Subject: Runway Analysis "escape procedure" utilization under Part 135/91 likely creating false sense of safety.

Purpose: This SAFO serves to alert operators utilizing runway analysis solutions (ie "escape procedures") to the necessity of conforming to navigation database validation, aircraft certification, flightcrew procedures and pilot training requirements. It is highly unlikely that operator's equipment, aircraft certification or pilot training and currency are adequate to meet the demands of runway analysis escape procedures. An "authorization required" to utilize runway analysis procedures under part 135/91 operations should fashion similar standards as currently utilized within LOA C384 RNP-AR approach requirements.

Background: Within the current US airspace, unique approaches are allowed that provide an "unprecedented level of flexibility" due to the incorporation of narrower obstacle clearance and path structure, referred to as "RNP AR" Approach procedures. These approaches require aircraft and crew authorization per operator due to the specialized equipment and CRM requirements necessary. AR-RNP approach guidance is provided by AC90-101A including OpSpec issuance (LOA C384);

> (2) Final Authorization. The CHDO/FSDO will issue OpSpecs, MSpecs, or LOA authorizing use of lowest applicable minima after operators satisfactorily complete their interim authorization period and upon the CHDO/FSDO review of reports from the operator's RNP monitoring program.

Due to the higher and necessary standards set in equipment and crew training to safely navigate the narrow corridors of RNP-AR procedures, few operators have elected to invest the time and money to acquire the authorization required.

Recently, Honeywell announced FAA approval for an Aspen RNP approach (RNP-AR). Within the announcement, specific acknowledgement that

"pilots must be trained for RNAV(RNP) using a training program approved by the regulatory agency. For operators of US-registered aircraft, this is already a requirement of LOA C384. Pilots must review the Aspen RNAV(RNP) briefing package prior to using the approach."

Also included and reflected in AC90-101A

"The aircraft must meet the following requirements as well:

- *RNAV(RNP) to RNP 0.1 lines of minima*
- *RNP less than 1.0 in the missed approach*
- *Radius to Fix legs"*

Correspondingly, runway analysis departure procedures, so called "Escape Procedures" or "Special Procedures" (AC 120-91A) utilize similarly narrow obstacle clearance allowances (narrower in many cases) and require unique aircraft specifications but are not classified as RNP-AR Departures, nor are they approved by the regulatory agencies and thus do not technically fall within AC90-101A guidance. Originally, Part 121 operators designed these departure procedures for their fleet and crew training and the small number of airports they service. Escape procedures can be routinely and safely used, as within the airline industry, with the corresponding approvals, proprietary databases and training. However, within the past decade, "off-the shelf" escape procedures are readily available to Part 135 and Part 91 operators for essentially every airport without any oversight, required training, equipment verification or crew authorization.

The discontent between the scrutiny of AR procedures and commercially available runway analysis "special" procedures is irreconcilable with safety practices within the industry.

Discussion: RNP-AR approaches provide an unprecedented level of flexibility in construction of approach procedures. These operations are RNAV procedures with a specified level of performance and capability. RNP-AR approach procedures build upon the performance-based National Airspace System (NAS) concept. When RNP approaches replace visual or Non-precision Approaches (NPA), safety is enhanced and efficiency improves through more repeatable and optimum flightpaths. Predefined aircraft capability and navigation system are the basis for conventional obstacle evaluation areas for ground-based NAVAIDs. The RNP-AR criteria design is flexible in order to adapt to unique operational requirements, which can include avoiding terrain or obstacles, de-conflicting airspace, or resolving environmental constraints. This allows for approach-specific performance requirements.

a) AR. RNP-AR approaches include unique capabilities that require special aircraft and aircrew authorization similar to Category (CAT) II/III instrument landing system (ILS) operations. All RNP-AR approaches have reduced lateral obstacle evaluation areas and vertical obstacle clearance surfaces predicated on the aircraft and aircrew performance requirements of the advisory circular (AC90-101A). In addition, selected procedures may require the capability to fly an RF leg and/or a missed approach, which requires RNP less than 1.0 to as low as 0.1.

b) Navigation Performance Monitoring. A critical component of RNP is the ability of the aircraft navigation system to monitor its achieved performance and to identify for the pilot whether the performance meets set standards during an operation. Alerting is based on computed Estimate of Position Uncertainty (EPU) or Actual Navigation Performance (ANP) which are measurements based on a defined scale in nautical miles (NM) that conveys the current position estimate of performance. If the RNP for the segment is set to 1.0, for example, the CDI scale will be set to 1 NM and alerting of performance not meeting the standard would be suppressed if the EPU or ANP is less than 1 NM. Latency of this alert can be upwards to 6 seconds. Changing the RNP manually, which is not possible on many FMS systems, does not improve the accuracy of the GNSS as it merely changes the CDI scaling and the point at which the alerting occurs.

c) Approval. Operators may receive operational approval to conduct RNP-AR approaches through operations specifications (OpSpecs), management specifications (MSpecs), or letters of authorization (LOA), as appropriate to the operator. Operators should comply with the requirements in Appendices 2 through 6 of the advisory circular 90-101A. Appendix 7 describes information operators should submit when seeking approval for RNP-AR operations. It contains a checklist to use as a guide in preparing the application (RNP-AR Approval Checklist (Optional)), as well as an approval process flowchart (RNP-AR Application Flow). Prior to application, operators and manufacturers should review all performance requirements. Installation of equipment by itself does not guarantee final approval for use.

Of specific note and of utmost importance above are three points:
A) Applicability of this AC for an RNP less than 1.0 due to the narrower obstacle margins,
B) The explicit denial of approval simply based on the installation of necessary equipment and
C) The implicit need for pilots to escape from the procedure ("go missed") if performance does not meet set standards, as triggered by an RNP alert.

Runway Analysis: This obstacle analysis process, as described within the advisory circular 120-91 defines the obstacle free corridor or Obstacle Accountability Area (OAA) as 2000 feet wide (from the centerline) along straight segments and 3000 feet in turns. These correlate to 0.3 NM and 0.5 NM respectively. The purpose of utilizing runway analysis is to reduce the limitations due to weight that would otherwise allow departures along established ODPs or SIDs, which utilize TERPS or PansOps obstacle clearance criteria. If an escape procedure path can be found that is 2000 feet wide and simply misses obstacles by 35 feet vertically, the takeoff weight becomes less restrictive; however, the risk-benefit tradeoff is rarely evaluated.

Operators who currently follow the recommendations of this SAFO employ databases that contain the "special" procedures by name. These proprietary databases include automatic RNP scaling for each segment. In addition, these same operators (mostly airlines) flight test the procedures and develop training standards before inclusion into the database. The training requirements are markedly designed for "special" procedure proficiency, limiting the number of procedures authorized to unique crew approvals.

In contrast, the vast majority of turbine operators (part 135, 125, 91K and 91) utilize generic navigation databases (no special procedures included) running on FMSs that do not allow manual adjustments to the RNP. These operators must manually enter the special procedure path into a flight plan which defaults to an RNP of 1.0. Observing crews utilizing runway analysis on an FMS software version that does allow RNP values to be manually adjusted, few if any, adjust the RNP accordingly or as part of their briefing.

As a result, these escape procedures would be flown with an RNP of 1.0. An EPU or ANP value exceeding 0.3 would NOT alert the pilot that the actual aircraft position is possibly, even likely, outside the Obstacle Clear Area even while navigating along the magenta line.

Unlike RNP AR approaches which give an "out", (i.e. a missed approach) to crews when the RNP alert system notifies the pilot that the performance standards are no longer met; runway analysis RNP 1.0 alerts, which are rare, provides, no "out". The aircraft is potentially below surrounding terrain with an engine inoperative and unable to "out fly" surrounding terrain.

Though alert response options are significantly more limiting to crew during departures than approaches (i.e no defined "missed departure" path), there are currently no OpSpec, MSpec or even a Letter of Authorization requirements to utilize these special procedures for most operators. For those operators who do receive "approval" from their POI to utilize runway analysis to comply with Part 135 obstacle clearance regulation, no minimal level of training or recurrency is required. In addition, there are no specific equipment requirements, no CRM training, no briefing requirements and no ground school familiarization criteria. The procedures themselves are not even flight tested.

To further establish this point, Gulfstream did a test a few years back whereby a mainstream runway analysis company trained a number of the OEM's demo and test pilots on the use of runway analysis. The crews were then issued random procedures to perform in a G550 simulator at the Savannah facility. The Director of Aviation at that time, Randy Gaston, shared the results at an operators meeting. He stated

"numerous procedures could not be flown without hitting or coming dangerously close to obstacles even though the procedures were flown on the magneta line".

It is baffling then why so many pilots and operators view the utilization of runway analysis procedures in their operation with such casual indifference.

RNP Monitoring and Runway Analysis: As stated previously, runway analysis protocols establish an Obstacle Accountability Area (OAA) of a maximum 2000 feet from the centerline in straight legs and a maximum of 3000 feet in turns. None of the off-the-shelf procedures are coded into the standard NAV databases currently available to general aviation operators. Thus, the path must be entered manually. Virtually all FMSs will default the RNP to 1.0 for manually entered routes regardless of the proximity to an airport. Typically, pilots will not (or cannot) change the RNP from the default RNP 1.0. With an entered RNP of 1.0, the default entry of manually entered paths such as runway analysis, and an EPU of 0.8, still no alert is initiated by the FMS. None of the aircraft in figure 1, labelled "Default Entry of RNP 1.0", initiates an alert to the pilot.

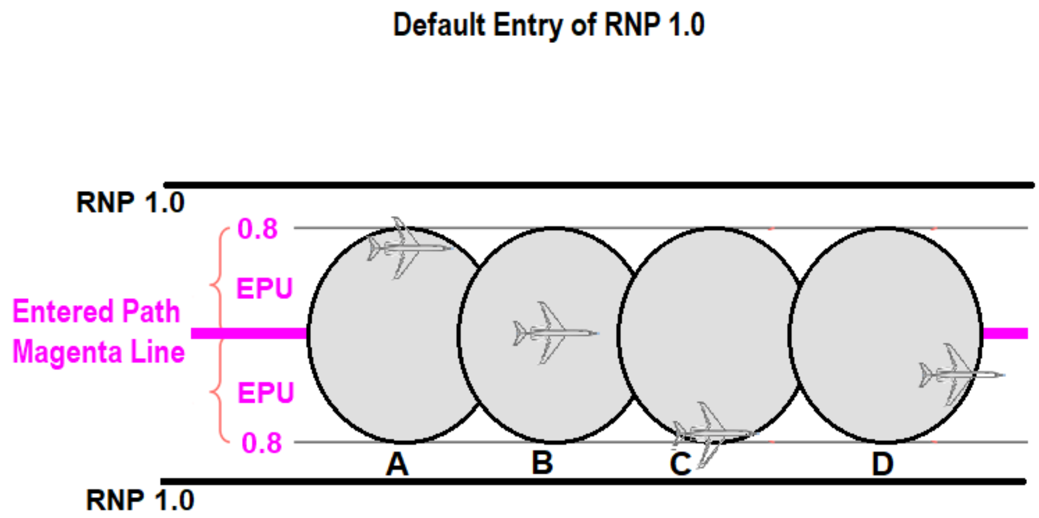


Figure 1

Figure 2 (No-Alert Scenario #1) overlays the Obstacle Clear Area of a runway analysis path. Notice that even with the CDI centered, three of the four depicted aircrafts' actual positions are potentially outside the Obstacle Clear Area and none of the aircraft are generating any alerts.

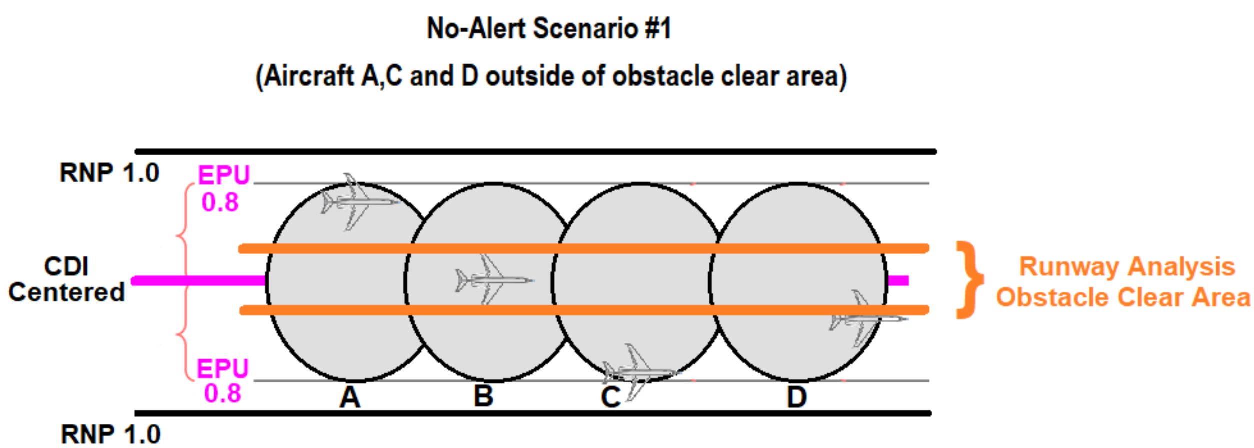


Figure 2

If the pilot has the luxury of adjusting the RNP to 0.3, there is still no guarantee that the aircraft's actual position remains within the Obstacle Clear Area. In this scenario, figure 3, the EPU is a low 0.2. Remember that adjusting the RNP within the FMS, does not increase the accuracy of the position. If you are running an EPU of 0.4 when RNP of 1.0 is entered, changing the RNP to 0.3 will still generate an EPU of 0.4. The ability to remain CDI centered diminishes with CDI scale reduction. Thus the scenario utilizes a "1 dot left" CDI indication or .15NM.

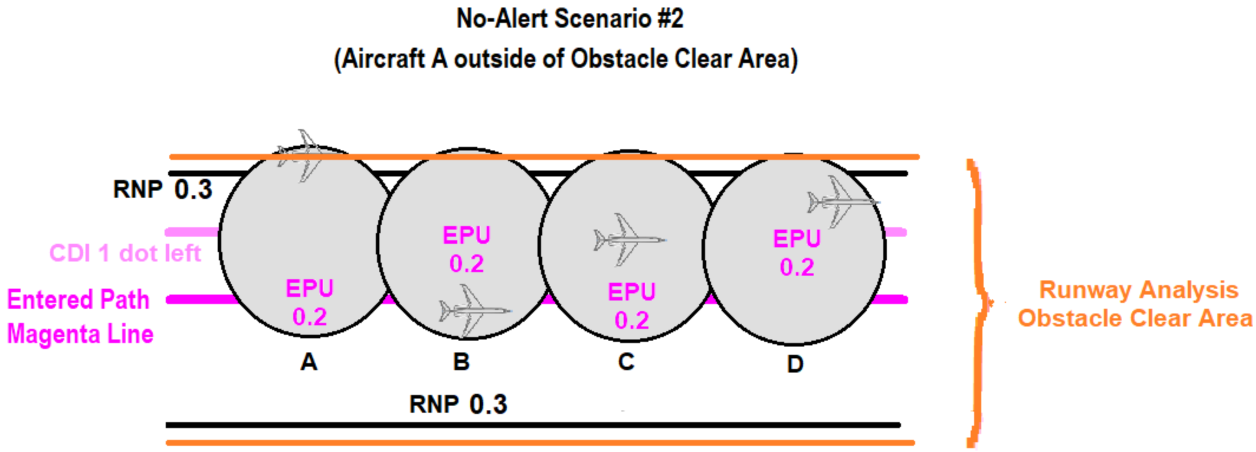


Figure 3

In figure 3, none of the aircraft are generating an alert as the EPU remains below the RNP of 0.3. Aircraft A, .15NM + .2NM=.35NM, is outside the Obstacle Clear Area demonstrating that a scenario even with the RNP set to 0.3 does not assure the aircraft remains clear of obstacles even though no alert is generated.

In the final scenario (figure 4), an RNP of 0.1 is set manually. Note, the few FMSs that do allow RNP to be overwritten, do not allow an RNP of 0.1 to be entered. Here, even if a very low EPU of 0.1 should be entered, the pilot will be alerted yet remain within the Obstacle Clear Area even with a full scale CDI deflection. Again, though the pilot does receive such an alert, there are precious few options available as no "escape procedure" from the escape procedure is analyzed. Clearly delineated training must explore this situation and prepare the crew for its eventuality.

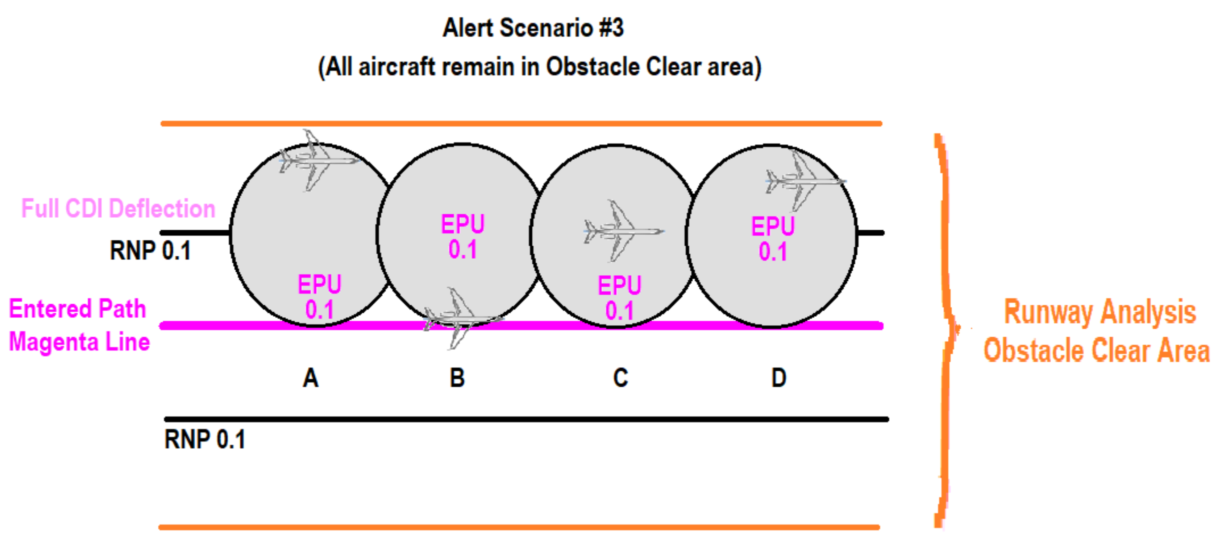
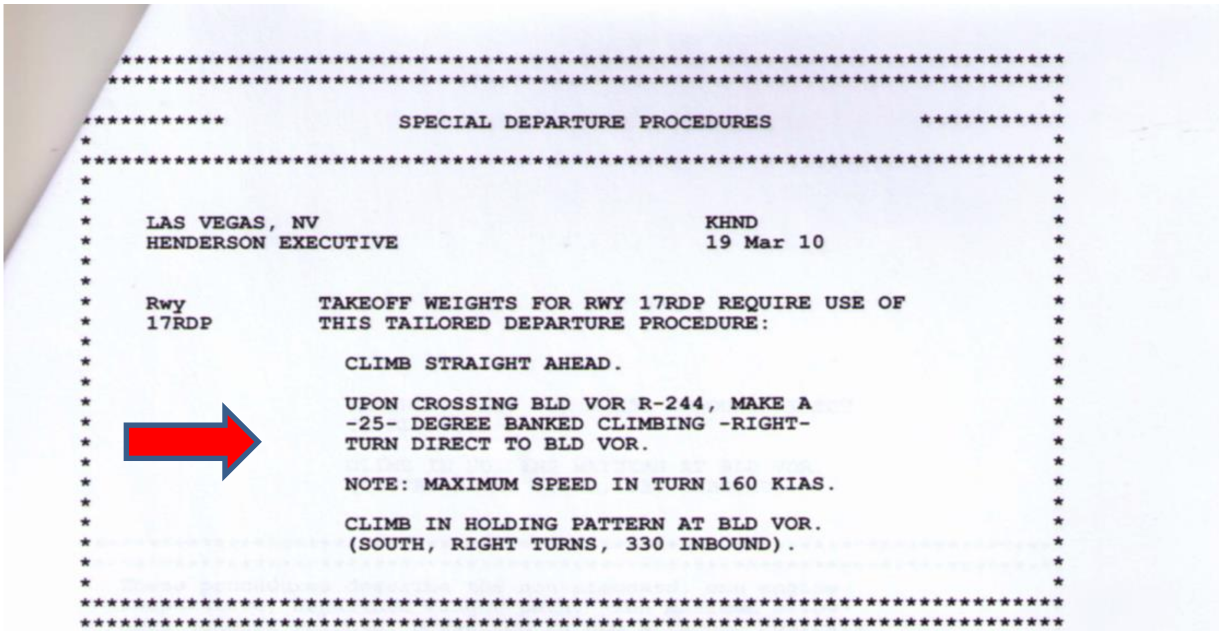


Figure 4

Variability of Runway Analysis Procedures: Runway analysis procedures are not subject to certification or review. Routinely, these departure procedures deviate from criteria within the AFM. Below is an example of instructions requiring the bank angle to be 25 degrees (figure 5) during turns with one engine inoperative.



SPECIAL DEPARTURE PROCEDURES

LAS VEGAS, NV KHND

HENDERSON EXECUTIVE 19 Mar 10

Rwy 17RDP TAKEOFF WEIGHTS FOR RWY 17RDP REQUIRE USE OF THIS TAILORED DEPARTURE PROCEDURE:

CLIMB STRAIGHT AHEAD.

UPON CROSSING BLD VOR R-244, MAKE A -25- DEGREE BANKED CLIMBING -RIGHT- TURN DIRECT TO BLD VOR.

NOTE: MAXIMUM SPEED IN TURN 160 KIAS.

CLIMB IN HOLDING PATTERN AT BLD VOR. (SOUTH, RIGHT TURNS, 330 INBOUND).

Figure 5

This deviates from virtually every certified part 25 Aircraft Flight Manual's aircraft instructions for engine out procedures.

There are routinely runway analysis procedure instructions, see figure 6, that reject the level off procedure that is an integral component of the net takeoff flight path profile appearing in every AFM and is a component of the aircraft's Part 25 certification.

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SPECIAL DEPARTURE PROCEDURES

RENO, NV                                   KRNO
RENO/TAHOE INTL                            30 Dec 10

Rwy        TAKEOFF WEIGHTS FOR RWY 16LDP REQUIRE USE OF
16LDP      THIS TAILORED DEPARTURE PROCEDURE:

             NOTE: THIS PROCEDURE IS APPLICABLE ONLY
             FOR AIRCRAFT OPERATING AT V2 LESS THAN
             135 KIAS.

             NOTE: DO NOT UTILIZE THE ACCELERATION
             HEIGHT PUBLISHED ON THE RUNWAY ANALYSIS.

             NOTE: POWER MUST BE REDUCED FROM TAKEOFF
             THRUST TO MCT AT THE AFM TIME LIMIT
             FOR TAKEOFF THRUST.

             FLY RUNWAY HEADING. (DIRECT IRNO/164/4.0)

             AT IRNO 4.0 DME, AT V2 SPEED (135 KIAS
             MAXIMUM), MAKE A 15 DEGREE BANKED CLIMBING
             -LEFT- TURN TO A HEADING OF 325 DEGREES
             (DIRECT FMG/246/5.3).  NOTE: DO NOT
             LEVEL-OFF, RETRACT FLAPS, OR ACCELERATE
             UNTIL ESTABLISHED ON THE 325 DEGREE
             HEADING.

             WHEN ON THE 325 DEGREE HEADING, LEVEL-OFF,
             ESTABLISH FINAL CLIMB CONFIGURATION
             AND SPEED, AND RESUME CLIMB.

             UPON CROSSING THE FMG VOR R-246, MAKE
             A 15 DEGREE BANKED CLIMBING -RIGHT-
             TURN TO HEADING 008 DEGREES. (DIRECT
             FMG/337/10.0)

             INTERCEPT THE FMG VOR R-337 OUTBOUND.

             CONTINUE ON THE FMG VOR R-337 OUTBOUND.

             AT FMG VOR R-337/D15.0, ENTER HOLD.
             (NORTHWEST, LEFT TURNS, 157 INBOUND).

These procedures describe the non-standard, one engine
inoperative, departure flight path.  The maximum allow-
able takeoff weights, presented in the attached analysis,
are based upon the procedure(s) outlined above.
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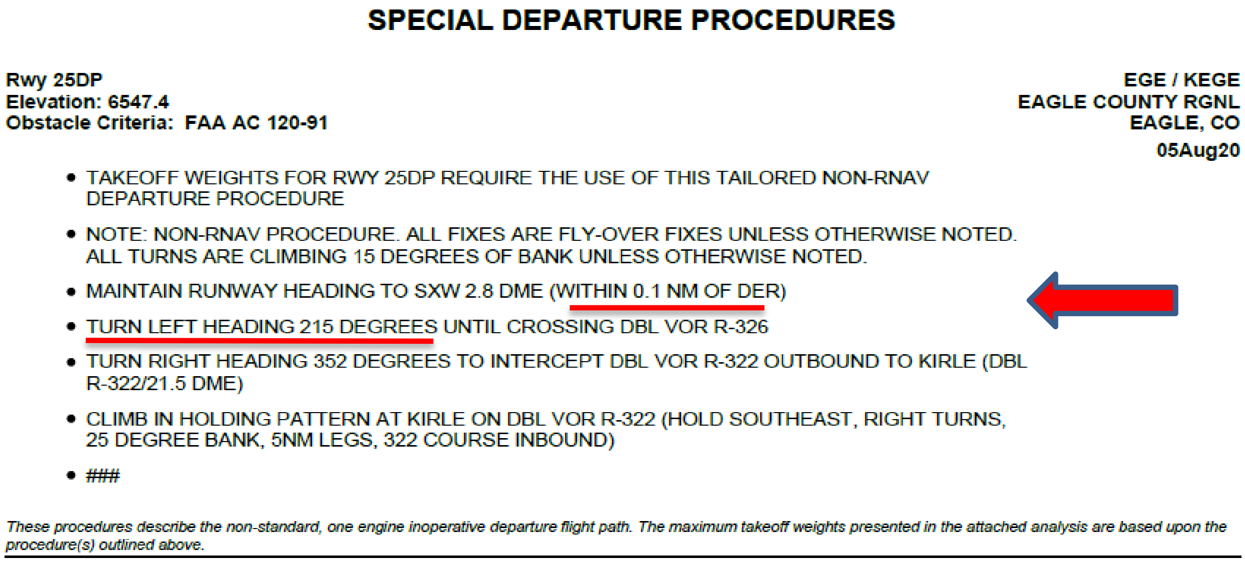
Figure 6

Many of the procedures (figure 7) include an immediate turn, purportedly below 400ft which is in contradiction to the AIM and standard operating procedures of most OEM and operators.



SPECIAL DEPARTURE PROCEDURES

Rwy 25DP
Elevation: 6547.4
Obstacle Criteria: FAA AC 120-91

EGE / KEGE
EAGLE COUNTY RGNL
EAGLE, CO
05Aug20

- TAKEOFF WEIGHTS FOR RWY 25DP REQUIRE THE USE OF THIS TAILORED NON-RNAV DEPARTURE PROCEDURE
- NOTE: NON-RNAV PROCEDURE. ALL FIXES ARE FLY-OVER FIXES UNLESS OTHERWISE NOTED. ALL TURNS ARE CLIMBING 15 DEGREES OF BANK UNLESS OTHERWISE NOTED.
- MAINTAIN RUNWAY HEADING TO SXW 2.8 DME (WITHIN 0.1 NM OF DER)
- TURN LEFT HEADING 215 DEGREES UNTIL CROSSING DBL VOR R-326
- TURN RIGHT HEADING 352 DEGREES TO INTERCEPT DBL VOR R-322 OUTBOUND TO KIRLE (DBL R-322/21.5 DME)
- CLIMB IN HOLDING PATTERN AT KIRLE ON DBL VOR R-322 (HOLD SOUTHEAST, RIGHT TURNS, 25 DEGREE BANK, 5NM LEGS, 322 COURSE INBOUND)
- ###

These procedures describe the non-standard, one engine inoperative departure flight path. The maximum takeoff weights presented in the attached analysis are based upon the procedure(s) outlined above.

Figure 7

The intricacy of some escape procedures adds to the difficulty of FMS entry and the propensity for error (see figure 8).

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SPECIAL DEPARTURE PROCEDURES

RENO, NV                                KRNO
RENO/TAHOE INTL                         30 Dec 10

Rwy          TAKEOFF WEIGHTS FOR RWY 16LDP REQUIRE USE OF
16LDP        THIS TAILORED DEPARTURE PROCEDURE:

               NOTE: THIS PROCEDURE IS APPLICABLE ONLY
               FOR AIRCRAFT OPERATING AT V2 LESS THAN
               135 KIAS.

               NOTE: DO NOT UTILIZE THE ACCELERATION
               HEIGHT PUBLISHED ON THE RUNWAY ANALYSIS.

               NOTE: POWER MUST BE REDUCED FROM TAKEOFF
               THRUST TO MCT AT THE AFM TIME LIMIT
               FOR TAKEOFF THRUST.

               FLY RUNWAY HEADING. (DIRECT IRNO/164/4.0)

               AT IRNO 4.0 DME, AT V2 SPEED (135 KIAS
               MAXIMUM), MAKE A 15 DEGREE BANKED CLIMBING
               -LEFT- TURN TO A HEADING OF 325 DEGREES
               (DIRECT FMG/246/5.3).  NOTE: DO NOT
               LEVEL-OFF, RETRACT FLAPS, OR ACCELERATE
               UNTIL ESTABLISHED ON THE 325 DEGREE
               HEADING.

               WHEN ON THE 325 DEGREE HEADING, LEVEL-OFF,
               ESTABLISH FINAL CLIMB CONFIGURATION
               AND SPEED, AND RESUME CLIMB.

               UPON CROSSING THE FMG VOR R-246, MAKE
               A 15 DEGREE BANKED CLIMBING -RIGHT-
               TURN TO HEADING 008 DEGREES. (DIRECT
               FMG/337/10.0)

               INTERCEPT THE FMG VOR R-337 OUTBOUND.

               CONTINUE ON THE FMG VOR R-337 OUTBOUND.

               AT FMG VOR R-337/D15.0, ENTER HOLD.
               (NORTHWEST, LEFT TURNS, 157 INBOUND).

These procedures describe the non-standard, one engine
inoperative, departure flight path.  The maximum allow-
able takeoff weights, presented in the attached analysis,
are based upon the procedure(s) outlined above.
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Figure 8

The variability of escape procedures, even procedures at the same airport but different runways, should necessitate the unique equipment, training, briefing, currency and authorization to use.

FMS and Runway Analysis: As stated previously, most FMS in operation at the time of this recommendation do not allow the user to override RNP values for routes manually entered. For FMS software versions that do allow said RNP override (usually only to 0.3), many pilots are not familiar with the need or the process to so.

Of major concern is the observed use of runway analysis on single FMS aircraft. This is quite literally impossible particularly for single pilot operators where single FMS aircraft are concentrated. For dual FMS aircraft and two pilot operations, the CRM demands to use runway analysis are significant. Crews utilizing these special procedures rarely observe an appreciation of confirming the path entry or briefing the procedure of switching to a secondary flight plan or second FMS, nor the reassigning of duties upon engine failure (i.e. Pilot monitor has the escape procedure on his side and the pilot flying becomes the pilot monitoring if engine failure occurs during climb out).

Recommended Actions: Runway analysis may be thought of as "RNP-AR approaches in reverse", thus runway analysis must be viewed as a highly specialized emergency procedure that requires extensive ground and flight training and aircraft requirements to safely incorporate within the operations of any department. This is demonstrated by the requirements and procedures utilized by airlines and the limited application of such procedures per approved crew (i.e. only a handful of procedures are authorized and trained for to a level of proficiency).

Commercial runway analysis product procedures are not flight tested and are not subject to any approval process. They are mathematical models only.

Many, if not most, aircraft equipment (i.e. FMS NAV database and user interface) are not capable of scaling runway analysis procedures to an acceptable RNP value (i.e. 0.1).

RNP alerting is not sufficient to keep aircraft safe utilizing these narrow runway analysis obstacle clear areas. Even when alerting is provided, the option for the crew to respond, in any practical sense, such as is available during an RNP-AR approach, is non-existent.

Therefore, it is recommended that all operators wishing to utilize runway analysis:

1) Receive OpSpec, MSpec or LOA authorization for the aircraft and the crew to use specific procedures.
2) Demonstrate that the depicted procedure can be safely flown by the operator (AC90-101A requires a minimum history of completed approaches before approval).
3) Develop a training syllabus for initial and recurrent training in the use of runway analysis procedures.
4) Develop minimum weather and ceiling standards for departing using a runway analysis procedure.
5) Develop an operator specific pre-takeoff briefing for each runway analysis procedure to include pilot flying and pilot monitoring duties in the event of actual runway analysis procedure departure. The briefing should also include "what-if" options in the case of RNP alerts.