St. Mary's Airport GNSS RNAV Instrument Approaches Runway 27/32 Impact Assessment

1) **Objective**

The objective of this document is to identify the differences between the existing NDB approaches for runways 27 and 32 and the proposed RNAV approaches and assess the possible impact of these differences on the local communities and environment.

2) Current Procedures

Runways 27 and 32 currently have timed NDB approach procedures with either a racetrack pattern or, in the case of the alternate approaches, a tear drop pattern for aircraft in speed Category A only. Runway 27 also has a Direct Arrival procedure which uses ranges and radials from the LND VOR/DME and includes a hold at LANLO.



The current NDB Intermediate and Final Approach tracks are 2 degrees (Runway 27) and 3 degrees (Runway 32) offset from the extended runway centre lines and intercept the runway centreline 0.9 nautical miles before the threshold. This ensures that aircraft on the NDB approaches are currently aligned with the runways when crossing the coast and the cliff-top location of the thresholds ensure that no Properties are overflown on the approaches.

The STM NDB is the missed approach holding fix for the holds associated with the NDB IAPs.

The table below illustrates the number Runway Movements with percentage usage along with the number of IAPs flown for runways 27 and 32 over a two year period as well as the overall percentage breakdown.

2017 Runway Landings				2018 Runway Landings				2019 Runway Landings			
Rwy 27	Rwy 32	Rwy 14	Rwy	Rwy 27	Rwy 32	Rwy 14	Rwy	Rwy 27	Rwy 32	Rwy 14	Rwy
			09				09				09
1852	2023	1446	581	1582	2602	1694	789	1370	2158	1997	537
31%	34%	25%	10%	24%	39%	25%	12%	22%	36%	33%	9%
IAP's Flown				IAP's Flown				IAP's Flown			
23	4			45	10			29	2		

Runway 27 gets the majority of IAPs as it is the most convenient with the Direct Arrival allowing aircraft to make an approach without first coming to the overhead.

Note: 2019 figures based upon data up to end of November.

Missed Approach

The missed approach procedures for both runways are to climb straight ahead to 1500' amsl and turn left back to the STM NDB, this lines the aircraft up to make the alternative procedure if they wish.

Although difficult to quantify it is believed that approximately 1% of NDB approaches flown result in a Missed Approach being executed.

3) New Procedures

In line with St. Mary's runway characteristics, the GNSS IAP's to be provided, have been designed in accordance with ICAO Doc. 8168 (Pans-OPS) for aircraft in Approach Speed Category A with the following approach types;

- LNAV Lateral navigation procedures equivalent to a GNSS Non Precision Approach that can be flown by aircraft equipped with a standard (TSO/ETSO 129) GPS receiver.
- LPV Localiser Precision Vertical procedures which provide both lateral and vertical Navigation that is
 presented as an "ILS type" of indication in an aircraft equipped with an SBAS receiver. (TSO/ETSO 145/146).
 LPV procedures can only be supported by augmented GNSS in accordance with the ICAO Satellite Based
 Augmentation System (SBAS), which in the European Union is provided by the European Geostationary
 Navigation Overlay Service (EGNOS)

The procedures have been prepared by Davidson Ltd for LNAV and LPV minima with 3.5 degree vertical path angles, harmonized with the existing PAPIs with a Reference Datum Height (Threshold Crossing Height) of 40' in accordance with ICAO 8168, Part 3 Section 2, Chapter 6, Para 6.2 b.

The 3.5 degree approach was a deliberate design choice to maintain aircraft height on approach, this is of particular importance as the AIP notifies that "Turbulence and/or windshear may affect the final half mile of approaches to all runways and may be increased by valley effect and/or structures when using Runways 09, 14 or 27."

The St. Mary's runways are considered to be Non Precision Instrument (with limitations) and therefore the minimum possible OCH for any LPV to a Non-Precision runway will be limited to 300' (LPV system minima + 50')

The 300' Minimum OCH for runways 27 & 32 appear to offer limited benefit compared to LNAV IAP's however, the LPV approaches will provide geometric vertical guidance with integrity facilitating a stabilized approach. It is also expected that the operators calculated visibility requirements will be lower for the LPV than for the LNAV procedures.

The missed approach for all procedures is to turn back to the Initial Approach Fix (IAF) and then follow the Initial Segment to hold at the Intermediate Fix (IF) of the active runway. All missed approach holds are located over the sea.

Proposed GNSS Procedure images from ACP Framework Briefing:

RWY 27:



RWY 32



4) NDB and RNAV Comparison

4.1) 27 Arrivals remain in line with the current NDB procedure direct arrival with no significant increase in track mileage.



4.2 32 Arrivals will be a slight reduction in track mileage compared to the NDB IAP due to the entry requirement to proceed outbound from the STM

4.3 RNAV Arrival and Approach to MDH/DH

The LNAV and LPV procedures provide a reduction in the OCH of approximately 100' compared to the existing NDB Non-Precision Approach procedures.

Dupuov	NDB	LNAV	LPV		
Runway	OCH (Feet)	OCH (Feet)	OCH (Feet)		
27	405	305	300		
32	418	318	300		

A 100' reduction in the OCH between the GNSS procedures and the existing NDB procedures is considered to provide a higher level of safety than the existing NDB procedures as;

- The LNAV and LPV Approach procedures ensure that the aircraft is aligned with the runway at Decision Height (DH).
- The LPV IAPs provide vertical guidance allowing a stabilized approach.
- The LNAV and LPV IAPs significantly reduce pilot workload compared with the NDB Non-Precision Approaches where the pilot has to assess and compensate for drift during the approach.
- The LNAV and LPV IAPs are not affected by Coastal Refraction, Precipitation Static and Night effect, all of which degrade the NDB approach increasing pilot workload.

All MDH/DH are over the sea.

4.4 Undershoot Events

There is no history of undershoot events at St. Mary's Airport and the GNSS instrument approaches and recent runway improvements will reduce the probability of undershoot occurrence compared to the existing NDB Non-Precision Instrument approaches.

With the GNSS IAPs, there is a significant Visual Phase between DH/MDH to the runway threshold during which the improved aerodrome marking and lighting, in particular PAPIs aligned with the GNSS approach, Green threshold bars, runway edge lighting and white Strobescopic Runway Threshold Indicator Lights will provide the necessary visual guidance to the runway threshold.

The GNSS IAPs will, in the case of an LNAV approach, provide lateral guidance aligned with the runway heading facilitating a CDFA approach down to the MDH and in the case of an LPV approach, 3 dimensional guidance will be provided facilitating a stabilized approach thereby minimizing significant aircraft positioning within the visual phase of the landing.

5) Benefits of the RNAV IAPs.

The improved performance of the proposed RNAV approaches contribute to improved safety and improved operating minima in poor weather conditions.

a. RNAV Increased Safety

The following factors contribute to improved levels of safety

- LNAV Aircraft will be aligned with Runway
- LPV Aircraft will be stabilized at higher altitude aligned with runway and harmonized with the PAPI visual guidance.
- RNAV approaches are not affected by Coastal Refraction, Precipitation Static or Night Effects that reduce accuracy of an NDB approach,

Human Factors - Lower pilot workload as the pilot does not have to correct for wind drift and knowing that runway and lighting will be directly ahead.

b. Fewer Missed Approaches

It is expected that the RNAV procedures will result in fewer missed approaches due to the geometric vertical guidance aligned with the runways and PAPIs facilitating stabilized approaches.

c. Improved Service Regularity

The RNAV approaches will improve the regularity of air services into St Mary's through:

- Stabilized approaches precisely positioning the aircraft at Decision Height providing a higher probability of a successful landing.
- RNAV approaches have an improved Decision Height potentially reducing the numbers of cancelled flights.

6) Conclusion

From the comparison of the new RNAV and the existing NDB Instrument Approach Procedures presented in section 4, it is shown that there are only small differences in the approach tracks. These differences are confined to the overwater portions of the approaches and will therefore not be perceptible to the island communities.

The implementation of the RNAV approaches has no significant impact on emissions as the 27 approach is slightly longer and the 32 approach is slightly shorter in terms of track miles. The stabilized approach for the LPV approaches may allow the aircraft to be flown with lower power settings and the expected lower number of missed approaches may also contribute to lower overall emissions than the existing NDB approaches.