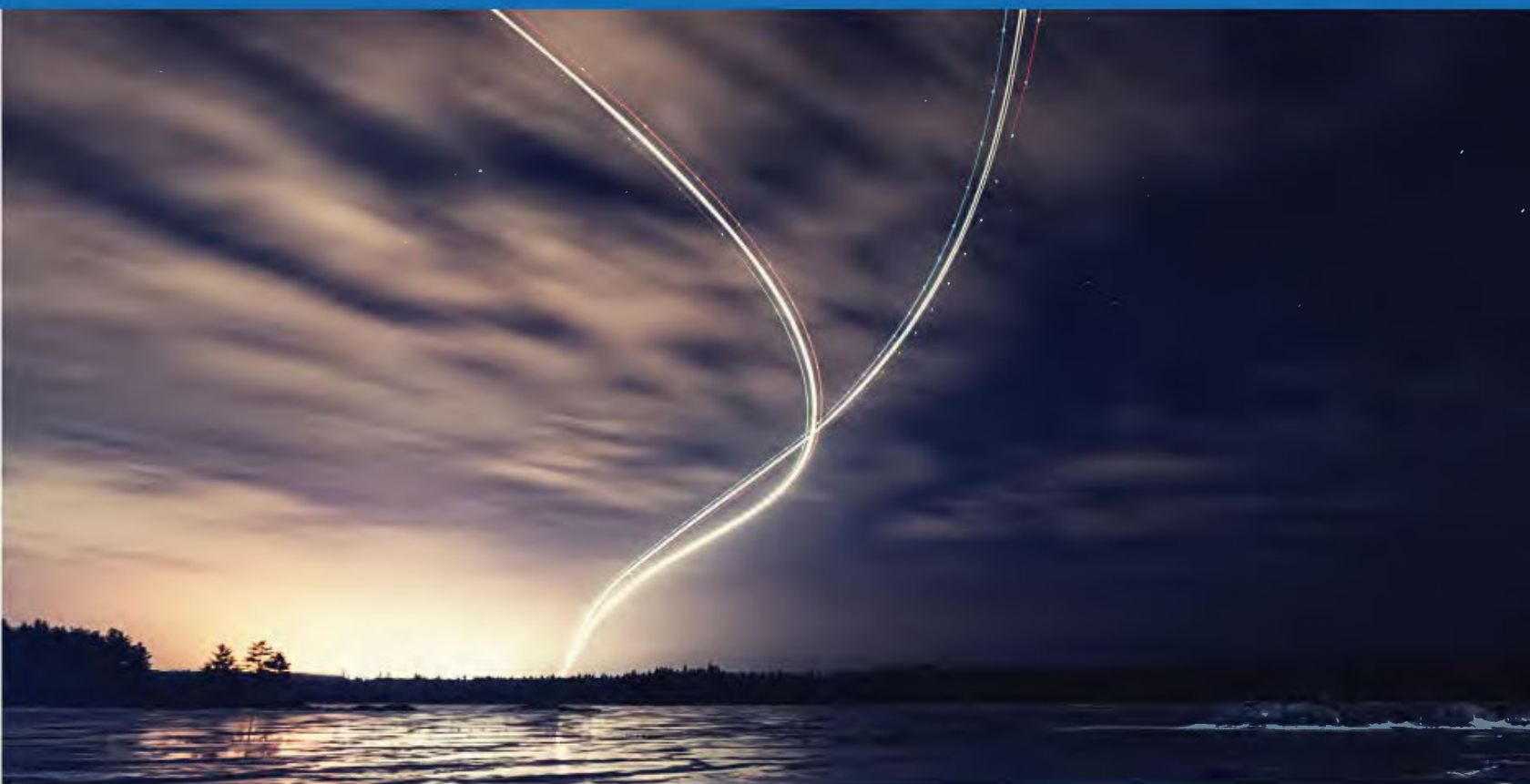




ICAO

Circular 350

Guidelines for the Implementation of Reduced Divergence Departures



Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION



Documents

Document Sharing Hub



| ICAO

Circular 350

Guidelines for the Implementation of Reduced Divergence Departures

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION 

Documents
Document Sharing Hub

Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

Cir 350, *Guidelines for the Implementation of Reduced Divergence Departures*

Order Number: 350

ISBN 978-92-9258-910-3

© ICAO 2020

All rights reserved. No part of this publication may be reproduced, stored in a
retrieval system or transmitted in any form or by any means, without prior
permission in writing from the International Civil Aviation Organization.

TABLE OF CONTENTS

Abbreviations and Acronyms	(v)
List of Publications	(vii)
Chapter 1 Introduction.....	1
1.1 Purpose.....	1
1.2 Scope	2
Chapter 2 Reduced divergence minima	3
Chapter 3 Safety assessment	5
3.1 Introduction	5
3.2 Scope	5
3.3 Objectives	6
3.4 Equivalent lateral spacing operation (ELSO) concept	7
3.5 Approach.....	9
3.6 Assumptions	9
3.7 Safety assessment.....	9
3.8 Review of the safety assessment	12
3.9 Adoption of a reduced divergence requirement	13
3.10 Hazard assessment	13
3.11 Conclusion	14
Chapter 4 Implementation safety assessment	15
4.1 Introduction	15
4.2 Implementation considerations	15
4.3 RNAV and RNP SID Procedure design guidance.....	16
Appendix Implementation hazard log	20

11/23/2020 09:07:54 MST

ABBREVIATIONS AND ACRONYMS

ANSP	Air navigation services provider
ATC	Air traffic control
ATO	Air Traffic Organization
ATS	Air traffic services
CF	Course to a fix
DER	Departure end of runway
DF	Direct to a fix
DME	Distance measuring equipment
ELSO	Equivalent lateral spacing operation
FAA	Federal Aviation Administration
FM	Fix to manual termination
FMS	Flight management system
GNSS	Global navigation satellite system
KATL	Hartsfield-Jackson International Airport
KDEN	Denver International Airport
KDFW	Dallas/Fort Worth International Airport
IFR	Instrument flight rules
IRU	Inertial reference unit
JO	Joint order
MSG	Mathematician Subgroup
OTG	Off-the-ground
PBN	Performance-based navigation
RNAV	Area navigation
RNP	Required navigation performance
SASP	Separation and Airspace Safety Panel
SID	Standard instrument departure
SMS	Safety management system
SRMD	Safety risk management document
TF	Track to a fix
VA	Heading to an altitude
VI	Heading to an intercept
VM	Heading to a manual termination

11/23/2020 09:07:54 MST

LIST OF PUBLICATIONS

(referred to in this circular)

The following documents are referred to in this circular or may provide additional guidance material.

ICAO DOCUMENTS PUBLICATION

Annexes to the Convention on International Civil Aviation

Annex 11 — *Air Traffic Services*

Annex 14 — *Aerodromes, Volume I — Aerodrome Design and Operations*

Procedures for Air Navigation Services (PANS)

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)

Procedures for Air Navigation Services — Aircraft Operations, Volume II — Construction of Visual and

Instrument Flight Procedures (PANS-OPS, Doc 8168)

Manuals

Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (Doc 9643)

Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689)

Global Air Navigation Plan (Doc 9750)

Safety Management Manual (Doc 9859)

Downloaded from https://www.icao.int/publications/CAO%20Circular%20350%202020

Chapter 1

INTRODUCTION

1.1 PURPOSE

1.1.1 This circular provides guidelines and supporting material for the implementation of performance-based navigation (PBN) departure procedures with reduced divergence. The reduced divergence is intended for use with aircraft flying area navigation (RNAV) departure procedures whose courses diverge immediately after departure. The material modifies provisions previously included in Chapter 6 of the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444).

1.1.2 The material also modifies provisions previously included in Chapter 6 of the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) and Chapter 3 of the *Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways* (SOIR, Doc 9643).

1.1.3 The continuing growth of aviation raises demands on airport departure capacity and increases noise emissions from aircraft operating in the vicinity of airports. Where possible, the use of diverging departure operations has improved operational efficiencies to accommodate increasing demands. Where operational constraints (e.g., noise constraints) preclude or limit conducting diverging departure operations with the current minimum divergence requirement of 15 degrees, PBN-enabled reduced divergence departures may enable needed gains in operational efficiencies. The procedures with reduced divergence utilize existing aircraft equipment and air traffic control (ATC) capabilities to enable (or increase) beneficial uses of diverging departure operations.

1.1.4 As outlined in the *2013-2028 Global Air Navigation Plan* (Doc 9750), implementation of PBN in terminal airspace is recognized as a key enabler for advanced terminal operations. Various Separation and Airspace Safety Panel (SASP) activities currently support the development and amendment of terminal separation Standards.

1.1.5 The SASP's work on reduced divergence requirements was based on research previously conducted by The MITRE Corporation's Center for Advanced Aviation System Development. Initially presented at the nineteenth SASP Working Group of the Whole Meeting¹ (Montréal, Canada, 23 May to 3 June 2011), the reduced divergence requirements were based on the application of the equivalent lateral spacing operation (ELSO) concept. For variable runway layout geometries, application of the concept enables reduced divergence angles that provide lateral spacing between diverging flight paths of PBN departures in a manner equivalent to the spacing observed in conventional departure operations conducted using the minimum requirement (15 degrees) of the conventionally applicable divergence Standard.

1.1.6 Further work on the subject, particularly related to assessing the safety of the proposed operations and the adoption of a reduced divergence Standard, was presented at the SASP's twenty-first² (Seattle, United States, 29 October to 9 November 2012), twenty-second³ (Montréal, Canada, 13 to 24 May 2013), and twenty-third⁴

1. SASP-WG/WHL/19-IP/2, *Reduced Divergence Departures — A Standard for Equivalent Lateral Spacing Operations*
2. SASP-WG/WHL/21-WP/19, *Concept, Application, and Benefits of Equivalent Lateral Spacing Operation (ELSO) Departures* and SASP-WG/WHL/21-FL/14, *Collision Risk Calculations in Support of WP/19 – ELSO Trial*
3. SASP-WG/WHL/22-WP/06, *Evaluation of PBN-Enabled Reduced Divergence for Departures*
4. SASP-WG/WHL/23-IP/05, *Engineering Analysis for Reduced-Divergence Departures* and SASP-WG/WHL/23-IP/05, *Engineering Analysis for Reduced-Divergence Departures — Resubmission*, Montréal, Canada, 5 to 16 May 2014