NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C. 20594

May 1, 2015

CXO Runway 1 Examination Test Plan

by John O'Callaghan

A. ACCIDENT

Location: Conroe, TX (Lone Star Executive Airport (CXO))
Date: September 19, 2014
Time: 08:47 Central Daylight Time (CDT)
(13:47 Universal Coordinated Time (UTC))[1]
Aircraft: Embraer EMB-505, N322QS
NTSB#: CEN14FA505

B. PARTICIPANTS

NTSB: John O'Callaghan
National Resource Specialist – Aircraft Performance
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Craig Hatch
Aerospace Engineer / Air Safety Investigator
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4760 Oakland Street, Suite 500
Denver, CO 80239

CXO Airport: Scott Smith
Airport Manager
Lone Star Executive Airport
10260 Carl Pickering Memorial Dr.,Conroe, TX 77303

[1] Local time at Conroe on the day of the accident was Central Daylight Time (CDT). CDT = UTC - 5 hours. Times in this *Test Plan* are in CDT unless otherwise noted.

IAH Airport:	James Knott Staff Analyst – Training Bush Intercontinental Airport (IAH) 2800 N Terminal Rd, Houston, TX 77032
FAA:	James Moore Houston Flight Standards District Office Principal Maintenance Inspector 12650 N. Featherwood, Suite 230, Houston, Texas 77034
Embraer:	Daniel Satoshi Marimoto Air Safety Engineer Embraer Air Safety Department 276 SW 34th St., Ft. Lauderdale, FL 33315 – USA
NetJets:	R. Brian Clark Director, Safety Management System NetJets® Aviation, Inc. 4111 Bridgeway Avenue, Columbus, OH 43219
NJASAP:	CA Bob Ferguson Safety Committee/ Industry Affairs NetJets Association of Shared Aircraft Pilots (NJASAP) 630 Morrison Road, Suite 110, Gahanna, Ohio 43230

C. HISTORY OF FLIGHT

On September 19, 2014, about 08:47 central daylight time, an Embraer EMB-505 airplane, N322QS, encountered soft terrain and mud after over running the runway while landing at the Lone Star Executive Airport (CXO), Conroe, Texas. Neither of the airline transport rated pilots on board were injured. The airplane was substantially damaged. The airplane was operated by Net Jets as a 14 Code of Federal Regulations Part 91 positioning flight. Instrument meteorological conditions prevailed for the flight, which was operated on an instrument flight rules flight plan. The flight originated from the Nashville International Airport (BNA), Nashville, Tennessee, at 07:10.

According to the air traffic controller who witnessed the accident, the pilots flew the area navigation (RNAV) runway 1 approach and broke out of the clouds at the minimums for the approach. The controller stated the airplane touched down just past the 1,000 foot marker on the runway and did not appear to decelerate as it continued down the runway. The airplane traveled off the departure end of the runway and continued about 400 feet through soft/muddy terrain before coming to rest half way down a ditch. The controller stated there was moderate to heavy rain at the time of the accident.

The role of the Aircraft Performance Specialist in the investigation is to determine and analyze the motion of the airplane and the physical forces that produce that motion. In particular, the Specialist attempts to define the airplane’s position and orientation during the relevant portion of the flight, and determine the airplane’s response to control inputs, external disturbances, ground forces, and other factors that could affect its trajectory.

The data used to determine and analyze the airplane motion includes but is not limited to the following:

- Wreckage location and condition.
- Ground scars / markings.
- Airport Surveillance Radar (ASR) data.
- Flight Data Recorder (FDR) data.
- Cockpit Voice Recorder (CVR) information.
- Runway macrotexture, cross-slope, and friction measurement information.
- Weather information.
- Airplane thrust and aerodynamic performance information.
- Output from computer programs and simulations that calculate aircraft performance.

This *Test Plan* describes the objectives of and methods for an examination of runway 1 at CXO, including the data to be gathered, the equipment required, and the test procedures.

D. DETAILS OF THE TEST

I. Test Objectives

The objectives of the test are to:

1. Measure the runway 1 macrotexture depth at 40 locations, as defined below.
2. Measure the runway 1 cross-slope at those same 40 locations.
3. Measure the runway friction along the length of runway 1 using the NAC DFT trailer provided and operated by IAH personnel, at 4 different speeds and at 4 different distances from the runway centerline, as defined below.
4. Use the measured DFT data to compute the wet runway braking coefficient as a function of ground speed for the EMB-505 airplane, using a method developed by NASA Langley (see Appendix B).
5. Use the measured macrotexture and cross-slope data to compute the expected water depth on the runway as a function of rainfall rate, per a drainage model developed by the Texas Transportation Institute (TTI).[2]
6. Examine the runway 1 edges for vegetation or other obstructions that would prevent proper water drainage from the runway.

II. Test Location and Date

The test is scheduled for Tuesday, May 5, 2015, on runway 1 at CXO. The street address of CXO is:

Lone Star Executive Airport
10260 Carl Pickering Memorial Dr.,Conroe, TX 77303

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[2] B. Gallaway, R. Schiller, Jr., and J. Rose, *The Effects of Rainfall Intensity, Pavement Cross Slope, Surface Texture, and Drainage Length on Pavement Water Depths*. Texas Transportation Institute (TTI) Research Report 138-5, May 1971.

The test team should meet at the CXO airport offices at 8:00 CDT to brief the test plan for the day.

If weather forecasts preclude testing on that day, the test will be postponed.

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III. Test Equipment

- Geo7x survey GPS
- Measuring wheel for measuring off runway distances
- 250 ft. tape measure
- Chalkte
- Level (3 ft. or 6 ft.)
- Digital inclinometer
- ELAtextur macrotexture scanner
- Newbert Aero Corporation Dynamic Friction Tester (NAC DFT) Continuous Friction Measurement Equipment (CFME) trailer and truck
- Data log – macrotexture and cross slope measurements
- Run matrix and log – NAC DFT measurements
- Video / still camera (e.g., iPhone)

IV. Safety Equipment

- VHF radio for ATC Tower communications, for each of two teams (described below), operated by CXO personnel
- Visibility vest
- Whistle for signaling personnel on the runway

V. Test Teams

The tests will be conducted by two teams, working independently:

- The “DFT team”: operates the DFT CFME truck and trailer.
- The “Macrotexture” team: conducts the macrotexture and cross-slope measurements at discrete points on the runway; examines runway edge.

For simplicity and safety reasons, only one team will be working on the runway at a time. The DFT team will do its work first, so as to release the DFT vehicle as soon as possible. The sequence of runs and test points for each team is prioritized as shown in Appendix C.

VI. Runway 1-19 closure and coordination with the ATC Tower

Runway 1-19 will be NOTAM'd "closed" prior to the test, and will remain closed during the duration of the test. The CXO person assigned to each test team will monitor the VHF radio and communicate as required with the ATC tower and the other team, and advise when the team should clear runway 1 and / or remain clear of the 250 ft. safety zone on either side of the centerline of intersecting runway 14-32.[3] Any presence of the teams inside the safety zone must be coordinated with the ATC tower through the CXO team member.

While the Macrotexture team is on the runway, the CXO team member will be in possession of a whistle. If this person determines that the team must clear the runway immediately, he will blow three blasts on the whistle. Upon hearing the whistle, team members will exit the runway immediately. If he blows one long blast, the team will assemble at his location.

VII. Test Procedure: NAC DFT friction runs

1. Set up the DFT per IAH's normal operating procedures / checklists.

2. Measure and record the friction tire's inflation pressure at the start of the day, at water refills, and at the end of the day. Adjust inflation pressure as necessary to maintain a constant value throughout the tests.

3. Conduct friction test runs in one direction only: starting from the threshold of runway 1, and testing towards the threshold of runway 19. Drive back to the runway 1 threshold to start a new run.

4. Conduct runs at the matrix of speeds and runway "y" coordinates shown in the "CFME runs" sheet of the "KXCO_RWY1_measurements.xls" *Excel* spreadsheet. Number the runs consecutively, and note the run number in the appropriate cell of the matrix. Note the time of the start of the run, and any other identifying information, in the "Run Log" section of the spreadsheet, so that the data recorded by the DFT can be associated with the correct run number later.

   The "PLANNED" matrix shows the suggested order of runs, sequenced so as to obtain the high-priority runs first. Note that runs 13, 14, 19, & 20 are repeat runs. Log the actual conduct of the runs in the "ACTUAL" matrix.

   The runway coordinates originate at the threshold of runway 1 on the centerline. The +x coordinate runs down the runway towards the threshold of runway 19. The +y coordinate runs towards the right edge of the runway. Note that the test y coordinates are not centered about the centerline, but are biased toward the left side of the runway. This is to reflect the actual track of N322QS as evidenced by the skid marks left by the airplane.

   Set up the Geo7x to record a "generic line" feature during each run, logging GPS coordinates at regular time intervals. These coordinates can then be later used to compare the actual track of the DFT to the planned track.

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[3] Runway 14-32 intersects runway 1-19 about 4170 ft. from the runway 1 threshold (see diagram in Appendix A).

In addition to the driver, the DFT tow vehicle can accommodate 4 observers. One of these should be the CXO team member to handle communications with the tower. A second, at least, should be present to take notes and fill out the run log.

VIII. Test Procedure: Macrotexture and cross-slope measurements

1. In advance of the test, create waypoints in the Geo7x device locating the x runway coordinate of measurement points, as shown in the “Macrotexture” sheet of the “KXCO_RWY1_measurements.xls” *Excel* spreadsheet.

2. Navigate to the measurement x coordinate using the Geo7x, and double-check with measuring wheel. Then, use the tape measure to find the correct y coordinates (see Appendix D). Note that the test y coordinates are not centered about the centerline, but are biased toward the left side of the runway. This is to reflect the actual track of N322QS as evidenced by the skid marks left by the airplane.

3. Mark and label the measurement point with chalk. See the spreadsheet for the point names (the names are constructed from the x and y coordinates of the point).

4. Using the ELAtextur scanner, measure the macrotexture three times, on and around the marked point. Record all three measurements in the appropriate cells in the spreadsheet. (Note the gray cells in the spreadsheets are for calculations that will be performed after the data is collected).

5. Using the level and digital inclinometer, measure and record the runway cross slope in the spreadsheet. Positive slope is for the centerline higher than the runway edge. Negative slope is for the centerline lower than the runway edge.

6. Photograph both the left and right runway edges to document vegetation or other obstructions that might cause runway drainage problems.

7. Repeat until all 40 points have been measured and recorded. See Appendix D for the suggested order of x-runway coordinate stations to test, so as to maximize coverage of the runway in the minimum amount of time (in the case that testing gets interrupted).

8. If the CXO team member determines that the team should clear the runway, he will blow 3 short blasts on the whistle. Upon hearing the whistle, the team will immediately clear the runway. If he blows one long blast, the team will assemble at his location.

IX. Other information

Appendix A contains an airport diagram and other useful information for CXO.

Appendix B contains the NASA Langley method for relating CFME measurements to airplane braking coefficients on a wet runway.

Appendix C contains printouts of the “Macrotexture” and “CFME runs” sheets in the “KXCO_RWY1_measurements.xls” *Excel* spreadsheet.

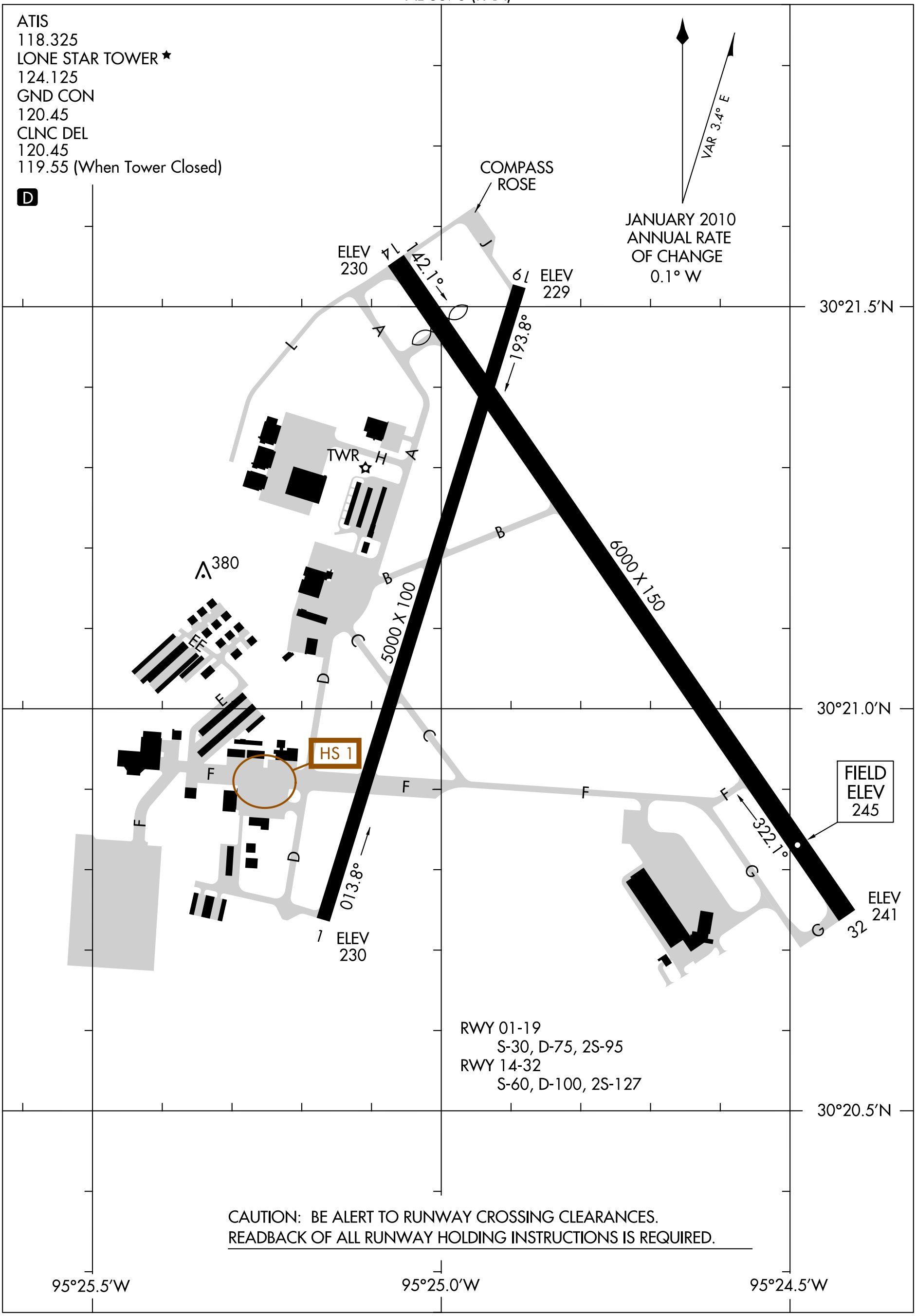
Appendix D contains details of proposed procedures for locating the measurement points on the runway.

Appendix A: KCXO Airport Diagram and Other Information

AIRPORT DIAGRAM

AL-5573 (FAA)

HOUSTON/ LONE STAR EXECUTIVE (CXO)
HOUSTON, TEXAS



SC-5, 13 NOV 2014 to 11 DEC 2014

Airport Details for KCXO - ACTIVE
Chart Date: 09/23/2010
LONE STAR EXECUTIVE
HOUSTON
AL #: 5573

State:	TEXAS	Magnetic Variation/Year:	E05/2000	Weather Station:	YES
Country:	United States	Site Nbr:	24072.1	Control Tower:	NO
Category:	AERODROME ONLY	Data Source:	405 NGS		
FAR Part 139:	NO	Owner:	NTL	Use:	CIVIL
				Military Type:	

Coordinates

Latitutde:	N 30° 21' 08.5000"
Longitude:	W 095° 24' 52.3000"
Field Elevation:	244.9
Ellipsoid Elevation:	154.5 E
Horizontal Datum:	NAD83
Vertical Datum:	NAVD88

Office

Flight Inspection:	OKC
Procedure Development:	120
Region Code:	SW
Service Area:	CNTL
OCC Code:	MID
International:	NO

Local Auto Weather

Weather Source:	ASOS
Type:	3
Frequency:	
Service A:	N

CONTACTS

ALTIMETERS

Type	Primary	Airport ID	Field Alt Source	Latitude	Longitude	Operational Timing
L	YES	KCXO	ASOS	N 30° 21' 08.5000"	W 095° 24' 52.3000"	FULL-TIME
R	NO	KDWH	ASOS	N 30° 03' 42.6000"	W 095° 33' 10.0000"	FULL-TIME

ALTIMETER COMMENTS

RUNWAYS

01 (A) 19 (A) 01 (P) 19 (P) 14 (A) 32 (A) 14 (P) 32 (P)

RUNWAY DETAIL

Landing Strip

Chart Date: 02/06/2014 Publication Status: A Pseudo Rwy:
Surface: ASPH GOOD Width: 99 Physical Length: 5000

Rwy Number: 01

Use Category: RUNWAY ONLY
Chart Date: 09/20/2012 Pub. Status: A
Data Source: 405 03/03/2009 NGS
Markings: NPI-G

Threshold

Latitude:	N 30° 20' 44.2700"
Longitude:	W 095° 25' 10.1600"
Elevation:	229.6
Ellipsoid Elev:	139.3 S
Ellipsoid Elev Model:	WGS84
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	
Vert. Datum:	

KCXO01

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	
Th Cross Ht:	49.4
High Angle:	
Com. Date:	
Com. Angle:	3.15
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 20' 51.4400"
Ref Pt Long:	W 095° 25' 07.5600"
Ref Pt Elev:	236.8
Ref Pt Thres:	762
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			

Landing Length:	5000
FI RWY Length:	5000
FI RWY Height:	228.8
Tdz Elevation:	236.6
True Bearing:	17.17
Ft Disp Th:	
Gradient:	0.0%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	NO
OIS Data Source:	ANALPV 03/03/2009 NGS_SURVEY
Assoc. Fac.:	

Rwy Number: 19

Use Category: RUNWAY ONLY
Chart Date: 09/20/2012 Pub. Status: A
Data Source: 405 03/03/2009 NGS
Markings: NPI-G

Threshold

Latitude:	N 30° 21' 31.5500"
Longitude:	W 095° 24' 53.3100"
Elevation:	228.8
Ellipsoid Elev:	138.5 E
Ellipsoid Elev Model:	WGS84
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	
Vert. Datum:	

KCXO19

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	
Th Cross Ht:	48.6
High Angle:	
Com. Date:	
Com. Angle:	3.00
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 21' 24.2900"
Ref Pt Long:	W 095° 24' 55.8500"
Ref Pt Elev:	237.4
Ref Pt Thres:	763
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			

Landing Length:	5000
FI RWY Length:	5000
FI RWY Height:	229.6
Tdz Elevation:	236.6
True Bearing:	197.18
Ft Disp Th:	
Gradient:	0.0%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	NO
OIS Data Source:	ANALPV 03/03/2009 NGS_SURVEY
Assoc. Fac.:	

RUNWAY LANDING STRIP COMMENTS

RUNWAY LANDING STRIP COMMENTS

RUNWAY 01 COMMENTS

RUNWAY 19 COMMENTS

RUNWAY DETAIL

Landing Strip

Chart Date: 03/05/2015 | Publication Status: P | Pseudo Rwy:
Surface: ASPH GOOD | Width: 99 | Physical Length: 5000

Rwy Number: 01

Use Category: RUNWAY ONLY
Chart Date: 03/05/2015 Pub. Status: P
Data Source: THIRD_PARTY 06/26/2011
Markings: NPI-G

Threshold

Latitude:	N 30° 20' 44.2266"
Longitude:	W 095° 25' 10.1247"
Elevation:	229.6
Ellipsoid Elev:	139.3 S
Ellipsoid Elev Model:	NAVD88
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	UNKNOWN
Vert. Datum:	UNKNOWN

Landing Length:	5000
Fl RWY Length:	5000
Fl RWY Height:	228.7
Tdz Elevation:	236.7
True Bearing:	17.16
Ft Disp Th:	
Gradient:	0.0%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	NO
OIS Data Source:	VG 06/26/2011 THIRD_PARTY
Assoc. Fac.:	

KCXO01

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	
Th Cross Ht:	49.4
High Angle:	
Com. Date:	03/21/2012
Com. Angle:	3.15
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 20' 51.4400"
Ref Pt Long:	W 095° 25' 07.5500"
Ref Pt Elev:	236.8
Ref Pt Thres:	762
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			

Rwy Number: 19

Use Category: RUNWAY ONLY
Chart Date: 03/05/2015 Pub. Status: P
Data Source: THIRD_PARTY 06/26/2011
Markings: NPI-G

Threshold

Latitude:	N 30° 21' 31.5059"
Longitude:	W 095° 24' 53.2773"
Elevation:	228.7
Ellipsoid Elev:	138.5 S
Ellipsoid Elev Model:	NAVD88
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	UNKNOWN
Vert. Datum:	UNKNOWN

Landing Length:	5000
Fl RWY Length:	5000
Fl RWY Height:	229.6
Tdz Elevation:	236.7
True Bearing:	197.17
Ft Disp Th:	
Gradient:	0.0%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	NO
OIS Data Source:	VG 06/26/2011 THIRD_PARTY
Assoc. Fac.:	

KCXO19

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	
Th Cross Ht:	48.6
High Angle:	
Com. Date:	03/21/2012
Com. Angle:	3.00
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 21' 24.2900"
Ref Pt Long:	W 095° 24' 55.8500"
Ref Pt Elev:	237.4
Ref Pt Thres:	763
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			

RUNWAY LANDING STRIP COMMENTS

RUNWAY 01 COMMENTS

RUNWAY 19 COMMENTS

RUNWAY DETAIL

Landing Strip

Chart Date: 02/06/2014 | Publication Status: A | Pseudo Rwy:
Surface: CONC GOOD | Width: 150 | Physical Length: 7501

Rwy Number: 14

Use Category: RUNWAY ONLY
Chart Date: 07/29/2010 Pub. Status: A
Data Source: 405 03/01/1991 NGS
Markings: PIR-G

KCXO14

Threshold

Latitude:	N 30° 21' 33.4734"
Longitude:	W 095° 25' 03.9041"
Elevation:	230.1
Ellipsoid Elev:	139.9 S
Ellipsoid Elev Model:	WGS84
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Rwy Number: 32

Use Category: RUNWAY ONLY
Chart Date: 07/29/2010 Pub. Status: A
Data Source: 405 03/03/2009 NGS
Markings: NPI-G

KCXO32

Threshold

Latitude:	N 30° 20' 44.5408"
Longitude:	W 095° 24' 25.1018"
Elevation:	241.3
Ellipsoid Elev:	151.0 S
Ellipsoid Elev Model:	WGS84
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	
Th Cross Ht:	31.0
High Angle:	
Com. Date:	
Com. Angle:	3.00
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	
Ref Pt Long:	
Ref Pt Elev:	
Ref Pt Thres:	
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MALSR		STATE			122.950
MIRL		STATE			122.950

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			122.950
REIL		STATE			122.950

Displaced Threshold

Latitude:	N 30° 21' 28.6715"
Longitude:	W 095° 25' 00.0957"
Elevation:	230.6
Ellipsoid Elev:	140.4 S
Ellipsoid Elev Model:	WGS84
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Landing Length:	5411
FI RWY Length:	5411
FI RWY Height:	241.3
Tdz Elevation:	242.8
True Bearing:	145.48
Ft Disp Th:	589
Gradient:	0.2%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	YES
OIS Data Source:	PIR 03/01/1991 NGS_SURVEY
Assoc. Fac.:	CXO ILS (A)

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	
Vert. Datum:	

Landing Length:	6000
FI RWY Length:	5411
FI RWY Height:	230.6
Tdz Elevation:	244.9
True Bearing:	325.49
Ft Disp Th:	
Gradient:	-0.2%
RVRTouchdown:	
MidPoint:	
Rollout:	
Rail:	NO
OIS Data Source:	ANALPV 03/03/2009 NGS_SURVEY
Assoc. Fac.:	

RUNWAY LANDING STRIP COMMENTS

RUNWAY 14 COMMENTS

RUNWAY 32 COMMENTS

RUNWAY DETAIL

Landing Strip

Chart Date: 03/05/2015 Publication Status: P Pseudo Rwy:
Surface: CONC GOOD Width: 150 Physical Length: 7501

Rwy Number: 14

Use Category: RUNWAY ONLY
Chart Date: 03/05/2015 Pub. Status: P
Data Source: THIRD_PARTY 06/26/2011
Markings: PIR-G

Threshold

Latitude:	N 30° 21' 45.7165"
Longitude:	W 095° 25' 13.6157"
Elevation:	234.1
Ellipsoid Elev:	143.8 S
Ellipsoid Elev Model:	NAVD88
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	NAVD88
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Landing Length:	7501
FI RWY Length:	7501
FI RWY Height:	241.3
Tdz Elevation:	242.9
True Bearing:	145.48
Ft Disp Th:	
Gradient:	0.1%
RVRTouchdown:	

KCXO14

VGSI Lights

VGSI Lights Type:	PAPI-4L
Owner:	STATE
Pilot Cntl Freq:	122.950
Th Cross Ht:	47.0
High Angle:	
Com. Date:	
Com. Angle:	3.00
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 21' 38.0500"
Ref Pt Long:	W 095° 25' 07.5400"
Ref Pt Elev:	231.8
Ref Pt Thres:	941
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
MIRL		STATE			122.950
MALSR		STATE			122.950

Rwy Number: 32

Use Category: RUNWAY ONLY
Chart Date: 03/05/2015 Pub. Status: P
Data Source: THIRD_PARTY 06/26/2011
Markings: NPI-G

Threshold

Latitude:	N 30° 20' 44.5408"
Longitude:	W 095° 24' 25.1015"
Elevation:	241.3
Ellipsoid Elev:	151.0 S
Ellipsoid Elev Model:	NAVD88
Horz. Datum:	NAD83
Vert. Datum:	NAVD88

Displaced Threshold

Latitude:	
Longitude:	
Elevation:	
Ellipsoid Elev:	
Ellipsoid Elev Model:	
Horz. Datum:	UNKNOWN
Vert. Datum:	UNKNOWN

Landing Length:	7501
FI RWY Length:	7501
FI RWY Height:	234.1
Tdz Elevation:	245.0
True Bearing:	325.48
Ft Disp Th:	
Gradient:	-0.1%
RVRTouchdown:	

KCXO32

VGSI Lights

VGSI Lights Type:	PAPI-2L
Owner:	STATE
Pilot Cntl Freq:	122.950
Th Cross Ht:	50.0
High Angle:	
Com. Date:	
Com. Angle:	3.00
DWB Elev:	
DWB Thres:	
Ref Pt Lat:	N 30° 20' 51.8100"
Ref Pt Long:	W 095° 24' 30.8700"
Ref Pt Elev:	245.0
Ref Pt Thres:	892
Height Group:	

Lights

Config	Len	Owner	Mil Type	Com Dt	Pilot Cntrl
REIL		STATE			122.950
MIRL		STATE			122.950

MidPoint:		MidPoint:	
Rollout:		Rollout:	
Rail:	YES	Rail:	NO
OIS Data Source:	VG 06/26/2011 THIRD_PARTY	OIS Data Source:	VG 06/26/2011 THIRD_PARTY
Assoc. Fac.:	CXO ILS (P)	Assoc. Fac.:	

RUNWAY LANDING STRIP COMMENTS

RUNWAY 14 COMMENTS

RUNWAY 32 COMMENTS

COMMENTS

Topic	Priority	Date	Remark
SURVEY	1	11/05/1999	NGS 405 SURVEY DATED 04/18/98
ADDITIONAL_FLIGHT_DATA	1	06/26/2000	ASOS. 936-760-4237
NFDD	3	02/25/2004	PER NFDD #049 DATED 03/12/04, ARPT NAME CHANGED FROM LONE STAR RGNL TO LONE STAR EXECUTIVE, CITY FROM CONROE TO HOUSTON
LIGHTS	5	06/05/2006	RWY 14/32 TO CHANGE RWY 14 VASI TO PAPI PER NFDD #080 DATED 04/26/06
SURVEY	5	06/27/2007	ALTERNATE ALTIMETER SOURCE, KDWH, ADDED PER AVN-120
OWNER	2	10/15/2007	LIGHTS OWNED BY MONTGOMERY COUNTY
GENERAL	7	10/16/2007	RWY 01/19 BEING EXTENDED ON NORTH END. DATA PROVIDED BY LOCAL SURVEY. NFDD #217 DATED 11/08/07 RWY 19 PAPI DATA PROVIDED BY PROJECT MGR, 11/05/07 RWY 01 PAPI DATA TO CHANGE ANGLE & MODIFY DATA FORWARDED BY TX ADO FROM PROJECT MGR, 10/15/07 TDZE USED IN LIEU OF UNKNOWN RRP ELEVATION TCH IS A CALCULATED VALUE
NFDD	9	12/09/2008	PER NFDD # 238 DATED 12/10/08 RWY 32 4 BOX VASI DELETED.

SIAPS

Nav Ident	Nav Type	Description	FAS	Amendment	Type
		RNAV (GPS) RWY 32	329 / TREE / N30°20'43.08" / W095°24'14.66"	1	CIVIL
			409 / TOWER / N30°17'30.60" / W095°21'41.30"		
CXO	ILS	ILS OR LOC RWY 14	379 / TREE / N30°22'36.00" / W095°26'19.00"	2B	CIVIL
		RNAV (GPS) RWY 14	325 / TREE / N30°21'38.48" / W095°25'20.28"	ORG	CIVIL
			553 / TOWER / N30°25'50.00" / W095°26'20.00"		
		RNAV (GPS) RWY 19	374 / TREE / N30°22'12.18" / W095°24'17.43"	ORG	CIVIL
			409 / TREE / N30°23'24.40" / W095°24'42.08"		
		RNAV (GPS) RWY 1	395 / TOWER / N30°20'19.00" / W095°25'43.00"	ORG	CIVIL
CXO	ILS	NDB RWY 14	480 / TANK / N30°23'34.00" / W095°28'30.00"	2B	CIVIL

ASSOCIATED MONITORS

ASSOCIATED DGPS

Airports | Navaids | Airspace Fixes | Aviation Fuel | AIRBOSS | iPhone App | My AirNav

952 users online LOGIN

KCXO Lone Star Executive Airport
Houston, Texas, USA

FAA INFORMATION EFFECTIVE 18 SEPTEMBER 2014

Loc | Ops | Rwys | IFR | FBO | Links
Com | Nav | Svcs | Stats | Notes

Location

FAA Identifier: CXO
Lat/Long: 30-21-08.5000N / 095-24-52.3000W
30-21.141667N / 095-24.871667W
30.3523611 / -95.4145278
(estimated)
Elevation: 245 ft. / 74.7 m (surveyed)
Variation: 05E (2000)
From city: 37 miles N of HOUSTON, TX
Time zone: UTC -5 (UTC -6 during Standard Time)
Zip code: 77303

Airport Operations

Airport use: Open to the public
Activation date: 05/1944
Sectional chart: HOUSTON
Control tower: yes
ARTCC: HOUSTON CENTER
FSS: MONTGOMERY COUNTY FLIGHT SERVICE STATION
NOTAMs facility: CXO (NOTAM-D service available)
Attendance: 0700-2100
Wind indicator: lighted
Segmented circle: yes
Lights: DUSK-DAWN. MIRL RY 14/32 PRESET LOW INTST; TO INCR INTST & ACTVT MALSR RY 14 AND REIL RY 32 - CTAF.
Beacon: white-green (lighted land airport)
Operates sunset to sunrise.

Road maps at: MapQuest Bing Google Yahoo!

Airport Communications

CTAF: 124.125
ATIS: 118.325
WX ASOS: 118.325 (936-760-4237)
LONE STAR GROUND: 120.45 [0700-2200]
LONE STAR TOWER: 124.125 [0700-2200]
HOUSTON APPROACH: 119.7
HOUSTON DEPARTURE: 119.7
CLEARANCE DELIVERY: 119.55 WHEN ATCT CLSD 120.45
BORRN DP: 119.7
DREMR DP: 119.7
INDIE DP: 119.7
KARRR DP: 119.7
LURIC DP: 119.7
MMALT DP: 119.7
STRYA DP: 119.7
STYCK DP: 119.7
WATFO DP: 119.7
WYLSN DP: 119.7
WX ASOS at DWH (19 nm S): PHONE 281-251-7853

Aerial photo

WARNING: Photo may not be current or correct

A7

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
IAHr346/24.0	HUMBLE VORTAC	116.60	05E
TNVr075/33.6	NAVASOTA VORTAC	115.90	08E

NDB name	Hdg/Dist	Freq	Var	ID
DAVID HOOKS	025/15.7	521	05E	DWH -.. .-- ....
NIXIN	329/23.9	326	05E	BVP -... ...- .--.
HUNTSVILLE	153/25.0	308	06E	UTS ..- - ...
WEISER	019/27.7	286	06E	EYQ . -.-- --.-

Airport Services

Fuel available: 100LL JET-A
Parking: hangars and tiedowns
Airframe service: MAJOR
Powerplant service: MAJOR
Bottled oxygen: HIGH/LOW
Bulk oxygen: NONE

Runway Information

Runway 14/32

Dimensions:	6000 x 150 ft. / 1829 x 46 m	
Surface:	concrete, in good condition	
Weight bearing capacity:	Single wheel: 60.0 Double wheel: 100.0	
Runway edge lights:	medium intensity	
	RUNWAY 14	**RUNWAY 32**
Latitude:	30-21.557890N	30-20.742347N
Longitude:	095-25.065068W	095-24.418363W
Elevation:	230.1 ft.	241.3 ft.
Gradient:	0.3%	0.3%
Traffic pattern:	left	left
Runway heading:	140 magnetic, 145 true	320 magnetic, 325 true
Displaced threshold:	589 ft.	no
Markings:	precision, in good condition	nonprecision, in good condition
Visual slope indicator:	2-light PAPI on left (3.00 degrees glide path)	
Approach lights:	MALSR: 1,400 foot medium intensity approach lighting system with runway alignment indicator lights	
Runway end identifier lights:		yes
Touchdown point:	yes, no lights	yes, no lights
Instrument approach:	ILS/DME	
Obstructions:	10 ft. road, 200 ft. from runway, 40 ft. left of centerline 10 FT ROAD FM THLD TO 200 FT.	9 ft. ant, 400 ft. from runway, 260 ft. left of centerline, 22:1 slope to clear

Runway 1/19

Dimensions:	5000 x 100 ft. / 1524 x 30 m	
Surface:	concrete, in good condition	
Weight bearing capacity:	Single wheel: 30.0 Double wheel: 75.0	
Runway edge lights:	medium intensity	
	RUNWAY 1	**RUNWAY 19**
Latitude:	30-20.737833N	30-21.525833N
Longitude:	095-25.169333W	095-24.888500W
Elevation:	229.6 ft.	228.8 ft.
Gradient:	0.2%	0.2%
Traffic pattern:	left	left
Runway heading:	012 magnetic, 017 true	192 magnetic, 197 true
Declared distances:	TORA:5000 TODA:5000 ASDA:5000 LDA:5000	TORA:5000 TODA:5000 ASDA:5000 LDA:5000
Markings:	nonprecision, in good condition	nonprecision, in good condition
Visual slope indicator:		

Photo by Nigel Milligan / Kevin Williams
Photo taken 25-Sep-2014
looking west.

Do you have a better or more recent aerial photo of Lone Star Executive Airport that you would like to share? If so, please send us your photo.

Sectional chart

Airport diagram

CAUTION: Diagram may not be current

Airport distance calculator

Flying to Lone Star Executive Airport? Find the distance to fly.

From ______ to KCXO

CALCULATE DISTANCE

Sunrise and sunset

Times for 06-Oct-2014

	Local (UTC-5)	Zulu (UTC)
Morning civil twilight	06:55	11:55
Sunrise	07:19	12:19
Sunset	19:00	00:00
Evening civil twilight	19:24	00:24

Current date and time

Zulu (UTC)	06-Oct-2014 11:58:15
Local (UTC-5)	06-Oct-2014 06:58:15

METAR

KCXO	061153Z 00000KT 10SM CLR 18/18 A2988 RMK AO2 SLP113 T01830178 10189 20167 58001
KDWH 19nm S	061053Z 00000KT 10SM CLR 20/18 A2987 RMK AO2 SLP114 T02000183

TAF

KCXO 060520Z 0606/0706 00000KT P6SM FEW025 FM061000 15005KT P6SM BKN020 FM061600 17009KT P6SM VCSH SCT030 BKN120 FM061900 17009KT P6SM VCSH SCT040 PROB30 0619/0623 TSRA BKN040CB BKN250

NOTAMs

Click for the latest **NOTAMs**

NOTAMs are issued by the DoD/FAA and will open in a separate window not controlled by AirNav.

	2-light PAPI on left (3.15 degrees glide path)	2-light PAPI on left (3.00 degrees glide path)
Touchdown point:	yes, no lights	yes, no lights
Obstructions:	none	4 ft. tree, 350 ft. from runway, 70 ft. right of centerline, 37:1 slope to clear

Airport Ownership and Management from official FAA records

Ownership: Publicly-owned
Owner: MONTGOMERY COUNTY
501 N. THOMPSON ST.
CONROE, TX 77301
Phone 936-539-7811
Manager: SCOTT SMITH
10260 CARL PICKERING MEMORIAL
CONROE, TX 77303
Phone 936-788-8311

Airport Operational Statistics

Aircraft based on the field:	329	Aircraft operations: avg 219/day *
Single engine airplanes:	234	58% local general aviation
Multi engine airplanes:	36	39% transient general aviation
Jet airplanes:	32	2% military
Helicopters:	3	<1% air taxi
Military aircraft:	24	* for 12-month period ending 30 July 2011

Additional Remarks

- A23 HELICOPTERS USE RIGHT-HAND TRAFFIC.
- EXTENSIVE MILITARY HELICOPTER ACTIVITY ON ARPT.
- AVOID NOISE SENSITIVE AREA 10 MI SW QUADRANT OF ARPT.
- UNMANNED ACFT MAY BE OPERATING IN THE IMMEDIATE AREA DURING DALGT HRS.

Instrument Procedures

NOTE: All procedures below are presented as PDF files. If you need a reader for these files, you should download the free Adobe Reader.

NOT FOR NAVIGATION. Please procure official charts for flight.
FAA instrument procedures published for use between 18 September 2014 at 0901Z and 16 October 2014 at 0900Z.

STARs - Standard Terminal Arrivals

HUDZY TWO	2 pages: [1] [2]
OHIIO TWO	download
RIICE SEVEN	2 pages: [1] [2]
WHAEL ONE	download

IAPs - Instrument Approach Procedures

ILS OR LOC RWY 14	download
RNAV (GPS) RWY 01	download
RNAV (GPS) RWY 14	download
RNAV (GPS) RWY 19	download
RNAV (GPS) RWY 32	download
NDB RWY 14	download
NOTE: Special Alternate Minimums apply	download (12KB)

Departure Procedures

ALEXANDRIA SIX	2 pages: [1] [2]
BORRN ONE (RNAV) ****CHANGED****	2 pages: [1] [2]
BOWFN FIVE (RNAV)	download
CRIED FIVE	download
DREMR ONE (RNAV) ****CHANGED****	2 pages: [1] [2]
EL DORADO FOUR	2 pages: [1] [2]
GIFFA FIVE	2 pages: [1] [2]
INDIE ONE (RNAV) ****CHANGED****	2 pages: [1] [2]
INDUSTRY FIVE	2 pages: [1] [2]
JUNCTION SEVEN	download
KARRR TWO (RNAV) ****NEW****	2 pages: [1] [2]
LAKE CHARLES TWO	download
LEONA EIGHT	2 pages: [1] [2]
LUFKIN SEVEN	2 pages: [1] [2]

LURIC ONE (RNAV) **CHANGED**	2 pages: [1] [2]
MMALT ONE (RNAV) **CHANGED**	2 pages: [1] [2]
PALACIOS FIVE	2 pages: [1] [2]
STRYA ONE (RNAV) **CHANGED**	2 pages: [1] [2]
STYCK ONE (RNAV) **CHANGED**	download
WATFO ONE (RNAV) **CHANGED**	download
WYLSN ONE (RNAV) **CHANGED**	2 pages: [1] [2]
NOTE: Special Take-Off Minimums/Departure Procedures apply	download (70KB)

Other nearby airports with instrument procedures:

KDWH - David Wayne Hooks Memorial Airport (19 nm S)
6R3 - Cleveland Municipal Airport (21 nm E)
KIAH - George Bush Intercontinental/Houston Airport (22 nm S)
KUTS - Huntsville Municipal Airport (25 nm N)
KEYQ - Weiser Air Park (28 nm SW)

FBO, Fuel Providers, and Aircraft Ground Support

Business Name	Contact	Services / Description	Fuel Prices	Comments
General Aviation Services	**123.30** 936-760-1717 [web site] [email]	In business since 1982, General Aviation Services will provide you with the best FBO services in the area. We our located center field between taxi ways Bravo and Charlie,the best locaton on the field for a quick turn around and convenient to all runways, which allows for a smooth and hassle free arrival and departure. We have the best prices in the area. Our experienced, professional, and courteous staff will see to your every request. Make your next stop with us and see why our customers keep coming back for more!" More info and **photos** of General Aviation Services AIRBOSS US Government CONTRACT FUEL WSI AVTRIP COURTESY VAN Budget Diamond AIRCRAFT MOONEY AUTHORIZED CHART AGENT NBAA	100LL Jet A FS $5.65 $5.10 SS $5.25 --- GUARANTEED AIRBOSS **MEMBERS ONLY Discounts** Login Join	14 read write
Galaxy FBO	**ASRI 130.525** 936-494-4252 [web site] [email]	Come see what has made Galaxy the best reviewed FBO at the Lonestar Executive Airport! Our friendly and attentive staff is always ready to assist you during your stay at KCXO. Free courtesy cars, volume fuel discounts, maintenance, rental car reservations, oxygen/nitrogen services, hotel reservations, catering, aircraft detailing. More info and **photos** of Galaxy FBO AIRBOSS SAFETY 1st COLT International UVair WINGPOINTS CREW CARS Hertz WIFI NBAA	100LL Jet A FS $5.49 $5.19 GUARANTEED AIRBOSS **MEMBERS ONLY Discounts** Login Join	12 read write
Wing Jet Center, LLC	936-441-9555 toll-free 1-866-449-9555 [web site] [email]	Aviation fuel, Oxygen service, Aircraft parking (ramp or tiedown), Hangars, Hangar leasing / sales, GPU / Power cart, Passenger terminal and lounge, ... SAFETY 1st US Government CONTRACT FUEL US Government AIR Card WSI CREW CAR NBAA More info about Wing Jet Center, LLC	EPIC 100LL Jet A FS $6.69 $5.25 GUARANTEED	not yet rated 2 read write

FS=Full service
SS=Self service
UPDATE PRICES

Where to Eat: Catering, Restaurants, Food shops

Business Name	Contact	Services / Description	Distance	Comments
Black Walnut Cafe	936-202-2824 [web site]	Restaurant More info about Black Walnut Cafe	on airport	not yet rated 1 read write

Where to Stay: Hotels, Motels, Resorts, B&Bs, Campgrounds

In this space we feature lodging establishments that are convenient to the Lone Star Executive Airport. If your hotel/inn/B&B/resort is near the Lone Star Executive Airport, provides convenient transportation, or is otherwise attractive to pilots, flight crews, and airport users, consider listing it here.

FEATURE A LODGING ESTABLISHMENT

A10

AirNav users who flew into KCXO have stayed at...

	Miles	Price ($)
COURTYARD BY MARRIOTT HOUSTON THE WOODLANDS	12.8	110-111
SUPER 8 CONROE	4.1	48-64
BAYMONT INN AND SUITES	5.4	68-93
DAYS INN CONROE	4.9	47-60

Other hotels near Lone Star Executive Airport

	Miles	Price ($)
HOLIDAY INN EXPRESS HOTEL & SUITES CONROE INTERSTATE45 NORTH	3.9	116-117
HAMPTON INN & SUITES CONROE INTERSTATE 45 NORTH	3.9	125-135
COMFORT INN CONROE	4.0	89-90
FAIRFIELD INN & SUITES BY MARRIOTT HOUSTON CONROE/WOODLANDS	4.1	109-119
LA QUINTA INN & SUITES CONROE	4.2	95-96
DAYS INN CONROE	4.2	
RAMADA INN- CONROE/THE WOODLANDS	5.5	66-70

Distances are approximate, and may vary depending on the actual route traveled and the location of the travel start on the airport.

Hotels in other cities near Lone Star Executive Airport

9 in Conroe	3 in Magnolia
2 in Willis	3 in Cleveland
13 in The Woodlands	2 in New Caney
4 in Montgomery	

Would you like to see your business listed on this page?

If your business provides an interesting product or service to pilots, flight crews, aircraft, or users of the Lone Star Executive Airport, you should consider listing it here. To start the listing process, click on the button below

ADD YOUR BUSINESS OR SERVICE

Other Pages about Lone Star Executive Airport

- www.co.montgomery.tx.us/air
- Page from the Texas Airport Directory (PDF)

UPDATE, REMOVE OR ADD A LINK

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APPENDIX B: Data Reduction Procedures for Using Ground Vehicle Friction Measurements to Calculate Aircraft Tire Friction Performance

Tom Yager
Distinguished Research Associate
NASA Langley Research Center

Data Reduction Procedures

For

Using Ground Vehicle Friction Measurements

To

Calculate Aircraft Tire Friction Performance

Tom Yager, NASA Langley Research Center

Basic Data Requirements –

1. Accurate and suitable ground vehicle friction measurements must be collected through a speed range (e.g. 10-60 mph) for each wet surface condition evaluated.

2. The test tire(s) operating mode and inflation pressure must be properly maintained and documented

3. The test tire(s) operating mode should be selected to provide one of three friction boundary conditions: locked-wheel skidding, peak braked rolling, or peak yawed (cornering) rolling

4. A characteristic dry friction coefficient, μ_{cd} must be determined experimentally for each ground vehicle test tire operating mode by conducting test runs at very low speed ($<$3 mph)

5. The aircraft main landing gear tire inflation pressure value must be known

Overall Tire Friction Methodology – See figure 1

Data Reduction Procedures –

STEP 1 - Determine best fit curve for aircraft and ground vehicle friction- speed gradient data. Figure 2 provides an example of the friction data range obtained on a wet slurry seal asphalt surface with the NASA instrumental B-737 aircraft and four different ground test vehicles: a diagonal-braked vehicle, a mu-meter, a Saab friction tester, and a BV-11 skiddometer.

STEP 2 – For each test vehicle, calculate the minimum tire dynamic hydroplaning spin down speed using the following equation (see table I)

$$Vp, Knots \ = 9\sqrt{p} \tag{1a}$$

$$Vp, mph \ = 10.35\sqrt{p} \tag{1b}$$

where Vp, tire dynamic hydroplaning spindown speed

$p, tire\ inflation\ pressure, psi$

<u>NOTE:</u> Experimental data obtained with the mu-meter trailer indicates a Vp value of 45 mph rather than the 33 mph derived from eq. 1b. Use $Vp = 45mph$ for mu-meter calculations.

STEP 3 – Tabulate characteristic dry friction coefficient values obtained experimentally for each ground vehicle test tire (see table I).

STEP 4 – Calculate characteristic dry friction coefficient value for air craft main gear tire using the following equation:

$$\mu_{cd} = 0.93 - 0.0011\ p \tag{2}$$

where, μ_{cd} characteristic dry friction coefficient

$p, tire\ inflation\ pressure, psi$

<u>NOTE:</u> Table I gives these values for both the B-737 and B-727 aircraft together with the pertinent ground vehicle tire friction parameters.

STEP 5 – Select and tabulate an appropriate number (minimum 5) of the friction coefficient and ground speed values to properly define the friction-speed gradient data measured by each ground test vehicle. Determine the ground speed/hydroplaning speed ratio associated with each of the selected friction coefficient values (see table II).

STEP 6 – Determine ground vehicle tire hydroplaning parameter values using the following general relationship:

$$\boldsymbol{\bar{y}} = \frac{\boldsymbol{\mu_{wet}}}{\boldsymbol{\mu_{cd}}} \tag{3}$$

where $\bar{y}$, tire hydroplaning parameter

μ_{wet}, Experimental or predicted wet pavement friction coefficient value

μ_{cd}, characteristic dry friction coefficient value

In determining the tire hydroplaning parameter, distinction is made between two types of tire operating modes-non rotating and rotating. For locked-wheel, sliding (non rotating) tire friction data (e.g. DBV), the tire hydroplaning parameter is labeled $\overline{y}_L$. For braked or yawed rolling (rotating) tire friction data (e.g. BV-11, SFT and Mu-meter), the tire hydroplaning parameter is labeled $\overline{y}_R$The relationship between $\overline{y}_L$ and $\overline{y}_R$, which was empirically derived from NASA track aircraft tire test data, is given in table III. Hence, knowing one tire hydroplaning parameter allows determination of the other (see table III).

STEP 7 – Calculate aircraft tire maximum braking friction coefficient, μ_{max} , values by simply multiplying the $\overline{y}_R$ values determined in STEP 6 by the aircraft tire characteristic dry friction coefficient value determined for eq. 2 in STEP 4 (see table II).

STEP 8 – Determine estimated aircraft tire effective braking coefficient, μ_{eff} , values by use of the following equations:

For $\mu \max < 0.7; \mu_{eff} = 0.2\, \mu_{\max} + 0.7143\, \mu_{max\,2}$ (4a)

For $\mu_{max} \geq 0.7$; μ_{eff} = 0.7 μ_{max} (4b)

These relationships between aircraft tire maximum braking and effective braking friction coefficient are based on the assumption that the total aircraft braking system (tires, brakes, hydraulics, gear, and antiskid) efficiency can be generalized by a single curve defined by equations 4 a and b. Values derived for B-737 aircraft are listed in table II.

STEP 9 – Calculate an equivalent aircraft ground speed associated with each μ_{eff} value by multiplying the appropriate ground vehicle speed ratio obtained in STEP 5 by the aircraft tire hydroplaning speed determined in STEP 2 (see table II).

STEP 10 – Compare estimated aircraft tire friction performance to actual measured performance (see figure 3).

Supplemental Data Analysis –

1. Statistical methods should be used to identify data set tolerances and degree of confidence in data correlation.

2. Parameter sensitivity studies should be performed to define effects on data correlation agreement.

Table I. - Compilation of test aircraft and ground vehicle tire friction parameters

TEST PARAMETER	TEST AIRCRAFT		GROUND TEST VEHICLES			
	B-737	B-727	DIAGONAL BRAKED	MU-METER	FRICTION TESTER	BV-11 SKIDDOMETER
Tire: Size Infl. Press. kPa (psi) Tread design	Main gear 40 x 14 1069 (155) 4-Groove	Main gear 49 x 17 931 (135) 6-Groove	ASTM E524 G78 x 15 165 (24) Smooth	RL-2 4.00 - 8 69 (10) Smooth	RL-2 4.00 - 8 207 (30) Smooth	RL-2 4.00 - 8 207 (30) Smooth
Braking method	Maximum Antiskid	Maximum Antiskid	Locked Wheel	None (7.5° yaw)	Constant 10% Slip	Constant 17% Slip
Friction reading	μ_{EFF}	μ_{EFF}	μ_{SKID}	μ_{SIDE}	μ_{DRAG}	μ_{DRAG}
Spin-down hydroplaning Speed, V_p, knots (mph)	112* (129)	105* (121)	44.1* (50.8)	39.1 (45)	49.3* (56.7)	49.3* (56.7)
Low speed characteristic dry friction, μ_{cd}	0.76*	0.78*	1.20	0.90	1.10	1.10

* Calculated values using:

(V_p) spin-down $= 3.43\sqrt{p}$ for SI Units $\mu_{cd} = 0.93 - 1.6 \times 10^{-4}\ p$

(V_p) spin-down $= 9\sqrt{p}$ for U.S. Customary Units $\mu_{cd} = 0.93 - 1.1 \times 10^{-3}\ p$

where p, tire inflation pressure, kPa (psi)

Table II - Compilation of parameter values used to estimate aircraft braking performance from ground vehicle data

(a) Slurry seal asphalt surface; Track wetted; Water depth 0.51mm (0.02 in.)

GROUND TEST VEHICLE	FAIRED μ	SPEED, V_G KNOTS	SPEED, V_G MPH	V_G/V_p	TIRE HYDROPLANING PARAMETERS $\bar{Y}_L$	TIRE HYDROPLANING PARAMETERS $\bar{Y}_R$	ESTIMATED B-737 AIRCRAFT BRAKING μ_{MAX}	ESTIMATED B-737 AIRCRAFT BRAKING μ_{EFF}	ESTIMATED B-737 AIRCRAFT BRAKING V_G, KNOTS	ACTUAL B-737 A/C μ_{EFF}
Diagonal	0.77	10	12	0.227	0.642	0.895	0.680	0.466	25.4	—
Braked	.59	20	23	.454	.492	.742	.564	.340	50.8	0.365
Vehicle	.47	30	34	.680	.392	.642	.488	.268	76.2	.290
(DBV)	.38	40	46	.907	.317	.564	.429	.217	101.6	—
↓	.31	50	58	1.134	.258	.495	.376	.176	126.6	—
	.24	60	69	1.361	.200	.412	.313	.133	152.4	—
Saab	—	10	12	.203	—	—	—	—	22.7	—
Friction	.93	20	23	.406	.581	.845	.642	.423	45.5	.380
Tester	.78	30	34	.609	.460	.709	.539	.315	68.2	.315
(SFT)	.66	40	46	.811	.350	.600	.456	.240	90.8	.250
↓	.54	50	58	1.014	.255	.491	.373	.174	113.6	—
	.43	60	69	1.217	.188	.391	.297	.122	136.3	—
BV-11	—	10	12	.203	—	—	—	—	22.7	—
Skiddometer	.93	20	23	.406	.581	.845	.642	.423	45.5	.380
↓	.80	30	34	.609	.478	.727	.553	.329	68.2	.315
	.67	40	46	.811	.359	.609	.463	.246	90.8	.250
	.55	50	58	1.014	.262	.500	.380	.179	113.6	—
	.44	60	69	1.217	.193	.400	.304	.127	136.3	—
Mu-meter	.88	10	12	.256	.873	.978	.743	.520	28.7	.430
↓	.83	20	23	.512	.689	.922	.701	.491	57.3	.345
	.78	30	34	.767	.604	.867	.659	.442	85.9	.260
	.72	40	46	1.023	.544	.800	.608	.386	114.6	—
	.67	50	58	1.279	.494	.744	.565	.341	143.2	—
	.62	60	69	1.535	.441	.689	.524	.301	171.9	—

Table III. - Relationship between rotating ($\bar{Y}_R$) and nonrotating ($\bar{Y}_L$) tire hydroplaning parameters.

$\bar{Y}_R$	$\bar{Y}_L$	$\bar{Y}_R$	$\bar{Y}_L$	$\bar{Y}_R$	$\bar{Y}_L$	$\bar{Y}_R$	$\bar{Y}_L$	$\bar{Y}_R$	$\bar{Y}_L$
0.000	0.000	.200	.095	.400	.193	.600	.350	.800	.544
.005	.002	.205	.097	.405	.196	.605	.355	.805	.548
.010	.005	.210	.099	.410	.199	.610	.360	.810	.551
.015	.007	.215	.101	.415	.202	.615	.365	.815	.555
.020	.010	.220	.104	.420	.205	.620	.370	.820	.560
.025	.012	.225	.106	.425	.208	.625	.375	.825	.564
.030	.015	.230	.108	.430	.211	.630	.380	.830	.568
.035	.017	.235	.111	.435	.215	.635	.385	.835	.572
.040	.019	.240	.113	.440	.218	.640	.390	.840	.576
.045	.021	.245	.116	.445	.221	.645	.395	.845	.581
.050	.024	.250	.118	.450	.225	.650	.400	.850	.586
.055	.026	.255	.120	.455	.228	.655	.405	.855	.591
.060	.028	.260	.122	.460	.232	.660	.410	.860	.597
.065	.030	.265	.125	.465	.235	.665	.415	.865	.602
.070	.033	.270	.127	.470	.239	.670	.421	.870	.608
.075	.035	.275	.130	.475	.243	.675	.426	.875	.614
.080	.038	.280	.132	.480	.247	.680	.431	.880	.620
.085	.040	.285	.134	.485	.250	.685	.437	.885	.626
.090	.043	.290	.137	.490	.254	.690	.442	.890	.634
.095	.045	.295	.139	.495	.258	.695	.447	.895	.642
.100	.047	.300	.141	.500	.262	.700	.451	.900	.650
.105	.050	.305	.144	.505	.266	.705	.456	.905	.659
.110	.052	.310	.146	.510	.270	.710	.461	.910	.667
.115	.054	.315	.148	.515	.274	.715	.466	.915	.677
.120	.057	.320	.151	.520	.279	.720	.471	.920	.687
.125	.059	.325	.154	.525	.283	.725	.476	.925	.698
.130	.062	.330	.156	.530	.287	.730	.481	.930	.709
.135	.064	.335	.158	.535	.292	.735	.485	.935	.720
.140	.066	.340	.161	.540	.296	.740	.490	.940	.734
.145	.068	.345	.163	.545	.300	.745	.495	.945	.748
.150	.071	.350	.166	.550	.305	.750	.500	.950	.762
.155	.073	.355	.168	.555	.309	.755	.504	.955	.779
.160	.075	.360	.170	.560	.314	.760	.509	.960	.795
.165	.078	.365	.173	.565	.318	.765	.514	.965	.815
.170	.080	.370	.175	.570	.322	.770	.518	.970	.835
.175	.083	.375	.178	.575	.327	.775	.523	.975	.859
.180	.085	.380	.181	.580	.332	.780	.527	.980	.882
.185	.087	.385	.184	.585	.336	.785	.531	.985	.910
.190	.090	.390	.187	.590	.340	.790	.535	.990	.940
.195	.092	.395	.190	.595	.345	.795	.540	.995	.975
								1.000	1.000

NASA

Figure 1.- Methodology used to estimate aircraft tire friction performance.

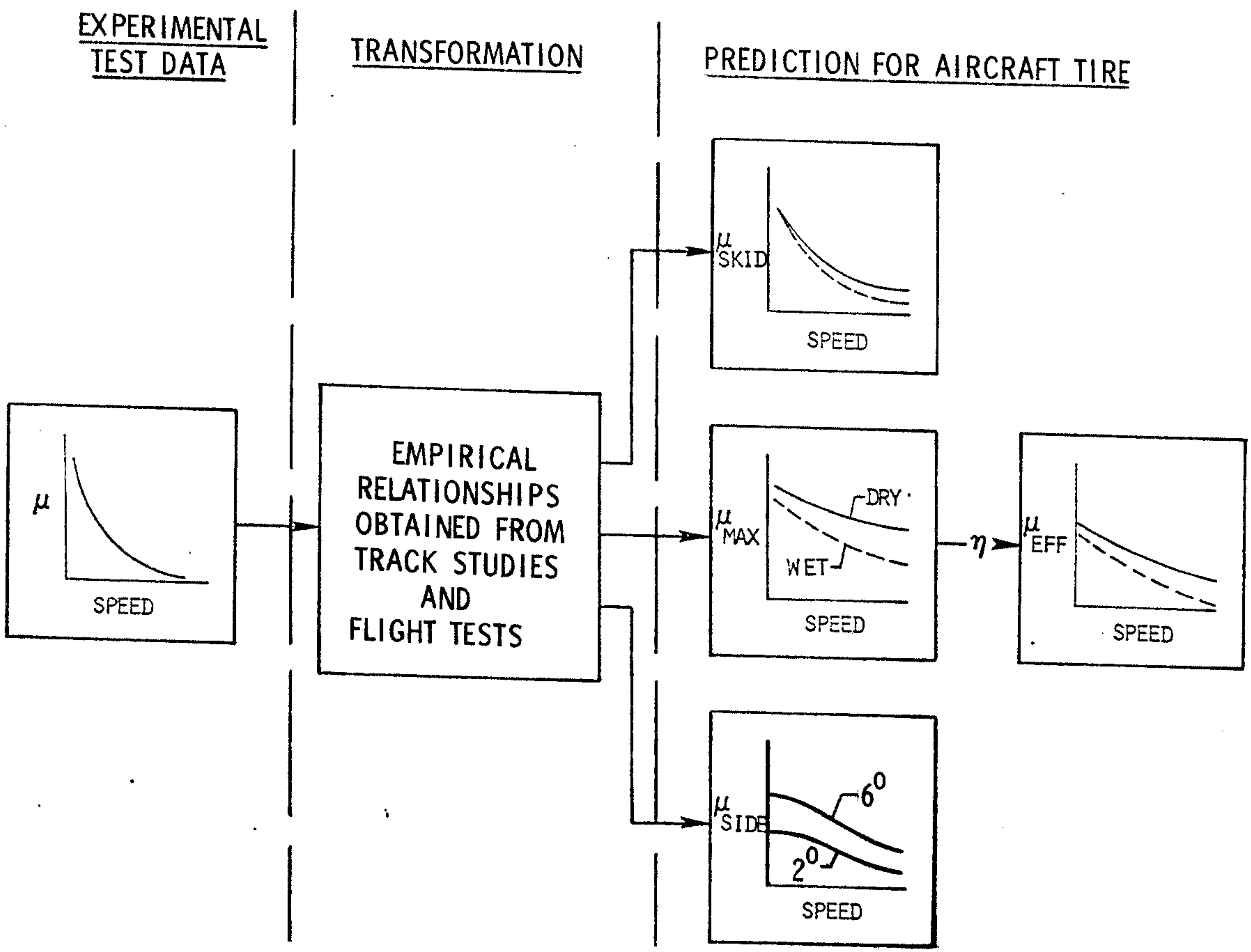


Figure 2 - RANGE OF AIRCRAFT AND GROUND VEHICLE FRICTION MEASUREMENTS

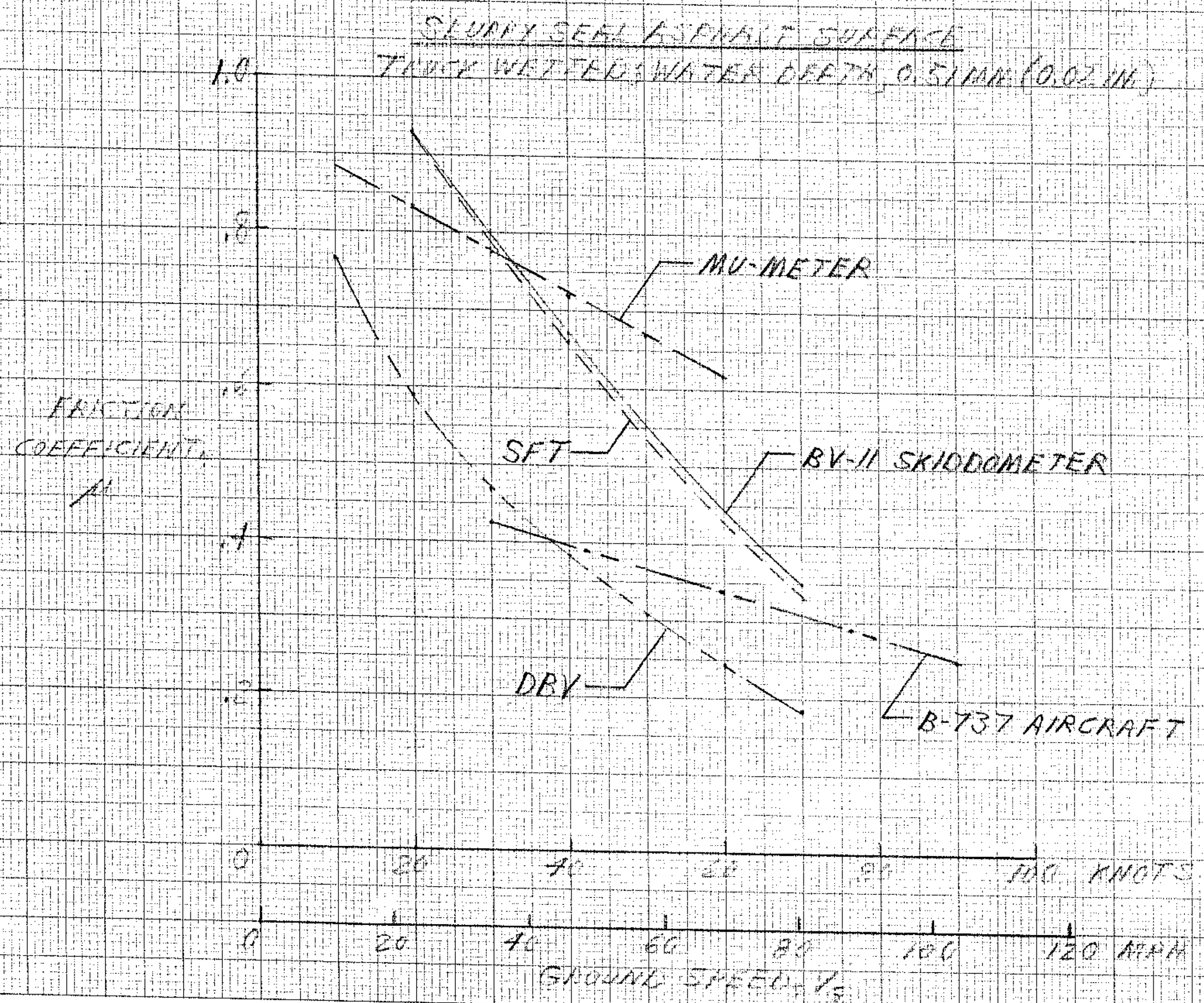
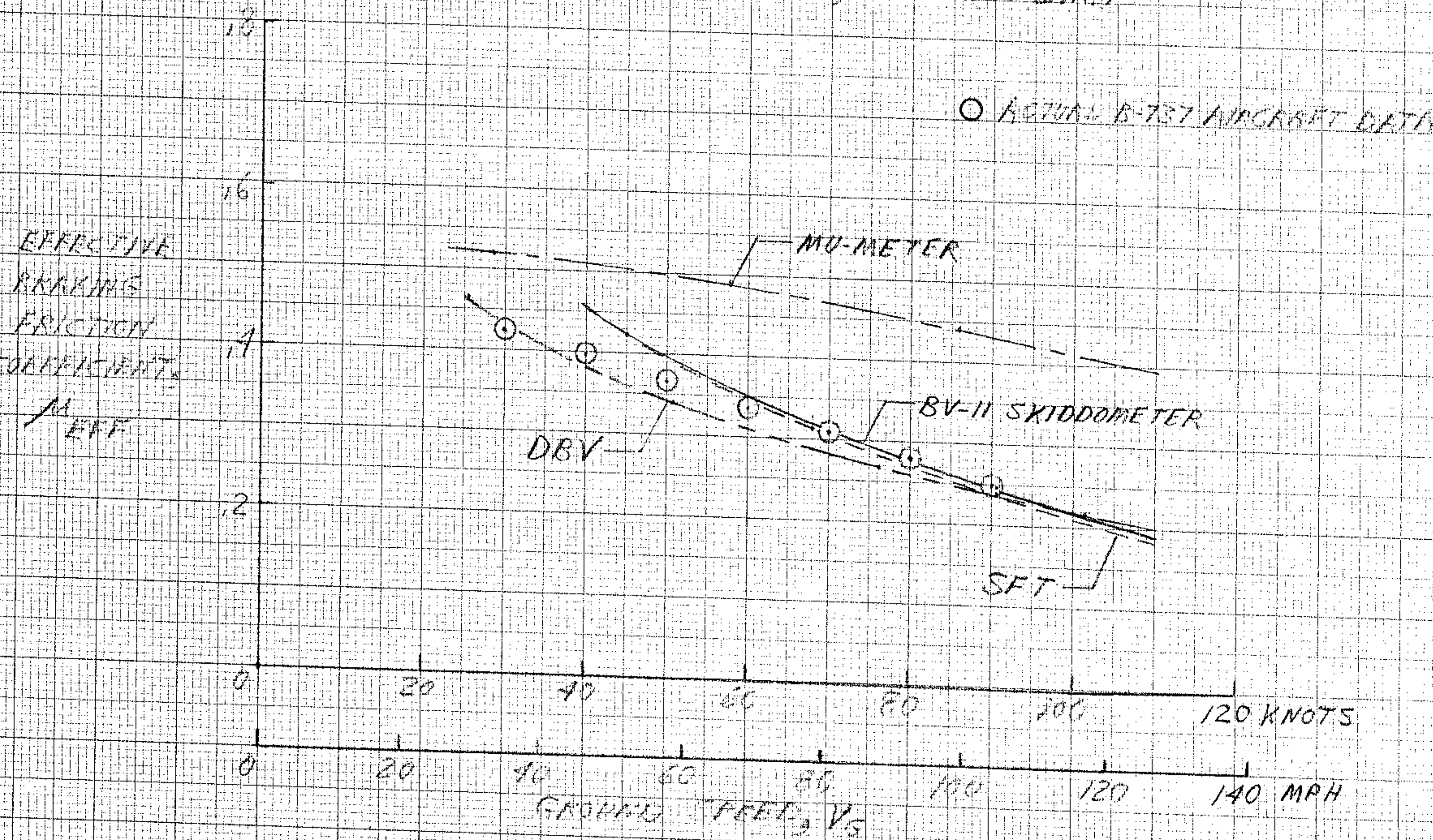


Figure 3.- ESTIMATED AIRCRAFT BRAKING PERFORMANCE FROM GROUND VEHICLE FRICTION DATA

SLURRY SEAL ASPHALT SURFACE

TRUCK WETTED; WATER DEPTH, 0.51 MM (.02 IN.)



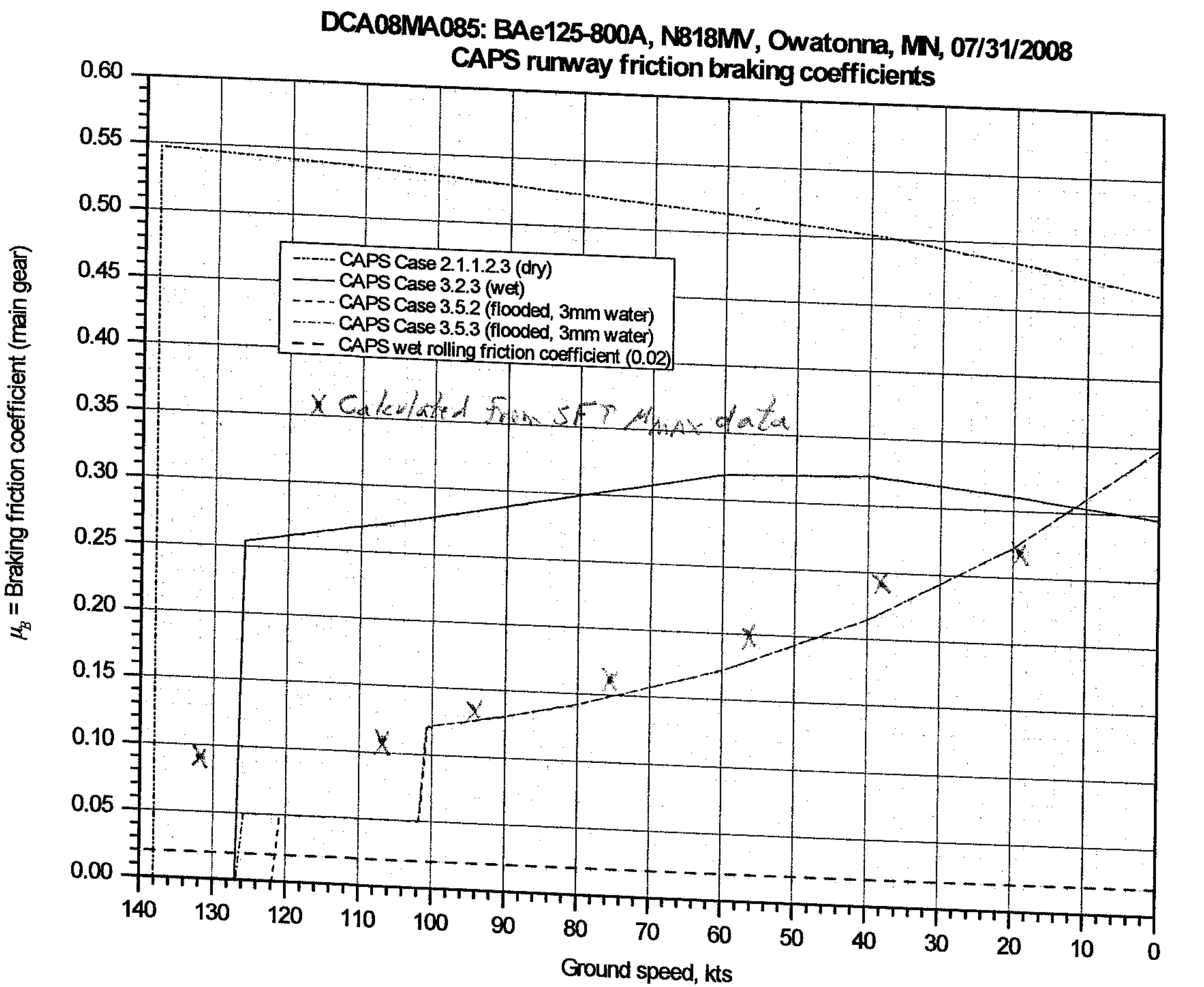
OWATONNA, MN; R/W 30; July 31, 2008

SFT μ_{DRY} = 1.10; V_P = 56.8 mph

A/C μ_{DRY} = 0.77; V_P = 107 Knots

RUNWAY SURFACE	SURF. COND.	SPEED, MPH	AVERAGE μ_{MAX}	V_G/V_P	$\bar{Y}_L$	$\bar{V}_R$	BAe 125-800A Aircraft			
							μ_{SKID}	μ_{MAX}	μ_{EFF}	V_G, KNOTS
Ungrooved	0.1 mm	60	0.39	1.001	0.168	0.355	0.129	0.273	0.108	107
Concrete	(0.04 in)	50	0.45	0.880	0.199	0.409	0.153	0.315	0.134	94
↓	↓	40	0.51	0.704	0.235	0.464	0.357	0.357	0.162	75
		30	0.58	0.528	0.285	0.527	0.219	0.406	0.199	56
		20	0.65	0.352	0.342	0.591	0.263	0.455	0.239	38
		10	0.70	0.176	0.380	0.636	0.297	0.490	0.270	19
		70	0.31	1.232	0.133	0.282	0.102	0.217	0.090	132

NASA-Langley Form 10 (AUG 1969)



DCA08MA085: BAe125-800A, N818MV, Owatonna, MN, 07/31/2008
CAPS runway friction braking coefficients
CAPS Case 2.1.1.2.3 (dry)
CAPS Case 3.2.3 (wet)
CAPS Case 3.5.2 (flooded, 3mm water)
CAPS Case 3.5.3 (flooded, 3mm water)
CAPS wet rolling friction coefficient (0.02)
X Calculated from SFT Mmax data
μ_B = Braking friction coefficient (main gear)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Ground speed, kts

B12

Appendix C: "KXCO_RWY1_measurements.xls"

Excel spreadsheet forms

NOTE: Darker-shaded points are lower priority			Runway y (ft.)			
Station #	**Runway x (ft.)**		**-35**	**-20**	**-5**	**+5**
1	300	Name	300-35	300-20	300-5	300+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
2	800	Name	800-35	800-20	800-5	800+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
3	1300	Name	1300-35	1300-20	1300-5	1300+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
4	1800	Name	1800-35	1800-20	1800-5	1800+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
5	2300	Name	2300-35	2300-20	2300-5	2300+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
6	2800	Name	2800-35	2800-20	2800-5	2800+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				

7	3300	Name	3300-35	3300-20	3300-5	3300+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
8	3800	Name	3800-35	3800-20	3800-5	3800+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
9	4300	Name	4300-35	4300-20	4300-5	4300+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				
10	4800	Name	4800-35	4800-20	4800-5	4800+5
		Macro 1 (mm)				
		Macro 2 (mm)				
		Macro 3 (mm)				
		Macro avg. (mm)				
		Slope (deg.)				
		Slope (%)				

Note: + slope is centerline higher than runway edge

Equipment: Neubert Aero Corp. (NAC) Dynamic Friction Tester (DFT)
Slip ratio: 12%
Tire inflation pressures:

Time	Pressure (psi)

***** Run numbers *****

PLANNED	Runway y coordinate (ft.)			
Speed (mph)	**-35**	**-20**	**-5**	**+5**
60	15	5	9	1 & 13
50	16	6	10 & 19	2
40	17 & 20	7	11	3
30	18	8 & 14	12	4

ACTUAL	Runway y coordinate (ft.)			
Speed (mph)	**-35**	**-20**	**-5**	**+5**
60				
50				
40				
30				

Run Log

Run #	Time	Other identifying information
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Appendix D:

Proposed Measurement Point Location Procedures

This Appendix contains proposed methods for efficiently locating the runway measurement points. These are only *proposed* procedures, and are the result of imagining how things might work out on the runway. In reality, the procedures will likely have to be adjusted by trial-and-error based on actual experience, in real-time, so as to achieve the most productive workflow.

Locating the runway measurement points

1. At the start of the test, navigate to the runway 35 threshold using the Timble Geo7x device, and verify that the device locates the threshold properly. This provides a "sanity check" on the combination of the coordinates programmed into the device, and the device's actual accuracy.

2. Proceed to the first runway x station (x=300 ft.), using *both* the Geo7x and the measuring wheel to locate the x coordinate. Verify agreement.

3. Stretch the measuring tape across the runway, with the 40 ft. mark located on the runway centerline, and the 0 mark (start of the tape) on the left side of the runway.

4. Using the chalk, mark and label the measurement points as shown in the Table D-1 and in Figure D-1:

Point label ***x* = runway x coordinate**	**Point y-coordinate**	**Tape measure mark**
x-35	-35 ft.	5 ft.
x-20	-20 ft.	20 ft.
x-5	-5 ft.	35 ft.
x+5	+5 ft.	45 ft.

Table D-1. Tape marks corresponding to measurement y-coordinates.

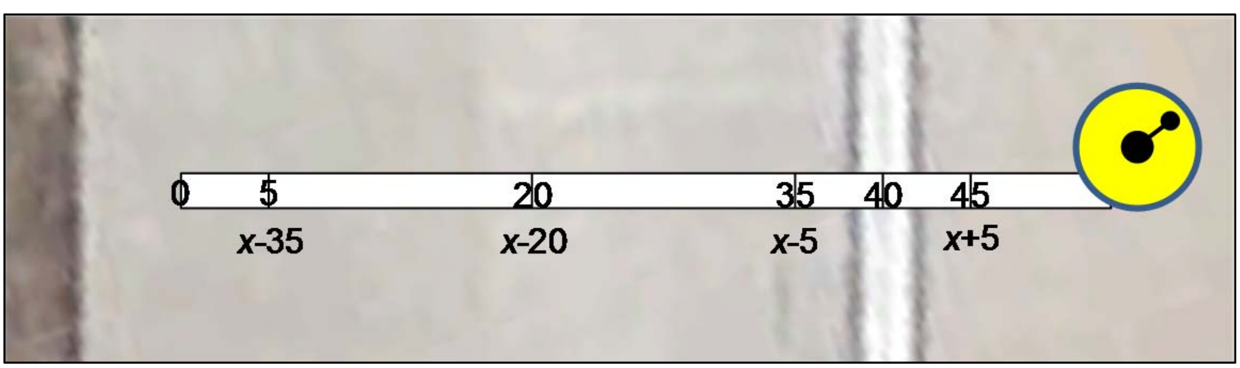


Figure D-1. Illustration of correspondence between tape marks and measurement y-coordinates.

5. After the measurement points are labeled, proceed to the next x-coordinate and locate / label the measurement points there. However, the Macrotexture team members locating the points should always remain within 1000 ft. of the CXO team member who is maintaining contact with the DFT team and airport tower. Further, no team members will venture north of the x=3800 ft. point by themselves, so as to avoid encroaching on the runway 14-32 intersection safety zone. Movement north of x=3800 ft. will be coordinated with the control tower by the CXO team members.

   The Macrotexture team will be attentive to whistle blows from their CXO team member. If this individual blows three short blasts on the whistle, the team will immediately clear the runway. If he blows one long blast on the whistle, the team will assemble at his location.

6. In order to obtain maximum coverage of the runway in the minimum amount of time (in case testing gets interrupted for whatever reason), the Macrotexture team should take macrotexture and cross-slope measurements at x-coordinate stations in the following order: Stations 1, 3, 5, 7, 9, 10, 8, 6, 4, 2. Note that Station 9 is within the runway 14-32 intersection safety zone, and may be tested “out of order” if a lull in airport traffic makes testing that point opportune. However, locating and labeling the measurement points can proceed in the numeric order of stations, since this activity should take less time than the macrotexture and cross-slope measurements.

Testing within the runway 14-32 intersection safety zone

Procedures for testing within the 14-32 intersection safety zone will be briefed by CXO personnel on the morning of the test. Note that the DFT team will likely need clearance from the tower before each of their test runs.