Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR

AC 139-05 v3.0

Plume rise assessments

Date January 2019

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Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory Circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- proponents of facilities generating a gas efflux or exhaust plume which may have a vertical exit velocity exceeding 6.1 metres per second (m/s)
- aerodrome operators
- The Civil Aviation Safety Authority (CASA).

Purpose

The purpose of this Advisory Circular (AC) is to provide:

- guidance to persons involved in the design, construction and operation of facilities with vertical exhaust plumes about the information required to assess the potential hazard from a plume to aircraft operations
- a standard method of determining the critical plume height of a vertical exhaust plume so that impacts of a plume near aerodromes and away from aerodromes can be assessed in a consistent and reliable way
- guidance to proponents and stakeholders on the plume rise assessment process.

CASA has identified the need to assess the potential hazard to aviation where the vertical exit velocity from gas efflux or exhaust plume exceeds 6.1 metres per second (m/s). Relevant legislation includes the potential hazard, under Regulation 139.370 of CASR 1998 and the potential danger, under Regulation 6 of the Airspace Regulations 2007.

For further information

For further information, contact CASA's Office of Airspace Regulation (OAR) (telephone 131 757 or email oar@casa.gov.au).

Unless specified otherwise, all subregulations, regulations, divisions, subparts and parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Status

This version of the AC is approved by the Manager, Flight Standards Branch.

Note: Changes made in the current version are not annotated. The document should be read in full.

Version	Date	Details
v3.0	January 2019	This second revision of the AC amends the original 4.3 m/s benchmark velocity parameter to 6.1 m/s in line with the Manual of Aviation Meteorology. Content and flowchart updates have been made to further clarify the process steps and roles.
(1)	November 2012	This is the first revision of the AC relating to conducting plume rise assessments and replaces AC 139-5(0) issued in June 2004. It has been simplified due to the introduction of computer-based modelling (referred to as the “Screening Tool”, see paragraph 5.1) to assist in the assessment process. The plume rise assessment process has also been clarified.
(0)	June 2004	This is the first AC on the subject of plume rise assessments.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	advisory circular
AD INSP	aerodrome inspector
AD OPR	aerodrome operator
ALARP	As Low As Reasonably Practicable
ALoS	Acceptable Level of Safety
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CPH	critical plume height
CPV	critical plume velocity
LSALT	Lowest Safe Altitude
m/s	metres per second
NOTAM	notice to airman
OAR	Office of Airspace Regulation
OLS	obstacle limitation surface
TAPM	The Air Pollution Model
TIFP	terminal instrument flight procedure

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below.

Term	Definition
buoyancy enhancement	Describes a situation in which multiple vertical exhaust plumes in close proximity can merge to alter the plume characteristics.
critical plume height	Means the height up to which the plume of critical velocity may affect the handling characteristics of an aircraft in flight.
critical plume velocity	A critical plume velocity of 6.1 m/s is the velocity at which a vertical plume rise can affect the handling characteristics of an aircraft in flight and requires assessment by CASA.
obstacle limitation surfaces	Are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

Term	Definition
protective airspace	Airspace declared by the Office of Airspace Regulation following receipt and assessment of an Airspace Change Proposal. The airspace accommodates activities that may be incompatible with routine flying operations and could be declared as a Prohibited, Restricted or Danger Area. Such airspace is predicated on an airspace risk assessment and enables an activity to be conducted to an Acceptable Level of Safety (ALoS).
regulated aerodromes	Certified and Registered aerodromes to which the Part 139 of CASR - Aerodromes applies. At these aerodromes the aerodrome operator must ensure that the obstacle limitation surfaces are established in accordance with the standards set out in these regulations.
screening tool	Is the computer-generated method of plume rise analysis used by CASA's Office of Airspace Regulation (OAR) to derive the heights at which the plume rise velocity is 4.3 m/s, 6.1 m/s and 10.6 m/s. The Screening Tool is based on The Air Pollution Model (TAPM) methodology which includes a buoyancy enhancement factor for multiple plumes.
TAPM	The Air Pollution Model derived by CSIRO.
terminal instrument flight procedure	Means an instrument approach procedure or instrument departure procedure. These procedures are protected by a series of design surfaces. Penetration of the design surfaces will result in an alteration to the associated instrument approach or departure procedure. Copies of the design surfaces for an aerodrome can be obtained from the aerodrome operator.

1.3 References

Regulations

Regulations are available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Regulation 6 of the Airspace Regulations 2007	
Regulation 139.370 of CASR	Hazardous Objects
Part 173 of CASR 1998	Instrument Flight Procedure Design
Part 61 MOS	
Part 139 MOS	
	Manual of Aviation Meteorology, Bureau of Meteorology (Published by Airservices Australia, 2003)

1.4 Forms

CASA's forms are available at http://www.casa.gov.au/forms

Form number	Title
Form 1247	Application for Operational Assessment of Proposed Plume Rise

2 Background

2.1.1 Exhaust plumes can originate from any number of sources. These can include:

- industrial facilities release process emissions through stacks or vents
- industrial flares create an instantaneous release of hot gases during the depressurisation of gas systems
- cooling towers produce large volumes of buoyant gases that can rise a significant distance into the atmosphere
- exhaust gases from power generation facilities that can produce plumes of varying velocities during different operating scenarios.

2.1.2 Part 139.370 of the *Civil Aviation Safety Regulations 1988* (CASR) provides that CASA may determine that a gaseous efflux having a velocity in excess of 4.3 m/s is, or will be, a hazard to aircraft operations because of the velocity or location of the efflux.

2.1.3 However, the Manual of Aviation Meteorology (2003) defines the classifications of turbulence intensity as:

- **Light.** (1.5 - 6.1 m/s) which can cause momentary changes in altitude and attitude.
- **Moderate.** (> 6.1 - 10.6 m/s) which can cause appreciable changes in altitude and attitude.
- **Severe.** (>10.6 m/s - 15.2 m/s) which can cause large abrupt changes in altitude and attitude and a momentary loss of control
- **Extreme.** (> 15.2 m/s) where it can be practically impossible to control the aircraft, and which can cause structural damage.

2.1.4 An exhaust plume of moderate or higher turbulence intensity has the potential to affect the safety of aircraft operations, such as aircraft in critical stages of flight (periods of high pilot workload) and low-level flying operations.

2.1.5 For example, a light aircraft in approach configuration is more likely to be affected by a plume rise than a heavy aircraft. Similarly, flying activities such as crop dusting, cattle mustering, pipeline inspection, firefighting etc may also be severely affected by a plume. The potential hazards and risks posed by these plumes must be mitigated to ensure the safety of aircraft operations in the vicinity of the plume rise.

3 Plume Rise Assessment Process

3.1 Process steps

3.1.1 The plume rise assessment process involves participation from the proponent and CASA and it involves 10 steps. A flowchart identifying the Plume Rise Assessment Process is provided at Appendix A to this AC.

Step 1 and Step 2 proponent assessment of plume velocity and form submission

3.1.2 A proponent may be operating an existing facility or proposing a development that will generate a plume rise. The proponent is required to make an initial assessment on the plume exit velocity, such that if the exit velocity is less than 6.1 m/s, no action is required by the proponent. If the exit velocity exceeds 6.1 m/s a Form 1247 (Application for Operational Assessment of a Proposed Plume Rise) must be submitted to CASA OAR (oar@casa.gov.au)

Step 3 assessment of critical plume velocity and critical plume height

3.1.3 CASA will undertake the following key assessments and actions:

- assessment of the critical plume velocity (CPV)
- assessment of the critical plume height (CPH)
- aviation stakeholder engagement
- assessment of the impact of the plume on aviation operations.

3.1.4 CASA OAR will consider the information provided and assess known aircraft operations at the location to determine potential risks to aircraft.

3.1.5 The following contributing factors are considered in determining the CPV benchmark:

- aircraft and weight categories potentially affected
- proximity of stack/s to aerodromes and their associated circuits
- geographical environment and any associated meteorological effects
- flight rules in use (visual flight rules versus instrument flight rules)
- classes of airspace impacted.

3.1.6 CASA will calculate the CPH using a Screening Tool that will model the plume rise. This is done using several inputs, including the previously determined CPV benchmark. The CPH will only be determined for plume rise exit velocities exceeding 6.1 m/s.

3.1.7 The expansion or modification of an existing facility with a plume rise may require a CASA assessment. If in doubt, a proponent should contact CASA to discuss further.

3.1.8 The Screening Tool is designed to work within specified limits and may be unable to determine a CPH outside of these limits. In such cases, CASA may request submission of a more detailed plume rise assessment, from the proponent. A technical brief regarding the application of plume rise models for the purpose of detailed plume rise assessments is available on request from CASA.

Step 4 conduct preliminary airspace risk assessment

3.1.9 Based on the calculated CPH, CASA OAR will conduct a preliminary airspace risk assessment to determine potential airspace impacts.

3.1.10 If CASA determines that there is an impact to the safety of flight, then CASA will work with the proponent to determine suitable risk control treatments.

Step 5 aviation stakeholder engagement

3.1.11 CASA will undertake engagement with aviation stakeholders to obtain information on aviation activity in the vicinity of the defined location to inform the impact assessment.

Step 6 impact assessment

3.1.12 The impact of the plume rise in the vicinity of the defined location is assessed using the CPH.

3.1.13 Plume rises may impact Terminal Instrument Flight Procedures (TIFPs) and circuit operations. They may also impact other operations in the vicinity of aerodromes. CASA will make an assessment on the impact of the plume rises considering the Part 61 and 139 Manual of Standards (MOS). When assessing the impact of the plume rise if CASA determines there is no impact, the proponent will be advised, and no further action is required.

3.1.14 Penetration of an obstacle limitation surface (OLS) may impact the safety of aircraft. These penetrations will be assessed by a CASA aerodrome inspector (AD INSP). The aerodrome operator (AD OPR) will also be requested to provide input for consideration. A recommendation for obstacle (gas efflux structure) lighting or markings may be necessary dependent on the potential risk to aircraft operating in the vicinity.

3.1.15 Impacts to TIFPs may result in CASA determining that a plume rise is a hazard under Regulation 139.370 of CASR. If the design of the structure cannot be altered to avoid impacting TIFPs and the TIFPs cannot be amended, CASA may not support the proposal.

3.1.16 Any plume rise that affects air routes and Lowest Safe Altitudes (LSALTs) may require the Part 173 of CASR authority to consider changes, which may generate cost implications for proponents.

Step 7 mitigation of the impact of the plume rise proposal

3.1.17 CASA will work with the proponent to determine risk control measures to mitigate the impact of the assessed CPH. In determining the appropriate measures, CASA will consider the likelihood and consequence of the potential risk to aircraft.

3.1.18 Risk control measures may be classified into three broad areas:

a. Engineering design or physical containment

i. Examples include installing baffles and/or covers, adjusting the exhaust outlet size, appropriateness of the location of a proposed facility by siting the facility away from critical aircraft operation areas, efflux orientation and masking of the plume efflux.

b. Procedural

i. Examples include limiting the occasions on which the efflux is released and redesigning TIFPs.

c. Reducing the exposure

i. Examples include insertion of a symbol and height on aeronautical charts to enhance awareness of the plume rise, issuing a notice to airmen (NOTAM) and designating an area of protective airspace.

Step 8 and Step 9 implementation of risk control measures to achieve acceptable level of safety

3.1.19 Implementation of such measures will ensure that the risk to the safety of aircraft is reduced in accordance with As Low As Reasonably Practicable (ALARP) principles to an Acceptable Level of Safety (ALoS). One, or more risk control measures may need to be implemented to achieve an ALoS.

3.1.20 State or local Government planning authorities will be provided with recommendations from CASA for consideration in the development approval

3.1.21 When necessary, CASA may refer proposals to other relevant authorities such as the Department of Defence, Airservices Australia and the Department of Infrastructure, Regional Development and Cities for comment.

Step 10 notice advising the application is not supported.

3.1.22 If the impact of the calculated CPH cannot be mitigated, CASA will advise the proponent that the Application for Operational Assessment of a Proposed Plume Rise is not supported.

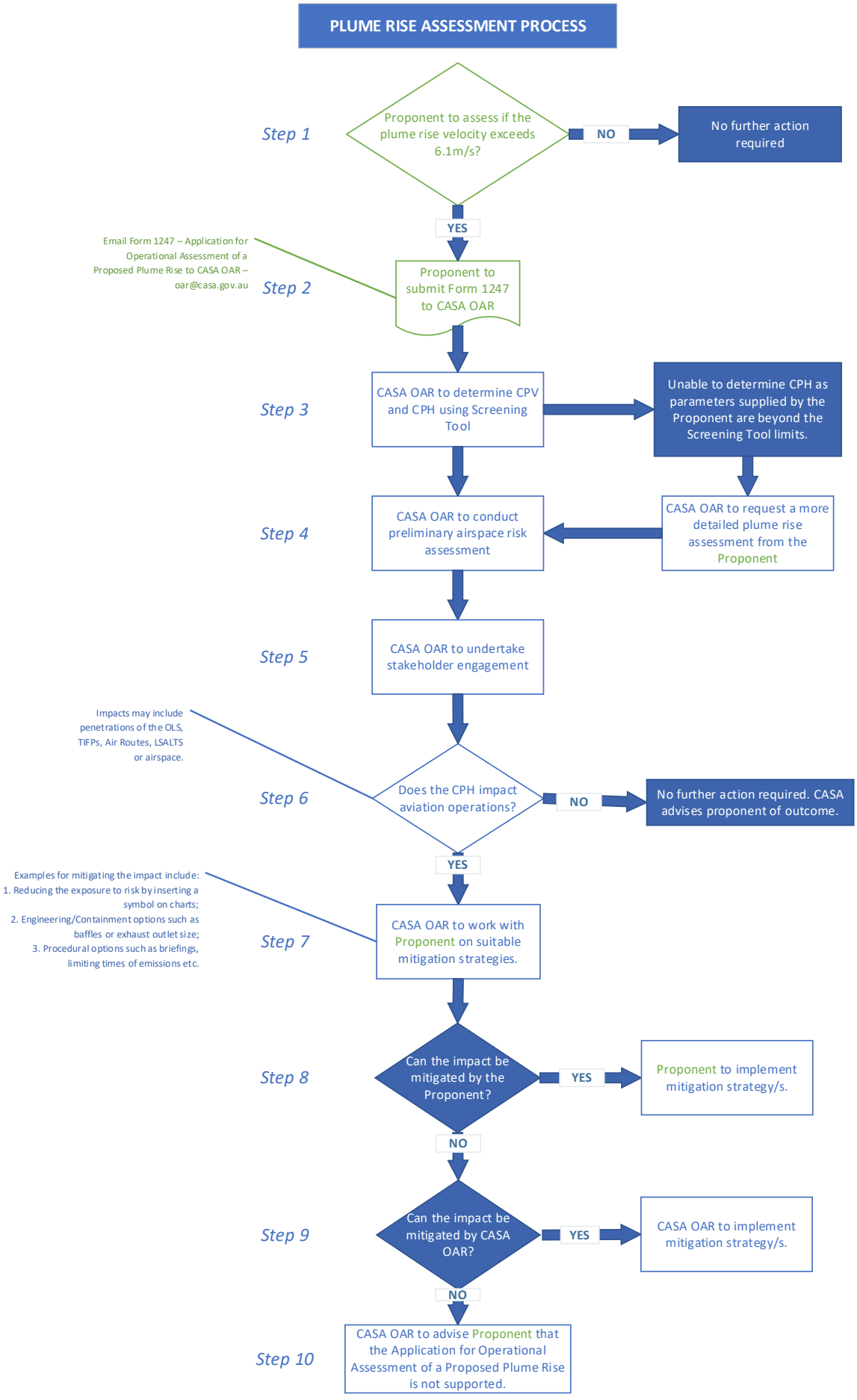
4 Other Information

4.1.1 To help guide in the planning process for new facilities, preliminary plume rise screening for possible locations under consideration, can be undertaken. CASA OAR (oar@casa.gov.au) can be contacted to discuss this option.

4.1.2 If alternative assessment methods for a plume rise have been conducted, these may be presented to CASA for consideration.

Appendix A

Plume rise assessment process


PLUME RISE ASSESSMENT PROCESS
Step 1
Proponent to assess if the plume rise velocity exceeds 6.1m/s?
NO
No further action required
YES
Email Form 1247 – Application for Operational Assessment of a Proposed Plume Rise to CASA OAR – oar@casa.gov.au
Step 2
Proponent to submit Form 1247 to CASA OAR
Step 3
CASA OAR to determine CPV and CPH using Screening Tool
Unable to determine CPH as parameters supplied by the Proponent are beyond the Screening Tool limits.
Step 4
CASA OAR to conduct preliminary airspace risk assessment
CASA OAR to request a more detailed plume rise assessment from the Proponent
Step 5
CASA OAR to undertake stakeholder engagement
Impacts may include penetrations of the OLS, TIFPs, Air Routes, LSALTS or airspace.
Step 6
Does the CPH impact aviation operations?
NO
No further action required. CASA advises proponent of outcome.
YES
Examples for mitigating the impact include:
1. Reducing the exposure to risk by inserting a symbol on charts;
2. Engineering/Containment options such as baffles or exhaust outlet size;
3. Procedural options such as briefings, limiting times of emissions etc.
Step 7
CASA OAR to work with Proponent on suitable mitigation strategies.
Step 8
Can the impact be mitigated by the Proponent?
YES
Proponent to implement mitigation strategy/s.
NO
Step 9
Can the impact be mitigated by CASA OAR?
YES
CASA OAR to implement mitigation strategy/s.
NO
Step 10
CASA OAR to advise Proponent that the Application for Operational Assessment of a Proposed Plume Rise is not supported.