TP 308 IMPACT STUDY TORONTO BILLY BISHOP/TORONTO CITY AIRPORT

for

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1.0 INTRODUCTION

Air Navigation Data has been retained by Porter Airlines to determine the impact of lengthening runways 08 and 26, as described in Figure 1, paragraph 8, with respect to instrument approach and departures only.

1.1 Company Background

Founded in 1995, Air Navigation Data is focused on the development of world-class software to support airspace and instrument approach procedure designers and on providing turnkey services to airport and aircraft operators.

1.2 Relevant Experience

Porter Airlines has partnered with Air Navigation Data to design several specialized procedures for Toronto City Centre Airport. Air Navigation Data also provides ongoing maintenance for the Toronto Port Authority to ensure that Porter is alerted to the possible impacts of airport and surrounding development.

1.3 Transport Canada Aviation Approval

Air Navigation Data recently has been formally approved to design RNAV(GNSS) procedures in accordance with TP 308 Change 5.3 (adding the design criteria for LPV procedures to Category I minimums).

1.4 Services

Responding to the needs of those who don't have a full time procedure design office, Air Navigation Data opened its services division in 1999. Since then, a variety of operators, from scheduled air carriers to medevac helicopters, have benefited from our support.

STARS, the helicopter air ambulance service provider for the provinces of Alberta, Saskatchewan and Manitoba, relies exclusively on Air Navigation Data to design and maintain some three dozen approaches to their various helipads at hospitals around throughout this region. This is inclusive of the initial design, as well as maintenance and periodic review, as required by the regulations.

1.5 Products

1.5.1 Pathfinder®

The first product released by Air Navigation Data was Pathfinder, an advanced geodesic calculator, which has been the product of choice for many agencies around the world. Pathfinder performs a number of other functions designed specifically for the requirements of Aeronautical Information Service (AIS) officers.

1.5.2 Final Approach®

In response to the increasing complexity and number of instrument approach procedure criteria, Air Navigation Data began development of a complete and fully integrated design tool. The goal was to deliver a program that would automate and simplify the often trial-and-error process of instrument approach procedure design. Final Approach has achieved that objective and is now utilized by both civilian and military agencies to perform two major roles. Firstly, of course, to design of instrument approach procedures. Secondly, to verify designs produced by others. As such, regulatory agencies use Final Approach as a final validation of designs submitted for approval.

2.0 OVERVIEW

The Billy Bishop Toronto City Airport, formerly named the Toronto City Centre Airport, is a certified airport, as defined by the Canadian Air Regulations, and operated by the Toronto Port Authority (the TPA). Its geographic coordinates are N43° 37´ 38.51" W79° 23´ 46.33". The airport has three runways designated 15/33, 08/26, and 06/24. The airport is used for commercial scheduled operation's, by Porter Airlines and Air Canada, non-scheduled air ambulance services and general aviation.

The TPA is a federal public authority established under the *Canada Marine Act* (June 8, 1999). As successor to the Toronto Harbour Commissioners, which was constituted as a corporation in 1911 under the *Toronto Harbour Commissioners Act*, the TPA operates pursuant to Letters Patent issued by the Federal Minister of Transportation.

The operation of the City Airport is subject to a Tripartite Agreement, created in 1983 at the request of the City of Toronto, between the then Toronto Harbour Commissioners (now the TPA), the Government of Canada and the City of Toronto.

3.0 REFERENCE DOCUMENTS

- Aerodrome Standards and Recommended Practices (TP 312), Transport Canada;
- Criteria for the Development of Instrument Procedures (TP308), Transport Canada;
- International Civil Aviation Organization (ICAO Annex's 14 and 15);
- Canadian Aviation Regulation 803.01.

4.0 UNITS OF MEASURE

Units of measure used are imperial, as these are used predominantly in aviation, with the exception of the aerodrome standards which are metric. All obstacle heights however, are provided in both metres and feet, relative to Mean Sea Level (MSL). Geographic coordinates are in Latitude and Longitude, referenced to WGS 84 datum.

5.0 SOFTWARE

Software used for assessing the instrument procedures, departures, and Obstacle Limitation Surfaces (OLS) is Final Approach version 2.9. Final Approach is an instrument procedure design, airspace and aeronautical management software produced by Air Navigation Data.

6.0 SOURCES OF INFORMATION

Air Navigation Data has used the following sources of information to complete its assessment:

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- Digital Terrain Elevation Data - Geomatics Canada;
- Obstacle data - Nav Canada current as of 10 January, 2013 and supplemented with data obtained by Air Navigation Data;
- Aeronautical data from Jeppesen Sanderson Inc. current as of 10 January, 2013;
- Canada Air Pilot (CAP) – Ontario, Nav Canada. Effective date 10 January, 2013, (TAB 4);
- Restricted Canada Air Pilot (RCAP), Nav Canada. Effective date 10 January, 2013, (TAB 4);
- Canada Flight Supplement, Nav Canada. Effective date 10 January, 2013, (TAB 5).

6.1 Digital Terrain Elevation Data

Digital terrain elevation data is used to provide the topography within the design domain. This data is used in Final Approach and was obtained from Geomatics Canada. All height references in Final Approach are with respect to Mean Sea Level. The terrain data provides ground height.

6.2 Obstacles Assessment

Obstacle data was obtained from Nav Canada and supplemented with data obtained by Air Navigation Data. All obstacles are assumed to have a horizontal margin of error of 100ft (30.48 m). Wherever possible, Air Navigation Data's obstacle data is supported by source documentation. Where source documentation is unavailable and the obstruction is deemed critical, a survey is recommended.

6.3 Aeronautical Data

Aeronautical Data is required to replicate instrument procedures and aircraft operations. This data describes the type, position and characteristics of: airports, runways, navigation facilities, waypoints, and

fixes. This data changes frequently and is released on a predetermined cycle. For this analysis, the data released on the 56 day cycle starting 10 January, 2013 was used. This data was obtained from Jeppesen Sanderson Inc.

6.4 Canada Air Pilot (CAP)
The Canada Air Pilot for Ontario dated 10 January, 2013 was used in the replication of procedures.

6.5 Restricted Canada Air Pilot (RCAP)
The Restricted Canada Air Pilot, dated 10 January, 2013, was used in the replication of procedures.

6.6 Canada Flight Supplement,
The Canada Flight Supplement, dated 10 January, 2013, was used to for aeronautical data verification.

7.0 Methodology
To assess the new runway configuration, new instrument approach and departure procedures were designed based on the new runway threshold coordinates. Currently published instrument procedure configurations were adhered to as closely as possible.

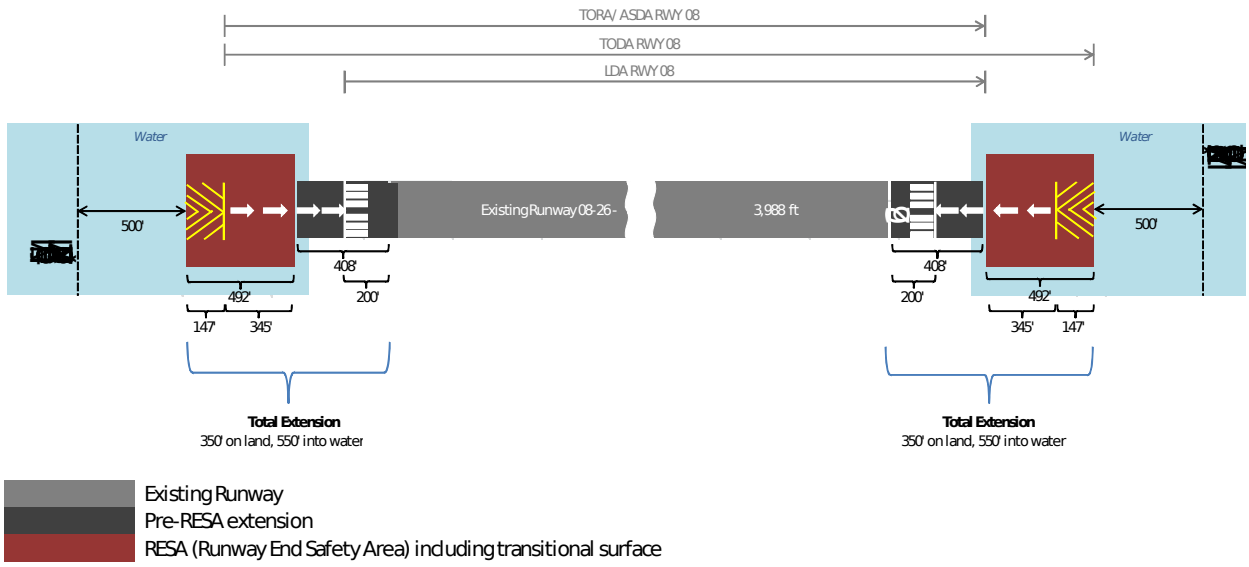
7.1 Instrument Approach Replication
The instrument procedures published in the Canada Air Pilot and Restricted Canada Air Pilot are designed according to The Criteria for Instrument Procedure Development (TP308). Instrument procedure analysis was conducted using Final Approach software version 2.9.

7.2 Aircraft Departure Assessment
Departure assessments using Final Approach software were made to ensure that climb gradients agreed with published values in the Canada Air Pilot's Aerodrome Chart.

8.0 TP 308 Impact Study for BBTCA
The purpose of this Impact Study is to evaluate the existing instrument approach and departure procedures with respect to the revised runway length described in Figure 1 in paragraph 8.0.

YTZ Runway 08-26 Proposed Extension Distances

TORA	Clearway	Stopway	TODA	ASDA	LDA	RESA
5149'	492'	0'	5641'	5149'	4596'	492'



147' at end of pavement is unusable buffer required per Transport Canada TP-312

Figure 1*

**The above distances are based on a proposal designed and vetted by an airport design consultant, using Transport Canada airport planning criteria. The design considers the operating environment surrounding the airport and other constraints specified by the air carrier. DEPICTION NOT TO SCALE.*

The revised runway threshold coordinates are as follows:

- Runway 08: N43 37 38.25 W79 24 14.59
- Runway 27: N43 37 51.97 W79 23 18.01

Based on the revised runway configuration described in Figure , paragraph 8.0, the following design elements have been analyzed:

Departure Assessment Runway 08;

- Departure Assessment Runway 26;
- ILS Runway 08 Relocation of Localizer and Glide Path Antenna;
- ILS Runway 08 obstacle assessment;
- ILS Runway 26 Relocation Localizer and Glide Path Antenna;
- ILS Runway 26 obstacle assessment;
- RNAV(GNSS) C obstacle assessment;
- RNAV(GNSS) C Increase to Category C;
- ILS/DME RWY 26 Increase to Category C.

8.1 Departure Assessment Runway 08

The published departure procedure for runway 08 does not meet criteria for Category C aircraft. Category A and B aircraft require an obstacle assessment outer boundary turning radius of 2 NM (see Figure 1). The Hearn Stack is not within this obstacle assessment area. A Category C aircraft departure requires an obstacle assessment area defined by a 5NM radius (this radius is normally 5.5 NM but can be reduced to 5 NM if aircraft speed on departure is kept below 250 Kts). An obstacle assessment area based on a 5 NM radius would include the Hearn Stack and as a result, a climb gradient 960 ft/NM would be required.

8.1.1 Mitigation

It would be possible to mitigate this issue using FAA Order 8260.58 departure criteria. By redesigning the runway 08 departure to have an immediate 15 degree right turn on take-off, a standard climb gradient of 200ft/NM is possible.

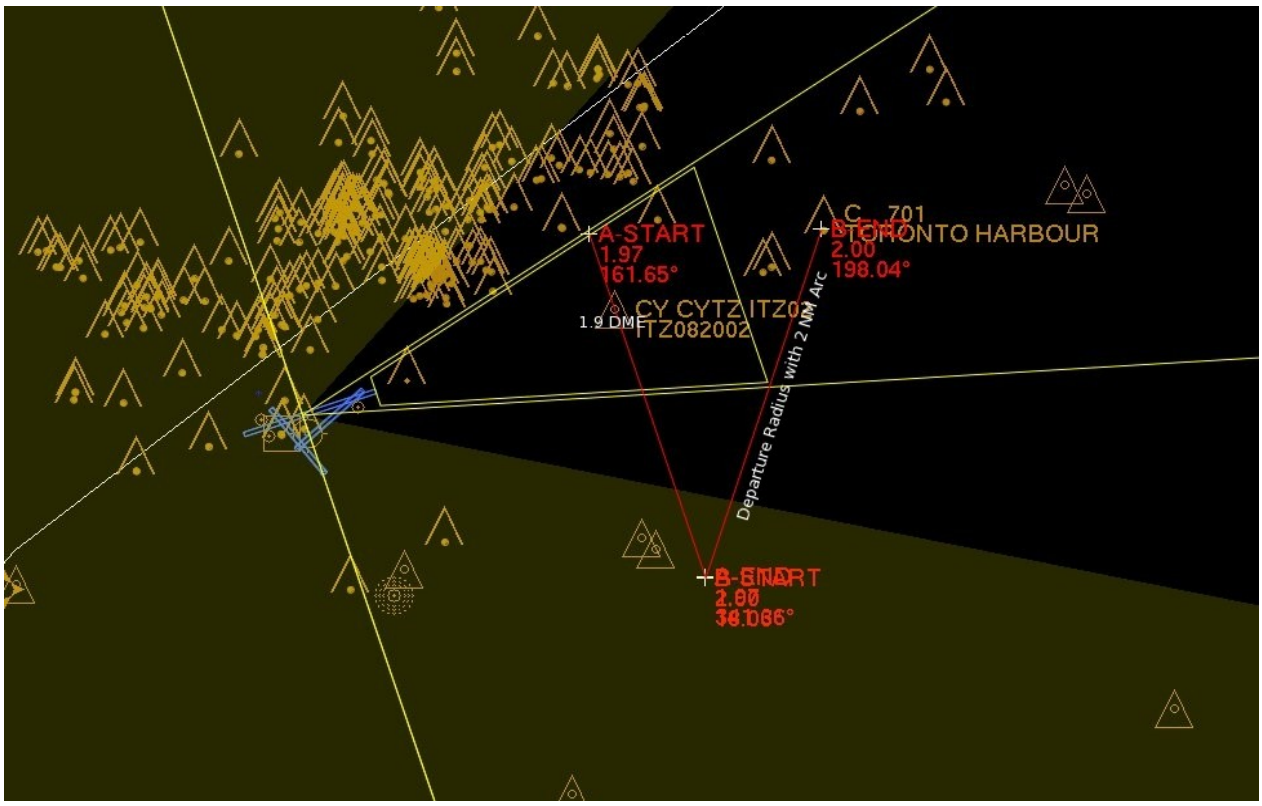


Figure 2

8.2 Departure Assessment Runway 26

A departure assessment for runway 26, based on the runway configuration described in Figure 1 in paragraph 8.0, has found that:

- A standard climb gradient is adequate for runway 26.
- The current published departure is suitable for all aircraft up to and including Category C.

8.3 ILS/DME RWY 08 - Relocated Localizer and Glide Path Antennas - See Map 1, TAB 2

ILS/DME RWY 08 has been assessed based on the revised runway configuration described in Figure 1 in paragraph 8.0.The following observations have been made:

- To produce an equivalent glide path angle of 3.5 degrees and maintain a Threshold Crossing Height (TCH) of 58 ft, the Glide Path antenna position needs to be relocated to N43 37 37.46 W79 24 00.61.

- The Localizer position, as currently shown in aeronautical data bases, is N43 37 47.69 W79 23 24.5. This position is not exactly in the centre of the antenna array, but to the northern end. This position causes the Decision Altitude (DA) to Localizer (LOC) Runway (RWY) Intersection to be outside the range of 1100 to 1200 ft. Re-adjusting the Localizer position so that it is in the centre of the array places the DA to LOC RWY Intersection at 1310ft. Shifting the Localizer position slightly off centre brings the DA to LOC RWY Intersection within range. The margin of error is within the Localizer signal tolerance.

- DME readings to the RONTO intersection will be 3.31 DME, which will be rounded to 3.3 DME for publication purposes.

- DME readings to the DA will be 0.84 DME, which will be rounded to 0.8 DME for publication purposes.

Air Navigation Data does not see any instrument procedure design issues with the relocation of the runway threshold and glide path antenna.

There is a risk that ILS signal integrity cannot be attained due to propagation issues.

Note: *Air Navigation Data does not have the capability to measure or assess ILS signal integrity, or the flight inspection equipment necessary to assess any changes to the glide path or Localizer antenna positions.*

8.4 ILS/DME RWY 08 Obstacle Assessment – See Map 2 & 3, TAB 3

The published ILS/DME RWY 08 instrument procedure has been assessed with the revised runway configuration described in Figure 1 in paragraph 8.0.

- The most westerly edge of the MEZ is 1218.62ft (371.4m) from the new threshold of runway 08. At a 3.5 degree glide path, the height of the GQS at the western edge of the MEZ is 54 ft (16.5m) above MSL. This is 6ft (1.8m) lower than before the change in runway threshold. In order to preserve the 60ft GQS height at the western edge of the MEZ an increase in the glide path angle to 3.9 degrees will be required. This is a standard glide path angle which will not create any issues for aircraft accessing the airport or using this approach.

- The controlling obstacle in the Missed Approach Segment is YTZ32, a building at 218 Queens Quay West at 635ft (193.5 m) MSL, which is 7.5ft below the missed approach surface and therefore meets the instrument approach design criteria.

8.5 ILS/DME RWY 26 - Relocated Localizer and Glide Path Antennas – See Map 1, TAB 2

The published ILS/DME RWY 26 instrument procedure has been assessed with the revised runway configuration as described in Figure 1 in paragraph 8.0. The glide path antenna needs to be relocated to N43 37 52.09 W79 23 30.93. This is approximately 200ft (60.9m) east of its current position. The following

issues that exist for the glide path antenna in its current position will remain.

- Possible glide path signal disturbance with a vehicle or aircraft on taxi way Delta. The Hold line currently in place will still be required on the apron side.
- Possible signal disturbance by a vehicle or aircraft on runway 24, adjacent to the glide path antenna.
- Glide path signal disturbance or reflection may be caused by new and/or existing buildings on the shoreline.
- The Localizer antenna can remain in its current location.

There is a risk that ILS signal integrity cannot be attained due to signal propagation issues.

In order to preserve the DA to Localizer runway intersection within the 1100ft to 1200ft range we have changed the Localizer bearing to 264.6 magnetic, which would reduce the offset from 3.0 degrees to 2.4 degrees.

8.6 ILS/DME RWY 26 Obstacle Assessment - See Map 2, TAB 3

The ILS/DME RWY 26 published instrument procedure has been assessed with the revised runway configuration described in Figure 1 in paragraph 8.0.

- With the threshold of runway 26 being moved 200ft to the east, the Hearn Stack, identified as obstacle 701 Toronto Harbour and standing at 954ft (290.5m) (Figure 1), becomes the controlling obstacle in the Final Segment. Using coordinates provided by Nav Canada, the stack stands at 4.7ft (1.4m) below the obstacle limitation surfaces in this segment and therefore meets the instrument procedure design criteria. Air Navigation Data *recommends a legal survey prior to redesigning the approach*. All values are within a margin of error.
- A condominium at 90 Stadium Road, identified as YTZ09 90 Stadium Road and standing at 504 ft (153.6 m) MSL, is the controlling obstacle in the Missed Approach; this is 6 ft (1.83m) below the missed approach surface and therefore meets the instrument procedure design criteria. The height of this obstacle has been verified using technical drawings obtained from Architects Alliance.

8.7 ILS/DME RWY 26 Increase to Category C

The ILS/DME RWY 26 has been assessed with the revised runway configuration described in Figure 1 in paragraph 8.0.

- The existing ILS/DME RWY 26 has a glide path angle of 4.8 degrees which is considered a steep approach.
- The ILS/DME RWY 26 GQS is currently 71.36ft (12.8m) above MSL at the eastern end of the MEZ and provides the required MEZ clearance. If this procedure is to be used by Category C aircraft it must be approved for “steep approaches.”
- Required Navigation Performance – Authorization Required (RNP-AR) instrument approach would permit a lower glide path angle and a different approach configuration which would avoid the Hearn Stack and also preserve the current MEZ clearance.

8.8 RNAV (GNSS) C Obstacle Assessment

RNAV (GNSS) C has been assessed with the revised runway configuration described in Figure 1 in

paragraph 8.0.

- RNAV (GNSS) C will not be affected by the change in runway configuration; although, a slight adjustment to the final segment waypoints will be necessary. The offset angle is currently at 15 degrees and the change in runway threshold causes this angle to increase to 15.1 degrees. This is 0.1 degrees greater than the maximum allowed so the location of the approach waypoints will be slightly altered in order to maintain the 15 degree offset.

- The controlling obstacle in the Final Segment is YTZ23 888 Newfoundland Road at 500ft (152.4m) MSL.

- The controlling obstacle in the Missed Approach Segment is Obstacle 17981 Toronto at 584ft (178.0m) MSL.

8.9 RNAV (GNSS) C Increase to Category C

The RNAV (GNSS) C has been assessed with the revised runway configuration described in Figure 1 in paragraph 8.0.

- There are no restrictions to category C aircraft when using RNAV (GNSS) C to the current published minimums.