capturing the variations seen in the stall characteristics of the aeroplane (e.g. the presence or absence of a pitch break, deterrent buffet, or other indications of a stall where present on the aeroplane);

(9) where known limitations exist in the aerodynamic model for particular stall maneuvers (such as aeroplane configuration and stall-entry methods), these limitations must be declared in the required SOC;

(10) specific guidance should be available to the instructor which clearly communicates the flight configurations and stall maneuvers that have been evaluated in the FSTD for use in training; and
(11) FSTDs that are to be qualified for full stall training tasks must also meet the instructor operating station (lOS) provisions for upset prevention and recovery training (UPRT) tasks as described under ‘1. General, h.2’ of the FSTD Standards table.

2. FSTD validation tests
   2.1 Stall characteristics test:
   (1) Control inputs must be plotted and demonstrate correct trend and magnitude.
   (2) Each of the following stall entries must be demonstrated in at least one of the three flight conditions (please refer to Table of FSTD Validation Test, 8(a)):
   (a) stall entry at wings level (1g);
   (b) stall entry in turning flight of at least 25° bank angle (accelerated stall); and
   (c) stall entry in a power-on condition (required only for propeller-driven aeroplanes).
   (3) The cruise flight condition must be conducted in a flaps-up (clean) configuration. The second-segment climb flight condition must use a different flap setting than for the approach or landing flight condition.
   (4) The stall warning signal and initial buffet, if applicable, must be recorded. Time - history data must be recorded for a full stall through recovery to normal flight. The stall warning signal must occur in the proper relation to buffet/stall. FSTDs of aeroplanes exhibiting a sudden pitch attitude change or ‘g break’ must demonstrate this characteristic. FSTDs of aeroplanes exhibiting a roll-off or loss-of-roll control authority must demonstrate this characteristic.
   (5) Numerical tolerances are not applicable past the stall angle of attack, but must demonstrate correct trend through recovery. Please refer to AC No.2 FSTD(A).050 for additional information concerning data sources and required angle of attack ranges.
   (6) For aeroplanes with stall envelope protection systems, the normal -mode testing is only required at an angle of attack range necessary to demonstrate the correct operation of the system. These tests may be used to satisfy the required (angle of attack) flight maneuver and envelope protection tests of Appendix 1 to AC No.1 to JCAR-FSTDA.030. Non-normal control states must be tested through stall identification and recovery.
   (7) In instances where flight test validation data is limited due to safety-of-flight considerations, engineering simulator validation data may be used in lieu of flight test validation data for angles of attack that exceed the activation of a stall protection system or stick pusher system.
   (8) Buffet threshold of perception should be based on 0.03 g peak to peak normal acceleration above the background noise at the pilot seat. Initial buffet to be based on normal acceleration at the pilot seat with a larger peak to peak value relative to buffet threshold of perception (some airframe manufacturers have used 0.1 g peak to peak). Demonstrate correct trend in growth of buffet amplitude from initial buffet to stall speed for normal and lateral acceleration.
   (9) The maximum buffet may be limited based on motion platform capability/limitations or other simulator system limitations. If the maximum buffet is limited, the limit should be sufficient to allow proper use in training (e.g. not less than 0.5 g peak to peak), and in any case the instructor should be informed of the limitations.
   (10) Tests may be conducted at centers of gravity (CG) and weights typically required for aeroplane certification stall testing.
   (11) This test is only for FSTDs that are to be qualified to conduct full stall training tasks.

(12) Where approved engineering simulation validation is used, the reduced engineering tolerances (as defined in Appendix 1 to AC No. 1 to JCAR-FSTD A.030(2) (interpretative material) Validation Test Tolerances do not apply.

2.2 Approach-to-stall characteristics test:

(1) Control displacements and flight control surfaces must be plotted and demonstrate correct trend and magnitude.

(2) Each of the following stall entries must be demonstrated in at least one of the three flight conditions (please refer to AC No. 1 to JCAR-FSTD A.030 Table of FSTD Validation Test, (2.3).

(a) approach-to-stall entry at wings level (1g);

(b) approach-to-stall entry in turning flight of at least 25° bank angle (accelerated stall); and

(c) approach-to-stall entry in a power-on condition (required only for propeller-driven aeroplanes).

(3) The cruise flight condition must be conducted in a flaps-up (clean) configuration. The second-segment climb flight condition must use a different flap setting than for the approach or landing flight condition.

(4) For computer-controlled aeroplanes (CCAs) with stall envelope protection systems, the normal-mode testing is only required at an angle of attack range necessary to demonstrate the correct operation of the system. These tests may be used to satisfy the required (angle of attack) flight maneuver and envelope protection tests of AC No. 1 to JCAR-FSTD A.030 (h).

2.3 Engine and airframe icing effects demonstration (high angle of attack):

(1) Time history of a full stall and of the initiation of the recovery: tests are intended to demonstrate representative aerodynamic effects caused by in-flight ice accretion. Flight test validation data is not required.

(2) Two tests are required, to demonstrate engine and airframe icing effects. One test demonstrates the FSTDs baseline performance without ice accretion, and the second test demonstrates the aerodynamic effects of ice accretion relative to the baseline test.

(3) The test must utilize the icing model(s) as described in the SOC required in Appendix 1 to AC No.4 to FSTD A.050.t.(1). The test must include a rationale that describes the icing effects being demonstrated. Icing effects may include, but are not limited to, the following effects, as applicable to the particular aeroplane type:

(a) decrease in the stall angle of attack;

(b) changes in the pitching moment;

(c) decrease in control effectiveness;

(d) changes in control forces;

(e) increase in drag;

(f) change in stall buffet characteristics and threshold of perception; and

(g) engine effects (power reduction/variation, vibration, etc. where expected to in the ice accretion scenario being tested).

(4) Tests are evaluated for representative effects on relevant aerodynamic and other parameters, such as angle of attack, control inputs, and thrust/power settings.

Recorded parameters (in the validation test result) should include the following:

(a) altitude;

(b) airspeed;

(c) normal acceleration;

(d) engine power;

(e) angle of attack;

(f) pitch attitude;

(g) bank angle;
(h) flight control inputs; and
(i) stall warning and stall buffet onset.

AC No.2 FSTD (A).050 Guidance on high angle of attack/stall model evaluation

1. This AC applies to all FSTDs that are used to satisfy training provisions for stall manoeuvres conducted at angles of attack beyond the activation of the stall warning system. This AC is not applicable to FSTDs that are only qualified for approach-to-stall manoeuvres where recovery is initiated at the first indication of the stall. This AC supplements the following:

(a) Appendix 1 to AC No.2 to JCAR-FSTD A.030(A)'Flight Simulation Training Device Standards';

(b) AC No.1 to JCAR-FSTD A.030 (8)(a)'Table of FSTD Validation Tests'; and

(c) AC No.1 to JCAR-FSTD A.030 (3) 'Functions and subjective tests'.

2. General provisions

The provisions for high angle of attack modelling should be applied to evaluate the recognition cues as well as performance and handling qualities of a developing stall through the stall identification angle of attack and stall recovery. Strict time-history-based evaluations against flight test data may not adequately validate the aerodynamic model in an unsteady and potentially unstable flight regime, such as stalled flight. As a result, the objective testing provisions of AC No. 1 to JCAR-FSTD A.030 do not contain strict tolerances for any parameter at angles of attack beyond the stall identification angle of attack. In lieu of mandating such objective tolerances, an SOC should define the source data and methods used to develop the aerodynamic stall model.

3. Fidelity provisions

The provisions for the evaluation of full stall training manoeuvres should provide the following levels of fidelity:

(a) aeroplane-type-specific recognition cues of the first indication of the stall (such as the stall warning system or aerodynamic stall buffet);

(b) aeroplane-type-specific recognition cues of an impending aerodynamic stall; and

(c) recognition cues and handling qualities from stall break through recovery which are sufficiently representative of the aeroplane being simulated to allow successful completion of the stall recovery training tasks.

For the purposes of stall manoeuvre evaluation, the term 'representative' is defined as a level of fidelity that is type-specific of the simulated aeroplane to the extent that the training objectives can be satisfactorily accomplished. Therefore, the term 'representative' in this AC is specifically limited to the characteristics of the aerodynamic model in the post-stall region. The description of this term is given to explain the intent of the model rather than defining the meaning of the term 'representative modelling' which may be described in other simulator definitions.

4. SOC (aerodynamic model) At a minimum, the following must be addressed in the SOC:

(a) Source data and modelling methods

The SOC must identify the sources of data used to develop the aerodynamic model. These data sources may be from the aeroplane original equipment manufacturer (OEM), the original FSTD manufacturer/data provider, or other data providers acceptable to the competent authority. Of particular interest is a mapping of test points in the form of an alpha/beta envelope plot for a minimum of flaps-up and flaps-down aeroplane configurations. For the flight test data, a list of the types of manoeuvres used to define the aerodynamic model for angle of attack ranges greater than the first indication of stall must be provided per flap setting. Flight test reports, when available, describing stall characteristics of the aeroplane type being modelled, issued by the OEM or flight test pilot, can be referred to. In cases where it is impractical to develop and validate a stall model with flight-test data (e.g. due to safety concerns involving the collection of flight-test data past a certain angle of attack), the data provider is expected to make a reasonable attempt to develop a stall model through the required angle of attack range using analytical methods and empirical data (e.g. wind-tunnel data).

(b) Validity range .

The FSTD operator should declare the range of angle of attack and sideslip where the aerodynamic model remains valid for training. Satisfactory aerodynamic model fidelity must be shown through stall recovery training tasks. For the purposes of determining this validity range, the stall identification angle of attack is defined as the angle of attack where the pilot is given a clear and distinctive indication to cease any further increase in the angle of attack where one or more of the following characteristics occur:

(1) no further increase in pitch occurs when the pitch control is held at the full aft stop for two seconds, leading to an inability to arrest the descent rate;

(2) an un commanded nose-down pitch that cannot be readily arrested, which may be accompanied by an un commanded rolling motion;

(3) buffeting of a magnitude and severity that is a strong and effective deterrent to a further increase in the angle of attack;

(4) activation of a stick pusher.

For the validity range, the modelling continuity should allow for an angle of attack range that is adequate to allow for the completion of stall recovery; for pusher-equipped aeroplanes, this should be adequate to capture any inappropriate action during the recovery procedure. For aeroplanes equipped with a stall envelope protection system, the model should allow training with the protection systems disabled or otherwise degraded (such as a degraded flight control mode as a result of a pitot/static system failure).

(c) Model characteristics.

Within the declared model validity range, the SOC must address, and the aerodynamic model must incorporate, the following stall characteristics, where applicable by aeroplane type:

(1) degradation of the static/dynamic lateral-directional stability

(2) degradation in control response (pitch, roll, and yaw);

(3) un commanded roll acceleration or roll-off requiring significant control deflection to counter;

(4) apparent randomness or non-repeatability;

(5) changes in pitch stability;

(6) stall hysteresis;

(7) Mach effects;

(8) stall buffet; and

(9) angle of attack rate effects.

An overview of the methodology used to address these features must be provided.

5. SOC (subject-matter expert (SME) pilot's evaluation)

The operator must provide an SOC confirming that the simulation stall model has been subjectively evaluated by an SME pilot knowledgeable of the aeroplane's stall characteristics (please refer to 4 (1) above).

The operator is also required to provide a SOC to state that the simulation stall model, as defined above, has been implemented and verifies that the aerodynamic stall training tasks can be accomplished on the FSTD.

The purpose is to ensure that the stall model has been sufficiently evaluated using those general aeroplane configurations and stall-entry methods that will likely be conducted in training.

In order to qualify as an acceptable SME to evaluate the stall model characteristics, the SME must meet the following criteria:

(1) has held or currently holds a type rating/qualification in the aeroplane being simulated;

(2) has direct experience in conducting stall manoeuvres in an aeroplane that shares the same type rating as the make, model, and series of the simulated aeroplane; this stall experience must include hands-on manipulation of the controls at angles of attack sufficient to identify the stall (e.g. deterrent buffet, stick pusher activation, etc.) through recovery to stable flight;

(3) where the SME's stall experience is in an aeroplane of a different make, model, and series within the same type rating, differences in aeroplane-specific stall recognition cues and handling characteristics must be addressed using available documentation; this documentation may include aeroplane operating manuals (OMs), aeroplane manufacturer flight test reports, or other documentation that describes the stall characteristics of the aeroplane; and

(4) be familiar with the intended stall training manoeuvres to be conducted in the FSTD (e.g. general aeroplane configurations, stall-entry methods, etc.) and the cues necessary to accomplish the required training objectives.

This SOC will only be required at the time the FSTD is initially qualified for stall training tasks as long as the FSTD's stall model remains unmodified compared to what was originally evaluated and qualified. Where an FSTD shares common aerodynamic and flight control models with those of an engineering or development simulator, the competent authority will accept an SOC from the aeroplane manufacturer or data provider confirming that the stall characteristics have been subjectively assessed by an SME pilot on the engineering/development simulator (refer to AC No.1 to FSTD(A).005 and AC No. 2 to JCAR-FSTD A.030(c)for the description of an engineering/development simulator).

An FSTD operator may submit a request to the competent authority for approval of a deviation from the SME pilot's experience provisions under this paragraph. This request for deviation must include the following information:

(a) an assessment of pilot availability demonstrating that a subject-matter expert pilot, meeting the experience described in AC No.2 FSTD(A).050 (5), is not available; and

(b) alternative methods to subjectively evaluate the FSTD's capability to provide the stall recognition cues and handling characteristics needed to accomplish the training objectives.

6. SOC(subjective tests) Test provisions

The necessity of subjective tests arises from the need to confirm that the simulation model has been integrated correctly and performs as declared under (4) above. It is vital to examine, for example, that the simulation validity range allows modelling continuity that is adequate to allow for the completion of stall recovery.

Considerations on aeroplane certification flight test provisions. In aeroplane certification flight tests, there is no provision to go beyond the maximum coefficient of lift (CL max), and the aeroplane is not to be held indefinitely in a full stall condition, so this provision should be applied in the same way during the simulator's subjective evaluation.

The subjective tests of the simulation model should assess modelling continuity when slightly increasing the angle of attack beyond the validity range defined in paragraph 4 (2) of this section CL max.

The increase in angle of attack beyond the validity range CL max should be limited to a value not greater than the maximum angle achieved two seconds after stall recognition, which is sufficient to allow a proper recovery manoeuvre.

Stall recognition is defined as follows:

(1) no further increase in pitch occurs when the pitch control is held at the full aft stop for two seconds, leading to an inability to arrest the descent rate;

(2) an un commanded nose-down pitch that cannot be readily arrested, which may be accompanied by an un commanded rolling motion;

(3) buffeting of a magnitude and severity that is a strong and effective deterrent to a further increase in the angle of attack; and

(4) activation of a stick pusher.

Where known limitations exist in the aerodynamic model for particular stall event manoeuvres (such as aeroplane configuration, approach-to-stall entry methods, and limited range for continuity of the modelling), these limitations must be declared in the required SOC.

AC No.3 A FSTD(A).050 Guidance on upset prevention and recovery training (UPRT) for the FSTD Standards table

1. Background

1.1 This AC provides guidance on Appendix 1 to AC No.3 FSTD(A).050, namely on the following:

(1) General:

(a) h.2 (IOS tools);
(b) h.3 (upset scenarios); and
(c) s.1 (aerodynamics); and

(2) Motion system, a.1.

1.2 This AC applies to all FTSDs that are used to satisfy training provisions for UPRT manoeuvres. For the purposes of this AC, an aeroplane upset (as defined in the ICAO Airplane Upset Prevention & Recovery Training Aid (AUPRTA) Rev 3, February 2017) is an undesired aeroplane state characterised by unintentional deviations from parameters experienced during normal operations. An aeroplane upset may involve pitch and/or bank angle deviations as well as inappropriate airspeeds for the given conditions.

1.3 FSTDs that are used to conduct training manoeuvres where the FSTD is repositioned either into an aeroplane upset condition or an artificial stimulus (such as weather phenomena or system failures) that is intended to result in a flight crew entering an aeroplane upset condition, must be evaluated and qualified.

2. FSTD Standards provisions

2.1 The provisions of Appendix 1 to AC No.3 FSTD(A).050 define three basic elements that are required for qualifying an FSTD for UPRT manoeuvres:

(1) FSTD training envelope: see definition in AC No.1 FSTD(A).005 ;

(2) Instructor feedback: provides the instructor/evaluator with a minimum set of feedback tools to properly evaluate the trainee's performance in accomplishing a UPRT task; and
(3) Upset scenarios: where dynamic upset scenarios or aeroplane system malfunctions are used to drive the FSTD into an aeroplane upset condition, specific guidance must be available to the instructor, e.g. on the IOS or manual, which describes how the upset scenario is driven along with any malfunction or degradation in FSTD functionality required to stimulate the upset.

2.2 FSTD validation envelope
This envelope is defined by the following three subdivisions (see Appendix 3-D of the ICAO 'AUPRTA').
(1) Flight-test-validated region
This is the region of the flight envelope which has been validated with flight test data, typically by comparing the performance of the FSTD against these flight test data through tests incorporated in the QTG and other flight test data utilised to further extend the model beyond the minimum provisions.

Within this region, there is high confidence that the FSTD responds similarly to the aeroplane. Please note that this region is not strictly limited to what has been tested in the QTG; as long as the aerodynamics mathematical model has been conformed to the flight test results, that portion of the mathematical model is considered to be within the flight-test-validated region.

(2) Wind tunnel and/or analytical region

This is the region of the flight envelope for which there has been wind tunnel testing or the use of other reliable predictive methods (typically by the aeroplane manufacturer) to define the aerodynamic model. Any extensions to the aerodynamic model which have been evaluated in accordance with the definition of a representative stall model (as described in ACNo.2 to FSTD(A).030) must be clearly indicated. Within this region, there is moderate confidence that the FSTD will respond in a similar way as the aeroplane.

(3) Extrapolated region

This is the region extrapolated beyond the flight -test-validated and wind-tunnel/analytical regions. The extrapolation may be a linear one, a holding of the last value before the extrapolation began, or some other set of values. Whether this extrapolated data is provided by the aeroplane or FSTD manufacturer, it is a 'best estimation' only. Within this region, there is low confidence that the FSTD will respond in a similar way as the aeroplane.

3. IOS feedback mechanism

3.1 For the instructor/evaluator to provide feedback to the student during the upset prevention and recovery manoeuvre training, additional information must be accessible which indicates the fidelity of the simulation, the magnitude of the trainee's flight control inputs, as well as the aeroplane operational limits that could potentially affect the successful completion of the manoeuvre(s). At a minimum, the following must be available to the instructor/evaluator:

(1) FSTD validation envelope

The FSTD must employ a method to display the FSTD's expected fidelity with respect to the FSTD validation envelope. This may be displayed as an angle of attack versus sideslip (alpha/beta) envelope cross-plot on the IOS or other alternative method to clearly convey the FSTD's fidelity level during the manoeuvre. The cross-plot or other alternative method must display the relevant validity regions for flaps-up and flaps-down at a minimum. This validation envelope must be derived by the aerodynamic data provider, or using information and data sources provided by the aerodynamic data provider.

(2) Flight control inputs

The FSTD must employ a method for the instructor/evaluator to assess the trainee's flight control inputs during the upset recovery manoeuvre. Additional parameters, such as cockpit control forces (forces applied by the pilot to the controls) and the flight control law mode for fly-by-wire aeroplanes, must be portrayed in this feedback mechanism as well. For passive side-sticks, whose displacement is the flight control input, the force applied by the pilot to the controls does not need to be displayed. This tool must include a time history or other equivalent method of recording flight control positions.

(3) Aeroplane operational limits

The FSTD must employ a method to provide the instructor/evaluator with real-time information concerning the aeroplane operational limits. The simulated aeroplane's parameters must be displayed dynamically in real - time and provided in a time history or equivalent format. At a minimum, the following parameters must be available to the instructor/evaluator:

(a) airspeed and airspeed limits, including the stall speed and maximum operating limit airspeed (VMO)/maximum operating Mach (MMO);

(b) load factor and operational load factor limits; and

(c) angle of attack and stall identification angle of attack (refer to AC No.2 JCAR-FSTD(A).050 4 (b) for additional information on the definition of the stall identification angle of attack); this parameter may be displayed in conjunction with the FSTD validation envelope.

3.2 Optionally, a recorded feedback mechanism is available to the instructor/evaluator.

AC No.3 B FSTD(A).050 Additional guidance on upset prevention and recovery training (UPRT) for the FSTD Standards table

1. Introduction

The FSTD should be provided with information pertaining to the aeroplane's parameters as described in AC No.3A JCAR-FSTD(A).050.This AC details some of the performance provisions for these features.

The objective of the IOS feedback during UPRT exercises is to provide the instructor with the ability to assess the timely and proper control action, including sequence, to complete the recovery in a safe manner.

2. Background

IOS feedback, which may also be via a separate mobile device, is used to monitor and debrief the crew regarding UPRT exercises in order to verify that proper control activity was executed. The instructor should have the necessary information to clearly establish whether the recovery was completed within the FSTD training envelope (please refer to AC No.3A FSTD(A).050), and take any necessary action to complete the training.

The FSTD should include tools for the instructor to be able to immediately debrief the pilot(s) after the training event. All data recorded for the use in the UPRT debrief should be easily permanently deleted after the UPRT training event.

3. IOS parameters

The tool should normally display:

(a) Pilot-induced control inputs, including:

(1) pitch,
(2) roll,
(3) rudder pedal,
(4) throttles,
(5) flaps, and
(6) speed brake/spoilers.

Time history of control inputs, including cockpit control forces and flight control law (fly-by-wire aeroplanes), as applicable.

In order to ascertain that the control inputs are applied in a correct, timely and smooth manner, the display should indicate these at a sampling frequency rate that is sufficiently high to prevent from missing possible abrupt pilot action. This may be limited to the debrief mode following the execution of the exercise or individual manoeuvre.

(b) Display of the primary flight parameters; if applicable, display a copy of the Primary Flight Display (PFD); if a PFD is displayed, then the parameters shall be the same as the ones displayed on the aeroplane PFD, including:

(1) pitch attitude,
(2) roll attitude,
(3) turn/sideslip,
(4) indicated airspeed,
(5) stall warning speed/stall buffet speed,
(6) VMO/MMO,
(7) altitude,
(8) rate of climb,
(9) autopilot status, and
(10) auto-throttle status.

(c) Angle of attack.
(d) Angle of sideslip.
(e) G-loading.

The limitations of (c), (d), and (e) shall also be indicated, as follows:
One method is the simultaneous depiction of the angle of attack versus angle of sideslip and the corresponding FSTD validation envelope.
A presentation of the G-loading as function of the current airspeed and flight configuration.
The V-n diagram indicates the limitations of the aeroplane under given conditions. It displays the flight envelope as function of the airspeed versus G-loading. It shows the lower airspeed limits by means of a parabolic line. The intersection of this line with the 1.0g horizontal line corresponds to the stall speed at 1g. The regions above the 2.5g upper limit (maximum design limit) to the right of VNE and below the – 1.0g lower limit are the structural exceedance limits and should be avoided. The shape of the V-n diagram depends on the aeroplane itself, its configuration, as well as the environmental and flight conditions.

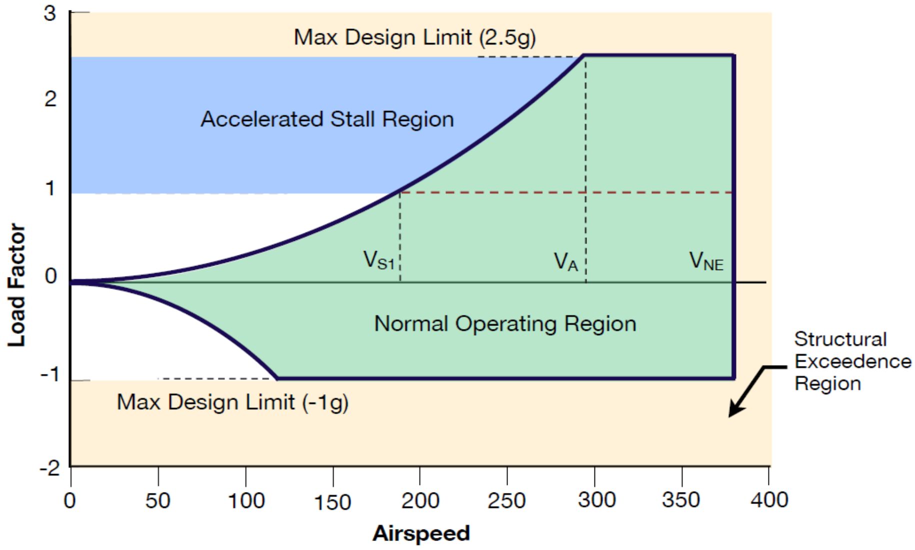

Figure 1 — V-n diagram (example)

Legend to Figure 1:

V_{S1} = clean stall speed at 1g

V_A = design manoeuvre speed

V_{NE} = never-exceed speed

AC No.4 to FSTD(A).050 Guidance material for engine and airframe icing evaluation provisions

1. Applicability

This AC applies to all FSTDs that are used to satisfy training provisions for engine and airframe icing. New general provisions as well as objective provisions for FSTD qualification have been developed in order to define aeroplane-specific icing models that support training objectives for the recognition of, and recovery from, an in-flight ice accretion event.

2. General provisions

The following elements should be considered when developing the qualified ice accretion models for use in FSTD training:

(a) icing models must be able to train the specific skills required for the recognition of ice accumulation and for generating the required response;

(b) icing models must contain aeroplane-specific recognition cues as determined through data supplied by an aeroplane original equipment manufacturer (OEM) or through other suitable analytical methods; and

(c) at least one qualified icing model must be objectively tested to demonstrate that it has been implemented correctly and that it generates the correct cues as necessary for training.

3. Statement of compliance (SOC)

The SOC described in Appendix 1to AC No.2 FSTD(A).050 must contain the following information to support FSTD qualification of aeroplane-specific icing models:

(a) A description of expected aeroplane-specific recognition cues and degradation effects due to a typical in-flight icing encounter.

Typical cues may include loss of lift, decrease in stall angle of attack, changes in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag. This description must be based on relevant data sources, such as aeroplane OEM-supplied data, accident/incident data, or other acceptable data sources. Where a particular airframe has demonstrated vulnerabilities to a specific type of ice accretion (due to accident/incident history), which requires specific training (such as super cooled large-droplet icing or tail plane icing), ice accretion models must be developed that address those training provisions.

(b) A description of the data sources used to develop the qualified ice accretion models. Acceptable data sources may be but are not limited to flight test data, aeroplane certification data, aeroplane OEM engineering simulation data, or other analytical methods based on established engineering principles.

4. Objective demonstration testing

The purpose of the objective demonstration test is to demonstrate that the ice accretion models, as described in the SOC, have been correctly implemented and demonstrate the proper cues and effects, as defined in the approved data sources. At least one ice accretion model must be selected for testing and included in the master

qualification test guide (MQTG). Two tests are required to demonstrate engine and airframe icing effects. One test
demonstrates the FSTD's baseline performance without icing, and the second test demonstrates the aerodynamic effects of ice accretion relative to the baseline test.

(a) Recorded parameters: in each of the two required MQTG cases, a time-history recording of the following parameters should be made:

(1) altitude;
(2) airspeed;
(3) normal acceleration;
(4) engine power/settings;
(5) angle of attack/pitch attitude;
(6) bank angle;
(7) pilot-induced flight control inputs;
(8) stall warning and stall buffet onset; and
(9) other parameters necessary to demonstrate the effects of ice accretion.

(b) Demonstration maneuver: the FSTD operator must select an ice accretion model, as identified in the SOC for testing. The selected maneuver must demonstrate the effects of ice accretion at high angles of attack from a trimmed condition through approach-to- stall and full stall (full stall is applicable only for those FSTDs that are to be qualified for full stall training tasks), as compared to a baseline (no ice build-up) test. The ice accretion models must demonstrate the cues necessary to recognize the onset of ice accretion on the airframe, lifting surfaces, and engines, and provide a representative degradation in performance and handling qualities to the extent that a recovery can be executed. Typical recognition cues that may be present, depending on the simulated aeroplane, include:

(1) decrease in stall angle of attack;
(2) increase in stall speed;
(3) increase in stall buffet threshold of perception speed;
(4) changes in pitching moment;
(5) changes in stall buffet characteristics;
(6) changes in control effectiveness or control forces; and
(7) engine effects (power variation, vibration, etc.).

The demonstration maneuver test may be conducted by initializing and maintaining a fixed amount of ice accretion throughout the maneuver in order to consistently evaluate the aerodynamic effects.