APPENDIX A

TEST PROCEDURES USED FOR DATA COLLECTION

- Original Test Procedure Used for Montreal/Mirabel Data Collection
- Test Procedure Used for Syracuse Data Collection 2008-2009
- Test Procedure Used for Denver Data Collection 2008-2009

ORIGINAL TEST PROCEDURE USED FOR MONTREAL/MIRABEL DATA COLLECTION

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS

Prepared for

The Airport Cooperative Research Program
Transportation Research Board
of
The National Academies

Prepared by: David Youssef

Reviewed by: Michael Chaput

February 5, 2008
Version 1.0

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS

1. BACKGROUND

Holdover Time Determination Systems (HOTDS), such as D-Ice A/S Deicing Information System and National Center for Atmospheric Research (NCAR) Checktime, measure meteorological parameters at airport sites and calculate de/anti-icing fluid holdover times, thus facilitating better de/anti-icing fluid selection by flight crews.

Operational data collection activities performed by APS Aviation Inc. (APS) from 2004-06 at Montreal-Trudeau International Airport (YUL) clearly demonstrated the benefits that could be realized by the aviation industry through implementation of HOTDS equipment. In nearly 28% of all departures analyzed during winter precipitation events at YUL, Type IV fluids were unnecessarily applied to the departing aircraft. Implementation of HOTDS equipment could result in an immediate source reduction of glycol, reduced operating costs, reduced environmental impact, as well as improved operational efficiencies and improved safety.

APS has tested a HOTDS for the past fours years at YUL and the system recently received regulatory approval for use in Canadian air operations. A similar regulatory approval process is underway in the United States. HOTDS equipment will be readily available for airport implementation in the upcoming years.

As de/anti-icing fluid holdover time is directly dependent on precipitation intensity, it is vital that the intensity measured and used by the HOTDS reflects the highest intensity to which the aircraft may be exposed during its departure taxi. It is not known whether a precipitation sensor at a single location on an airport can provide data with sufficient reliability for this application. For this reason, the HOTDS project performed by APS on behalf of ACRP will focus on siting issues related to HOTDS implementation.

2. OBJECTIVES

The objective of this project is to determine if a single location precipitation sensor can reliably report precipitation conditions for the entire airport. The objective will be met by measuring precipitation intensity, as well as other meteorological parameters affecting de/anti-icing holdover time, at several locations at an airport simultaneously. The simultaneous collection of precipitation intensity and meteorological parameters will be performed to fully understand variances between test locations.

3. LOCATIONS OF STUDY

Two airport test locations have been selected for the HOTDS work, Montreal-Trudeau International Airport (YUL) and Boston-Logan International Airport (BOS). It is anticipated that data will be gathered during six winter precipitation events at YUL and during two winter precipitation events at BOS. Data will be collected during the months of February and March 2008.

Montreal-Trudeau International Airport (YUL)

Montreal-Trudeau Airport (YUL) has been selected as the primary location for testing, as efficiencies will be obtained by conducting research at the airport where the APS test site is located. Test procedures will be developed, tested and refined at this primary test location and the bulk of all HOTDS project-related data will derive from this site.

Boston-Logan International Airport (BOS)

Boston-Logan International Airport (BOS) is the secondary location where APS personnel will collect HOTDS data. The specific locations for testing at BOS will be finalized following consultations with local personnel.

4. TEST PROCEDURE

The test procedure developed for use during HOTDS testing is based on the precipitation intensity measurement procedure included in Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5485. This is the same rate measurement procedure that has been employed in the development of de/anti-icing fluid holdover time tables since 1990.

The test procedure consists of measuring the precipitation catch of four collection pans of a known surface area over a known period of time. The collection pans will be positioned on a specially-designed test stand.

4.1 Pre-Test Preparation

In preparation for testing, the configuration and installations at both airports will be analyzed to determine appropriate testing locations.

Montreal-Trudeau International Airport (YUL)

Testing completed at YUL will use the APS test site as the hub of data

collection operations and an off-site area as a remote test location. A survey of the areas in and around the airport will be analyzed to locate ideal locations for the off-site data collection. Priority will be given to those remote locations that are closest to runway departure points. Testing at the off-site location will be conducted in a mobile test unit, housed within a cube van and powered by generators. The same equipment employed at the APS test site for data collection will be employed at the off-site location. Test locations will be separated by about 4000 feet initially, but this distance may be lengthened based on preliminary results.

Boston-Logan International Airport (BOS)

The same preparations listed above for YUL apply to BOS, with the exception that both test locations will be serviced by a mobile test unit. For BOS preparations, the APS project manager will travel to Boston to meet with Massport and local authorities in early February to discuss the project objectives and requirements, as well as to determine appropriate locations at that airport for testing.

4.2 Test Procedure

All personnel will follow a step-by-step test procedure included in Attachment I. The procedure will be performed simultaneously by the two test units.

Testing will be performed on the hour and at 20 minutes and 40 minutes past the hour, using the sequence of test events included in Attachment II. Each precipitation rate collection will last ten minutes, thus allowing for three measurements per hour of activity.

5. EQUIPMENT

Equipment required for the conduct of testing is shown in Attachment III.

6. PERSONNEL

Four APS personnel will be required for this testing. For YUL tests, two personnel will operate the mobile unit in the remote location and two will remain at the APS test site.

For the BOS tests, each of the two remote locations will be manned by a mobile unit of two APS employees.

The APS personnel will be as follows:

- Test Manager Michael Chaput (MC)
- Tester #1 Dany Posteraro (DP)
- Tester #2 David Youssef (DY)
- Tester #3 Katrina Bell (KB)

7. DATA FORMS

One general data form will be used to record precipitation collection. This data form is included as Attachment IV.

Attachment I
Implementation of Holdover Time Determination Systems

Step-by-Step Data Collection Procedure

(Procedures are based on precipitation rate collection procedures in ARP 5485)

- Ensure all pre-test preparations are completed:
  - Monitor weather for ideal conditions;
  - Arrange for truck rental;
  - Arrange for personnel;
  - Verify all test equipment;
  - Arrange for security escorts, if applicable.
- Meet with all personnel to discuss selected locations and weather forecast;
- Transport mobile unit and test team to remote location and establish radio communication with other location;
- Start generator to power lights and weigh scale;
- Determine wind direction and position test stands into the wind;
- Ensure 10° slope (from horizontal) of collection pans is achieved;
- Set up and level weigh scale;
- Prepare rate pans by adding 350 ml of Type IV fluid to each pan;
- Weigh and record weight of each pan, cover with lid and place on stand;
- Communicate with other test unit as to start time of tests
- Follow the included sequence of tests and communicate regularly with other location to ensure there are simultaneous activities taking place.
- Continue collection of rates throughout precipitation event

Attachment II
Implementation of Holdover Time Determination Systems – Sequence of Testing
(Testing Performed at 0, 20 and 40 minutes past each hour)

Rate 1

TIME	Tester 1	Tester 2
T = - 5 Minutes	Weigh and record initial weight	Weigh and record initial weight
T = -3 Minutes	Verify wind direction and adjust stand	Verify wind direction and adjust stand
T = -2 minutes	Place two covered plates on stand	Place two covered plates on stand
T = 0	Remove Covers	Remove Covers
T= 2 minutes	Rotate Pans	
T= 4 minutes	Rotate Pans	
T= 6 minutes	Rotate Pans	
T= 8 minutes	Rotate Pans	
T= 10 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 2

TIME	Tester 1	Tester 2
T = 18 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 20	Remove Covers	Remove Covers
T= 22 minutes		Rotate Pans
T= 24 minutes		Rotate Pans
T= 26 minutes		Rotate Pans
T= 28 minutes		Rotate Pans
T= 30 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 3

TIME	Tester 1	Tester 2
T = 38 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 40	Remove Covers	Remove Covers
T= 42 minutes	Rotate Pans	
T= 44 minutes	Rotate Pans	
T= 46 minutes	Rotate Pans	
T= 48 minutes	Rotate Pans	
T= 50 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Attachment III
Implementation of Holdover Time Determination Systems
Equipment List per Test Team

- 15′ cube truck
- 2 rate stands
- 8 rate pans
- 8 rate pan covers
- Sartorius weigh scale
- NCAR scale (backup)
- 6′ portable table
- Shelving unit for rate pans
- Smart tool Inclinometer
- Stop watch x 2
- Power inverter
- Generator
- Gas for generator (more than 1 tank)
- 10w40 oil for generator
- Shop towels
- Water (2 x 18 litres)
- Small squeegee to clean pans
- Yellow flood lights
- Data forms and procedures
- Pencils and sharpies
- Pencil sharpener
- Motorola radios
- Lyondell Type IV 26 Neat
- Two waste containers
- Weather vane
- Fishing gloves
- Funnel
- Shovel
- Space heater
- Extension cable x 2
- Measuring cup
- Camera equipment

Attachment III
Implementation of Holdover Time Determination Systems
Data Form

LOCATION: DATE:

PLATE PAN WEIGHT MEASUREMENTS

PAN #	t TIME BEFORE (h:min:s)	t TIME AFTER (h:min:s)	w WEIGHT BEFORE (g)	w WEIGHT AFTER (g)	DELTA WEIGHT (g)

TEST PROCEDURE USED FOR SYRACUSE DATA COLLECTION

2008-2009

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS

Syracuse Hancock International Airport
Syracuse, New York

Prepared for

The Airport Cooperative Research Program
Transportation Research Board
of
The National Academies

Prepared by: David Youssef

Reviewed by: Michael Chaput

December 31, 2008
Version 1.1

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS
Syracuse Hancock International Airport
Syracuse, New York

1. BACKGROUND

Holdover Time Determination Systems (HOTDS), such as D-Ice A/S Deicing Information System and National Center for Atmospheric Research (NCAR) Checktime, measure meteorological parameters at airport sites and calculate de/anti-icing fluid holdover times, thus facilitating better de/anti-icing fluid selection by flight crews.

Operational data collection activities performed by APS Aviation Inc. (APS) from 2004-06 at Montreal-Trudeau International Airport (YUL) clearly demonstrated the benefits that could be realized by the aviation industry through implementation of HOTDS equipment. In nearly 28% of all departures analyzed during winter precipitation events at YUL, Type IV fluids were unnecessarily applied to the departing aircraft. Implementation of HOTDS equipment could result in an immediate source reduction of glycol, reduced operating costs, reduced environmental impact, as well as improved operational efficiencies and improved safety.

APS has tested a HOTDS for the past fours years at YUL and the system recently received regulatory approval for use in Canadian air operations. A similar regulatory approval process is underway in the United States. HOTDS equipment will be readily available for airport implementation in the upcoming years.

As de/anti-icing fluid holdover time is directly dependent on precipitation intensity, it is vital that the intensity measured and used by the HOTDS reflects the highest intensity to which the aircraft may be exposed during its departure taxi. It is not known whether a precipitation sensor at a single location on an airport can provide data with sufficient reliability for this application. For this reason, the HOTDS project performed by APS on behalf of ACRP will focus on siting issues related to HOTDS implementation.

1.1 Lake-Effect Snow

Lake-effect snow is produced in the winter when cold, Arctic winds move across long expanses of warmer lake water, providing energy and picking up water vapor

which freezes and is deposited on the lee shores. The areas surrounding lake effect snow are called snow belts.

Lake-effect snow can cause significant variance in precipitation rates in a small area. For this reason, it is unknown whether a single HOTDS at an airport site impacted by lake-effect snow, would provide sufficient coverage, or whether multiple HOTDS systems would be required at these airports.

2. PREVIOUS WORK

Previous tests were conducted during nine snowstorm events within the period from February 1, 2008 to March 13, 2008. All tests were conducted in the vicinity of Montreal Pierre Elliott Trudeau International Airport (YUL).

This previous work recommended that further tests be conducted with the same methodology but to extend to further examination of different precipitation types, rates, temperatures, and lake-effect snow.

3. OBJECTIVES

The objective of this project is to determine if a single location precipitation sensor can reliably report precipitation conditions for the entire airport. The objective will be met by measuring precipitation intensity, as well as other meteorological parameters affecting de/anti-icing holdover time, at two locations at an airport simultaneously. The simultaneous collection of precipitation intensity and meteorological parameters will be performed to fully understand variances between test locations.

4. LOCATIONS OF STUDY

Although many airports were analyzed as potential test sites, Syracuse Hancock International Airport (SYR) was identified as an ideal airport to collect lake-effect snowfall data.

Lake-effect snows on the Tug Hill Plateau (east of Lake Ontario) can frequently set the daily records for snowfall in the United States. Syracuse, New York is directly south of the Tug Hill Plateau and receives significant lake-effect snow from Lake Ontario, averaging 115.6 inches (294 cm) of snow a year.

It is anticipated that data will be collected on 2 or 3 occasions at SYR. Attempts will be made to schedule data collection at significant precipitation events commencing in December 2008.

5. TEST PROCEDURE

The test procedure developed for use during HOTDS testing is based on the precipitation intensity measurement procedure included in Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5485. This is the same rate measurement procedure that has been employed in the development of de/anti-icing fluid holdover time tables since 1990.

The test procedure consists of measuring the precipitation catch of four collection pans of a known surface area over a known period of time. The collection pans will be positioned on a specially-designed test stand.

5.1 Pre-Test Preparation Syracuse Hancock International Airport (SYR)

Site Selection at SYR

An aerial depiction of SYR is shown in Figure 1. Three potential locations have been identified:

Position 1: Vacant Parking Lot located adjacent to Syracuse Executive Air Service. Tuskegee Road

Position 2: Cul de Sac of Perimeter Road.

Position 3: Park Location on East Taft Road

An additional site survey will be completed at the time of data collection.

Contact Information

A contact list is included in Attachment I.

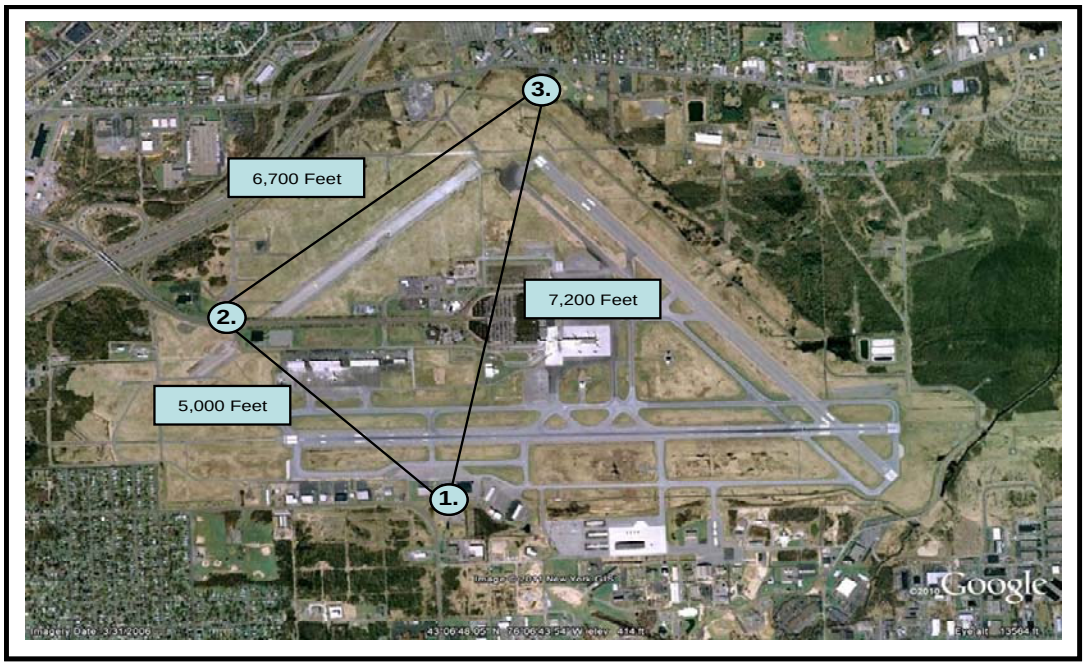

Figure 1: Aerial View of SYR

5.2 Test Procedure

All personnel will follow the step-by-step test procedure included in Attachment II. The procedure will be performed simultaneously by the two test units.

Testing will be performed on the hour and at 20 minutes and 40 minutes past the hour, using the sequence of test events included in Attachment III. Each precipitation rate collection will last ten minutes, thus allowing for three measurements per hour of activity.

6. EQUIPMENT

Equipment required for the conduct of testing is shown in Attachment IV.

7. PERSONNEL

Two APS personnel will be required for this testing. Each of the two remote locations will be manned by one APS tester

8. DATA FORMS

One general data form will be used to record precipitation collection. This data form is included as Attachment V.

Attachment I
Implementation of Holdover Time Determination Systems
Contact List

APS Aviation:

- Michael Chaput: (514) 878-4388 ext 228, (514) 261-5558
- David Youssef: (514) 878-4388 ext 225, (514) 967-3947
- Dany Posteraro: (514) 878-4388 ext 236, (514) 531-8988

Broker:

- Charles Higgerty Limited 613 -748-6600 Fax: 613-748-5581

Airport:

- Syracuse Hancock International Airport (SYR) (315) 454-3263, (315) 454-4330 Contact: John Carny

- Dean Hamm, Operations Manager Executive Air Services (315) 455-5957 dhamm@flyexecair.com

Attachment II
Implementation of Holdover Time Determination Systems

Step-by-Step Data Collection Procedure

(Procedures are based on precipitation rate collection procedures in ARP 5485)

- Ensure all pre-test preparations are completed:
  - Monitor weather for ideal conditions;
  - Arrange for truck rental;
  - Arrange for personnel;
  - Verify all test equipment; and
  - Arrange for security escorts, if applicable.
- Meet with all personnel to discuss selected locations and weather forecast;
- Transport mobile unit and test team to remote location and establish radio communication with other location;
- Start generator to power lights and weigh scale;
- Determine wind direction and position test stands into the wind;
- Ensure 10° slope (from horizontal) of collection pans is achieved;
- Set up and level weigh scale;
- Prepare rate pans by adding 450 ml of Type IV fluid to each pan;
- Weigh and record weight of each pan, cover with lid and place on stand;
- Communicate with other test unit as to start time of tests;
- Follow the included sequence of tests and communicate regularly with other location to ensure there are simultaneous activities taking place; and
- Continue collection of rates throughout precipitation event.

Attachment III
Implementation of Holdover Time Determination Systems – Sequence of Testing
(Testing Performed at 0, 20 and 40 minutes past each hour)

Rate 1

TIME	Tester 1	Tester 2
T = - 5 Minutes	Weigh and record initial weight	Weigh and record initial weight
T = -3 Minutes	Verify wind direction and adjust stand	Verify wind direction and adjust stand
T = -2 minutes	Place two covered plates on stand	Place two covered plates on stand
T = 0	Remove Covers	Remove Covers
T= 2 minutes	Rotate Pans	
T= 4 minutes	Rotate Pans	
T= 6 minutes	Rotate Pans	
T= 8 minutes	Rotate Pans	
T= 10 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 2

TIME	Tester 1	Tester 2
T = 18 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 20	Remove Covers	Remove Covers
T= 22 minutes		Rotate Pans
T= 24 minutes		Rotate Pans
T= 26 minutes		Rotate Pans
T= 28 minutes		Rotate Pans
T= 30 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 3

TIME	Tester 1	Tester 2
T = 38 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 40	Remove Covers	Remove Covers
T= 42 minutes	Rotate Pans	
T= 44 minutes	Rotate Pans	
T= 46 minutes	Rotate Pans	
T= 48 minutes	Rotate Pans	
T= 50 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Attachment IV
Implementation of Holdover Time Determination Systems
Equipment List per Test Team

- 15′ cube truck
- 4 rate stands
- 8 rate pans
- 8 rate pan covers
- Sartorius weigh scale
- NCAR scale (backup)
- 6′ portable table
- Shelving unit for rate pans
- Smart tool Inclinometer
- Stop watch x 2
- Power inverter
- Generator
- Gas for generator (more than 1 tank)
- 10w40 oil for generator
- Shop towels
- Water (2 x 18 litres)
- Small squeegee to clean pans
- Yellow flood lights
- Data forms and procedures
- Pencils and sharpies
- Pencil sharpener
- Motorola radios
- Lyondell Type IV 26 Neat
- Two waste containers
- Weather vane
- Fishing gloves
- Funnel
- Shovel
- Space heater
- Extension cable x 2
- Measuring cup
- Camera equipment

Attachment V
Implementation of Holdover Time Determination Systems
Data Form

LOCATION: DATE:

PLATE PAN WEIGHT MEASUREMENTS

PAN #	t TIME BEFORE (h:min:s)	t TIME AFTER (h:min:s)	w WEIGHT BEFORE (g)	w WEIGHT AFTER (g)	DELTA WEIGHT (g)

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TEST PROCEDURE USED FOR DENVER DATA COLLECTION

2008-2009

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS

Denver International Airport
Denver, Colorado

Prepared for

The Airport Cooperative Research Program
Transportation Research Board
of
The National Academies

Prepared by: David Youssef

Reviewed by: Michael Chaput

January 29, 2009
Version 1.0

IMPLEMENTATION OF HOLDOVER TIME DETERMINATION SYSTEMS

PROCEDURE FOR AIRPORT DATA COLLECTION OF PRECIPITATION INTENSITY AND METEOROLOGICAL PARAMETERS
Denver International Airport
Denver, Colorado

1. BACKGROUND

Holdover Time Determination Systems (HOTDS), such as D-Ice A/S Deicing Information System and National Center for Atmospheric Research (NCAR) Checktime, measure meteorological parameters at airport sites and calculate de/anti-icing fluid holdover times, thus facilitating better de/anti-icing fluid selection by flight crews.

Operational data collection activities performed by APS Aviation Inc. (APS) from 2004-06 at Montreal-Trudeau International Airport (YUL) clearly demonstrated the benefits that could be realized by the aviation industry through implementation of HOTDS equipment. In nearly 28% of all departures analyzed during winter precipitation events at YUL, Type IV fluids were unnecessarily applied to the departing aircraft. Implementation of HOTDS equipment could result in an immediate source reduction of glycol, reduced operating costs, reduced environmental impact, as well as improved operational efficiencies and improved safety.

APS has tested a HOTDS for the past five years at YUL and the system recently received regulatory approval for use in Canadian air operations. A similar regulatory approval process is underway in the United States. HOTDS equipment will be readily available for airport implementation in the upcoming years.

As de/anti-icing fluid holdover time is directly dependent on precipitation intensity, it is vital that the intensity measured and used by the HOTDS reflects the highest intensity to which the aircraft may be exposed during its departure taxi. It is not known whether a precipitation sensor at a single location on an airport can provide data with sufficient reliability for this application. For this reason, the HOTDS project performed by APS on behalf of ACRP will focus on siting issues related to HOTDS implementation.

1.1 Denver International Airport

In Winter 2008, APS developed a procedure for gathering experimental data related to this task, and an extensive data collection exercise was performed. The procedure consisted of measuring precipitation intensity, type and temperature at

two airport locations simultaneously to understand the variances between the two locations and determine the impact on the holdover times as a result of these variances. The data collection went extremely well, and APS personnel gathered 126 data points at YUL in Winter 2008. The separation distances between APS test personnel ranged from 4,000 to 13,000 feet for these tests.

When experimental data were analyzed, it was discovered that small separation distances between data collection locations resulted in little or no impact on the amount of precipitation collected during each precipitation rate collection period, but that the variance increased as the separation distance increased. As only a small amount of data was collected with separation distances above 7,000 feet, APS recommended to the ACRP 10-01 Project Panel that more data should be gathered to complete this study.

Denver International Airport (DEN) is one of the largest airports in the world from the perspective of surface area, with over 30,000 feet separating certain active runway departure points. For this reason, as well as for reasons related to the historical nature and severity of winter precipitation in Denver, DEN was selected as a desired test location for the continuation of the HOTDS siting study.

2. PREVIOUS WORK

Previous tests were conducted during nine snowstorm events within the period from February 1, 2008 to March 13, 2008. All tests were conducted in the vicinity of YUL.

In addition to the work performed in February-March, 2008, additional testing on HOTDS siting was performed at Montreal-Mirabel International Airport (YMX) and Syracuse-Hancock International Airport (SYR) in December 2008 and January 2009. The work at YMX was performed at long separation distances (28,000 feet), to examine test procedures in advance of the DEN testing. The work in SYR was performed to examine the impacts of lake-effect snow.

3. OBJECTIVES

The objective of this project is to determine if a single location precipitation sensor can reliably report precipitation conditions for the entire airport. The objective will be met by measuring precipitation intensity, as well as other meteorological parameters affecting de/anti-icing holdover time, at two locations at an airport simultaneously. The simultaneous collection of precipitation intensity and meteorological parameters will be performed to fully understand variances between test locations.

4. ANTICIPATED TEST PERIOD

The anticipated test period for the testing outlined in this document is between February 9, 2009 and March 27, 2009. APS personnel will deliver the required test equipment to DEN in advance of the onset of testing. The test equipment will be housed by the Denver Airport Authority until APS personnel arrive in Denver for the first test event. The equipment will then be transferred to an off-site warehouse with 24-hour access by APS personnel.

During the above-mentioned test period, APS personnel will undertake data collection activities on three or four occasions, based on the natural occurrence of suitable precipitation conditions. For this reason, APS personnel will not be permanently based in Denver, but rather will travel to and from Denver as required. APS personnel will notify DEN personnel as soon as possible in the event that testing is anticipated, according to the Detailed Test Procedures and Contact List, included in Attachments I and II, respectively.

5. TEST LOCATIONS AT DEN

In November 2008, APS personnel travelled to Denver to provide a presentation on the propose testing to the Denver Airport Authority and airport stakeholders (air carriers and service providers). Subsequent to this meeting, a site survey of the airport was performed to identify ideal test locations. Three suitable locations were identified in this site survey, and have been included in the aerial view of the Denver Airport in Figure 1.

1. AARFF Training Facility
2. Cul-de-Sac (off of Pena Boulevard)
3. Mt. Elbert Parking Lot, P42

Figure 1: Aerial View of DEN and Selected Test Locations

The computed distances between the selected data collection sites are:

- AARFF Training Facility and P42 = 30,000 feet
- AARFF Training Facility and Cul-de-Sac = 25,000 feet
- Cul-de-Sac and P42 = 13,000 feet

It is anticipated that the bulk of all data collection will be performed from the AARFF and P42 test locations.

6. TEST PROCEDURE

The test procedure developed for use during HOTDS testing in Denver is based on the precipitation intensity measurement procedure included in Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5485. This is the same rate measurement procedure that has been employed in the development of de/anti-icing fluid holdover time tables since 1990.

The test procedure consists of measuring the precipitation catch of four collection

pans of a known surface area over a known period of time. The collection pans will be positioned on a specially designed test stand.

All APS personnel will follow the step-by-step test procedure included in Attachment I. Attachment I also includes a list of required Test Pre-Preparation activities, which also includes a communication plan for APS test intentions.

The step-by-step procedure in Attachment I will be performed simultaneously by the two test units. Testing will be performed on the hour and at 20 minutes and 40 minutes past the hour, using the sequence of test events included in Attachment III. Each precipitation rate collection will last ten minutes, thus allowing for three measurements per hour of activity.

7. EQUIPMENT

Equipment required for the conduct of testing is shown in Attachment IV.

8. PERSONNEL

A minimum of two APS personnel will be required for this testing. Each of the two remote locations will be manned by at least one APS tester.

9. DATA FORMS

One general data form will be used to record precipitation collection. This data form is included as Attachment V.

Attachment I
Implementation of Holdover Time Determination Systems
Data Collection Procedure

- Ensure all Pre-Test Preparations are completed:

  - Communicate with Herald Hensley (see Attachment III) to ensure access to P42 (Mt. Elbert Parking Lot)

  - Make arrangements for equipment storage in Denver;

  - Monitor weather for ideal conditions;

  - Arrange for travel to Denver, if not already on site;

  - Communicate test plans and locations with Denver International Airport personnel (see Attachment III) according to the following guidelines, if possible:

    - Event minus 48 hours;
    - Event minus 24 hours;
    - Event minus 12 hours; and
    - Event minus 6 hours.

    If proposed communication is outside of normal operating hours, send email or text message, or establish boundaries for communication with the Denver International Airport personnel well in advance. In the event of timing change or test event cancellation, advise Denver International Airport personnel immediately;

  - Arrange for personnel and truck rentals;

  - Arrange for and undertake collection of test equipment from Denver International Airport personnel during normal operating hours (prior to first test event only);

  - Verify all test equipment.

- Transport mobile unit and test team to remote location and establish radio communication with other location;

- Communicate with Denver International Airport personnel, unless otherwise indicated, once on site and prior to onset of testing;

- Plug inverter to power lights and weigh scale;

- Determine wind direction and position test stands into the wind;
- Ensure 10° slope (from horizontal) of collection pans is achieved;
- Set up and level weigh scale;
- Prepare rate pans by adding 450 ml of Type IV fluid to each pan;
- Weigh and record weight of each pan, cover with lid and place on stand;
- Communicate with other test unit as to start time of tests;
- Follow the included sequence of tests and communicate regularly with other location to ensure there are simultaneous activities taking place; and
- Continue collection of rates throughout precipitation event.

Attachment II
Implementation of Holdover Time Determination Systems
Contact List

APS Aviation:

- APS Aviation office: (514) 878-4388

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- David Youssef:
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  - Office Phone: (514) 878-4388 ext. 225
  - Cellular Phone: (514) 967-3947

- Dany Posteraro:
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Denver International Airport:

- Janell Barrilleaux:
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- Craig Schillinger:
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- Herald Hensley (For access to Mt. Elbert Parking Lot-P42)
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Attachment III
Implementation of Holdover Time Determination Systems – Sequence of Testing
(Testing Performed at 0, 20 and 40 minutes past each hour)

Rate 1

TIME	Tester 1	Tester 2
T = - 5 Minutes	Weigh and record initial weight	Weigh and record initial weight
T = -3 Minutes	Verify wind direction and adjust stand	Verify wind direction and adjust stand
T = -2 minutes	Place two covered plates on stand	Place two covered plates on stand
T = 0	Remove Covers	Remove Covers
T= 2 minutes	Rotate Pans	
T= 4 minutes	Rotate Pans	
T= 6 minutes	Rotate Pans	
T= 8 minutes	Rotate Pans	
T= 10 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 2

TIME	Tester 1	Tester 2
T = 18 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 20	Remove Covers	Remove Covers
T= 22 minutes		Rotate Pans
T= 24 minutes		Rotate Pans
T= 26 minutes		Rotate Pans
T= 28 minutes		Rotate Pans
T= 30 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Rate 3

TIME	Tester 1	Tester 2
T = 38 minutes	Place pans back on stand. Verify wind direction and adjust stand	Place pans back on stand. Verify wind direction and adjust stand
T = 40	Remove Covers	Remove Covers
T= 42 minutes	Rotate Pans	
T= 44 minutes	Rotate Pans	
T= 46 minutes	Rotate Pans	
T= 48 minutes	Rotate Pans	
T= 50 minutes	Cover pans and bring in for measurement	Cover pans and bring in for measurement

----------*Elapse 8 Minutes*----------

Attachment IV
Implementation of Holdover Time Determination Systems
Equipment List per Test Team

- 15′ cube truck
- 4 rate stands
- 8 rate pans
- 8 rate pan covers
- Sartorius weigh scale
- Backup weigh scale
- 6′ portable table
- Shelving unit for rate pans
- Smart tool Inclinometer
- Stop watch x 2
- Power inverter
- Shop towels
- Water (2 x 18 litres)
- Small squeegee to clean pans
- Yellow flood lights
- Data forms and procedures
- Pencils and sharpies
- Pencil sharpener
- Motorola radios
- Two waste containers
- Weather vane
- Fishing gloves
- Funnel
- Shovel
- Space heater
- Extension cable x 2
- Measuring cup
- Camera equipment

Attachment V
Implementation of Holdover Time Determination Systems
Data Form

LOCATION: DATE:

PLATE PAN WEIGHT MEASUREMENTS

PAN #	t TIME BEFORE (h:min:s)	t TIME AFTER (h:min:s)	w WEIGHT BEFORE (g)	w WEIGHT AFTER (g)	DELTA WEIGHT (g)

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