Australian Government
Civil Aviation Safety Authority

# ADVISORY CIRCULAR
# AC 139.E-02 v1.0


# Plume rise assessments

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|---|---|
| **Date** | March 2023 |
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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) is for proponents of facilities generating exhaust plumes, land use planning authorities and aircraft/airport operators.

# Purpose

The AC provides:

- guidance to proponents and stakeholders on the plume rise assessment process
- an explanation of CASA's 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.

# For further information

For further information, contact CASA’s Air Navigation, Airspace and Aerodromes Branch (telephone 131 757 or email airspace.protection@casa.gov.au)

Unless specified otherwise, all sub regulations, 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 |
|---|---|---|
| v1.0 | March 2023 | The third revision incorporates the use of the MITRE Exhaust Plume Analyzer (EPA) which was originally developed on behalf of the United States Federal Aviation Administration and has now been amended for CASA. This AC replaces AC 139-05 v3.0. |
| AC 139-05 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 |
| AGL | above ground level |
| BoM | Bureau of Meteorology |
| CASA | Civil Aviation Safety Authority |
| CASR | *Civil Aviation Safety Regulations 1998* |
| CPH | critical plume height |
| EPA | Exhaust Plume Analyser |
| FIFO | fly-in fly-out |
| FT | feet |
| LSALT | lowest safe altitude |
| LUPA | Land Use Planning Authority |
| m/s | metres per second |
| NM | nautical miles |
| NOTAM | notice to airmen |
| OLS | obstacle limitation surface |
| RPT | regular public transport |
| TAPM | The Air Pollution Model |
| US FAA | United States' Federal Aviation Administration |

## 1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

| Term | Definition |
|---|---|
| critical plume height | The height up to which there is an unacceptable probability of the plume affecting the handling characteristics of an aircraft in flight such that there is an undesirable risk to aircraft safety. |
| obstacle limitation surfaces | 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 |
|---|---|
| PANS/OPS and Doc 9905/9613 surfaces | Surfaces which protect instrument flight procedures designed on the principles of ICAO PANS-OPS document and Documents 9905/9613 |
| certified aerodromes | Certified aerodromes to which the Part 139 of CASR - Aerodromes applies. At these aerodromes, the aerodrome operator must establish the obstacle limitation surfaces in accordance with the standards set out in these regulations. |
| screening tool | The computer-generated method of plume rise analysis used by CASA to derive the height at which the average plume rise velocity is 4.3 m/s. The Screening Tool is based on The Air Pollution Model (TAPM) methodology |
| TAPM | The Air Pollution Model developed by CSIRO. |

## 1.3 References

### Legislation

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

| Document | Title |
|---|---|
| Regulation 6 of the Airspace Regulations 2007 | Airspace Regulations 2007 |
| Regulation 139.370 of CASR | Hazardous objects etc |
| Part 173 of CASR | Instrument flight procedure design |
| Part 139 MOS | Aerodromes Manual of Standards |

## 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 Assessing potential impacts of plume rises on aircraft safety

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

- industrial facilities that release process emissions through stacks or vents
- industrial flares that create an instantaneous release of hot gases during the depressurisation of gas systems
- cooling towers that 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 Aircraft operations in various stages of flight may be affected by a plume rise. A light aircraft in approach configuration is more likely to be affected by a plume rise than a heavy aircraft cruising at altitude. Helicopters and light recreational aircraft may be severely affected by a high temperature plume and the altered air mixture above an exhaust plume.

2.1.3 Regulation 139.180 of the *Civil Aviation Safety Regulations 1998* (CASR) provides that CASA may determine that a gaseous efflux having a velocity in excess of 4.3 metres per second (m/s) will be a hazard to aircraft operations because of the velocity or location of the efflux.

2.1.4 In addition to Regulation 139.180, Regulation 6A of the Airports (Protection of Airspace) Regulations 1996 defines 4.3 m/s as the level of turbulence that may be capable of affecting normal flight. This applies around leased federal airports and is administered by the Australian Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA).

2.1.5 When necessary, CASA will refer proposals to other relevant authorities including the Department of Defence, Airservices Australia and DITRDCA.

2.1.6 Previous ACs on this topic were predicated on the use of The Air Pollution Model (TAPM) for the detailed assessment of plume rises. Based on research and analysis commissioned by the US FAA, this AC is based on the adoption of the Exhaust Plume Analyzer model (EPA)[1] to predict plume size and severity of flight impact created by a plume rise.

2.1.7 Turbulence is classified as shown in Table 1 and was developed by the Bureau of Meteorology which defines limits for light, moderate and severe turbulence relative to the vertical acceleration of the aircraft.

[1] The EPA was created by the MITRE corporation on behalf of the United States Federal Aviation Administration (FAA). CASA engaged MITRE to update the model for consistency with Australian legislation. The EPA is a sophisticated model which assesses the risk of encountering light, moderate and severe turbulence caused by plumes for generic aircraft types. It can also model specific aircraft types provided aerodynamic data is provided.

**Table 1: Turbulence intensity specifications (Bureau of Meteorology 2014)**

| Intensity | G load | Aircraft reaction | Reaction inside aircraft |
|---|---|---|---|
| Light | 0.15-0.49 | Momentary slight and erratic changes in attitude and/or altitude. Rhythmic bumpiness. | Little effect on loose objects. |
| Moderate | 0.50-0.99 | Appreciable changes in attitude and/or altitude. Pilot remains in control at all times. Rapid bumps or jolts. | Unsecured objects move. Appreciable strain on seatbelts. |
| Severe | 1,.00-1.99 | Large abrupt changes in attitude and/or altitude. Momentary loss of control | Unsecured objects are tossed about. Occupants violently forced against seatbelts. |

2.1.8 CASA has adopted the EPA and will use it if required to conduct plume rise assessments when approached for advice by Land Use Planning Authorities (LUPA) or airport operators.

2.1.9 The EPA uses the Spillane plume rise model to compute the mean plume trajectory; in addition, it then applies a turbulence model to account for turbulent gusts associated with the plume. MITRE found the Spillane model to be the plume rise model which had the best correlation with empirical evidence. MITRE found that TAPM underpredicted the height of plume rises in the immediate vicinity of the stack.

2.1.10 The use of the EPA should therefore result in reliable and targeted risk assessments.

2.1.11 For example, a LUPA may advise that it wishes to implement land use zoning which will ensure that the airport can cater to light sport aircraft. Alternatively, there may be cases where the airport operator may advise that it considers the airport is only available to high-capacity regular public transport (RPT) aircraft and the CASA assessment should be based on the assumption that no light general aviation (GA) and light sport aircraft types operate at the airport.

2.1.12 Another expected advantage of this approach is that proponents will no longer have to engage specialist consultants to conduct plume rise assessments. This should reduce the regulatory burden for proponents in terms of both cost and time. However, it is open to proponents to engage the services of specialist consultants to conduct an assessment based on the use of the Spillane model.

2.1.13 LUPAs should ensure that the requisite information in Form 1247 - Operational Assessment of a proposed plume rise is submitted accurately.

## 2.2 Plume rise assessment process steps

2.2.1 The plume rise assessment process involves participation from the proponent and CASA. 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**

2.2.2 The proponent should make an initial assessment of the plume exit velocity. If the exit vertical velocity is less than 4.3 m/s, no further action is required by the proponent.

2.2.3 If the exit vertical velocity exceeds 4.3 m/s, a Form 1247 should be submitted to CASA: (airspace.protection@casa.gov.au).

2.2.4 A copy of Form 1247 should be provided to the operator of any aerodrome within 15 km of the facility. This will enable the aerodrome operator to provide comments to CASA on the proposal after consulting their aircraft operators.

**Step 3: Preliminary assessment of the plume rise proposal - application of the CASA screening tool**

2.2.5 CASA will use the information provided in Form 1247 to conduct a preliminary assessment. This will be conducted using the CASA screening tool.

2.2.6 If the outputs of the screening tool indicate that the plume velocity will not infringe a flight protection surface at a velocity exceeding 4.3 m/s, no further assessment is required. Flight protection surfaces include Obstacle Limitation Surface (OLS)/Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS) surfaces, restricted/danger areas and established flight paths.

2.2.7 If the outputs of the screening tool indicate that the plume velocity will infringe a flight protection surface at a vertical velocity exceeding 4.3 m/s, CASA will use the information provided to conduct a detailed assessment of the impact of the plume rise proposal using the EPA.

2.2.8 If the proposal is located outside the OLS of the nearest regulated airport, CASA will conduct a detailed assessment using the EPA only if the plume velocity exceeds 4.3 m/s at 150 m above ground level (AGL).

**Step 4: Detailed assessment of the impact of the plume rise proposal- application of the EPA**

2.2.9 If required, CASA will use the information provided to conduct a detailed assessment of the impact of the plume rise proposal using the EPA.

2.2.10 CASA advice on the risk to aviation safety from a plume will be dependent on the location of the plume, the probability of the relevant turbulence risk thresholds being exceeded and the turbulence level that would be unacceptable (moderate in the case of locations below critical flight protection surfaces and established flight paths and severe in the case of locations below non-critical flight protection surfaces and not below established flightpaths).

2.2.11 CASA will provide a response, if a stakeholder such as a LUPA seeks specific advice on the probability of a given aircraft type to be affected by light turbulence.

2.2.12 The basis for application of EPA output to the assessment of risk from plume rises is detailed at Table 2.

**Table 2: Probability and turbulence threshold levels for assessment of risk**

| Location of plume/ protection surface | Probability threshold levels | Turbulence threshold levels |
|---|---|---|
| PANS-OPS/Doc 9905/9613 surface | 1 x $10^{-5}$ per operation | Moderate |
| Approach surface/ take off climb surface/inner horizontal, conical and outer horizontal surfaces (below established flight paths) | 1 x $10^{-5}$ per operation | Moderate |
| Inner horizontal, conical and outer horizontal surfaces (not below established flight paths) | 1 x $10^{-5}$ per operation | Severe |
| Outside the OLS (flight protection surface set at 1000m /3050 FT AGL) | 1 x $10^{-4}$ per operation | Severe |

## 2.3 Assessment of plume rises using the EPA

### 2.3.1 Infringement of PANS-OPS/Doc 9905/9613 surfaces

2.3.1.1 If there is an infringement of the above surfaces creating a probability of moderate turbulence greater than 1 x $10^{-5}$ per operation, CASA will take the position that the proposal will create an unacceptable risk to the safety of aircraft operations.

2.3.1.2 As a practical matter, any infringement of one of these surfaces creating moderate turbulence with a probability greater than 1 x $10^{-5}$ per operation will also involve an infringement of the overlying OLS.

2.3.1.3 If the proposal cannot be altered to avoid this impact, changes to Terminal Instrument Flight Procedures (TIFP) maybe an option. However, stakeholders such as LUPA, aircraft operators and airport operators must accept that any changes to TIFP will affect the regularity and efficiency of operations at the airport.

### 2.3.2 Infringement of approach/take-off climb/transitional surfaces

2.3.2.1 If there is an infringement of the above surfaces creating a probability of moderate turbulence greater than 1 x $10^{-5}$ per operation, CASA will take the position that the proposal will create an unacceptable risk to the safety of aircraft operations.

2.3.2.2 These surfaces protect critical phases of flying operations.

2.3.2.3 CASA may determine that an unacceptable risk in this location cannot be mitigated through means such as Aeronautical Information Publication (AIP)/chart publication or introduction of danger/restricted areas.

### 2.3.3 Infringement of inner horizontal surface- sites below established or potential flight paths

2.3.3.1 If there is an infringement of the above surface creating a probability of moderate turbulence greater than 1 x $10^{-5}$ per operation, CASA will take the position that the proposal will create an unacceptable risk to the safety of aircraft operations.

2.3.3.2 This surface protects critical phases of flying operations as aircraft may be in the circuit, departing the airport, or conducting a circling approach above the site.

2.3.3.3 CASA's may determine that an unacceptable risk in this location cannot be mitigated through means such as AIP/chart or introduction of danger/restricted areas.

### 2.3.4 Infringement of inner horizontal surface- sites not below established or potential flight paths

2.3.4.1 CASA's assessment of infringements in these cases will be based on the probability of creating severe turbulence.

2.3.4.2 The rationale for the higher risk threshold is that the proponent will have demonstrated in an aeronautical study that it is highly unlikely that aircraft will overfly the site.

2.3.4.3 If there is an infringement of the above surface creating a probability of severe turbulence greater than 1 x $10^{-5}$ per operation, CASA may determine that the proposal will create an unacceptable risk to the safety of future aircraft operations.

2.3.4.4 CASA may require publication of the plume in by AIP/charts.

### 2.3.5 Infringement of conical/outer horizontal surface - sites below established or potential flight paths

2.3.5.1 If there is an infringement of the above surfaces creating a probability of moderate turbulence greater than 1 x $10^{-5}$ per operation, CASA may determine that the proposal will create an unacceptable risk to the safety of aircraft operations.

2.3.5.2 This surface protects critical phases of flying operations as aircraft may be in the circuit, departing the airport, arriving at the airport, or conducting a circling approach above the site.

### 2.3.6 Infringement of conical/outer horizontal surface - sites not below established or potential flight paths

2.3.6.1 CASA's assessment of infringements in these cases will be based on the probability of creating severe turbulence.

2.3.6.2 The rationale for the higher risk threshold is that the proponent will have demonstrated in an aeronautical study that it is highly unlikely that aircraft will overfly the site.

2.3.6.3 If there is an infringement of the above surfaces creating a probability of severe turbulence greater than 1 x $10^{-5}$ per operation, CASA may determine that the proposal will create an unacceptable risk to the safety of aircraft operations.

### 2.3.7 Areas outside the vicinity of a regulated airport (site is not below OLS /PANS-OPS/Doc 9905/9613 surfaces for the airport)

2.3.7.1 CASA's assessment of infringements in these cases will be based on the probability of creating severe turbulence above 1000 m/3050 ft AGL and on a threshold of $1 \times 10^{-4}$ per operation.

2.3.7.2 The rationale for the higher risk threshold is that CASA will be satisfied that it is extremely unlikely that aircraft will overfly the site at an altitude where the plume rise will affect the safety of aircraft operations.

2.3.7.3 If there is an infringement of the above surfaces creating a probability of severe turbulence greater than $1 \times 10^{-4}$ per operation, CASA may determine that the proposal will create an unacceptable risk to the safety of aircraft operations.

2.3.7.4 If the plume rise affects air routes and lowest safe altitudes (LSALTs), changes to these may be an option subject to the agreement of stakeholders engaged through the aviation safety engagement forum (AvSEF) industry consultation process. Any changes made by the Part 173 authority (Airservices Australia) are likely to have cost implications for proponents.

## 2.4 Mitigation of the impact of the plume rise proposal

2.4.1 Outside the vicinity of an aerodrome, mitigation options for a plume rise may include the following:

a. insertion of a symbol and a height on aviation charts to enhance awareness of the plume rise
b. designation of a danger area in accordance with Regulation 6 of the Airspace Regulations 2007 to alert pilots to the potential danger to aircraft overflying the area.
c. designation of a restricted area in accordance with Regulation 6 of the Airspace Regulations 2007 to restrict the flight of aircraft over the area.

## 2.5 Assessment of stacks with engineering modifications/non-aligned/non-uniform spacing

2.5.1 If the proponent presents a stack design involving engineering modifications aimed to reduce the impact of the plume rise, the EPA cannot be used to assess risk levels directly. There will be a need for Computational Fluid Dynamics (CFD) modelling or scaled, physical modelling before the EPA can be used.

2.5.2 CASA notes that proposals of this nature may occasionally be presented for comment or input from a LUPA, such as the Department of Environment, Land, Water and Planning, Victoria or a local council. If a LUPA request comment from CASA, we may engage an independent engineering consultant on a full cost recovery basis from the LUPA to provide specialist advice that will underpin our comment on risk to aircraft operations from the proposed plume rise.

2.5.3 Alternatively, CASA can provide advice about the height above which the average plume velocity should not exceed 6.1m/s (consistent with the BoM parameter for

moderate turbulence) and the LUPA can itself arrange, or require the proponent to arrange, the commissioning of a plume study which will assess whether this parameter will be exceeded. It will then be a matter for the LUPA to satisfy itself on the validity of the plume study and CASA will not provide comments on the study.

2.5.4 Similarly, the EPA is designed to assess single stacks or multiple stacks which are aligned and are at uniform distances from each other. In some cases, it may be possible for CASA to make conservative assumptions regarding non-aligned/non-uniform stacks that will enable the use of the EPA. However, CASA may require the engagement of assistance from a provider of specialist services to confirm the assumptions are valid and conservative. Specialist services will be procured on a user pays basis and this approach will only be taken based on an agreement with the LUPA.

# 3 Examples of the outcomes of a plume rise assessment

## 3.1 Assessing plume rise information for potential impact on aircraft safety

3.1.1 To illustrate how CASA would base its advice to LUPAs on the assessment of plume rises, the following examples, which are based on cases presented to CASA for assessment, demonstrate how the risk to aircraft operations will be assessed.

3.1.2 CASA will initially use Form 1247 from the proponent to obtain information on the plume. For this exercise, the elevation of the site is taken to be the same as the runway height threshold.

3.1.3 CASA will initially use the screening tool to determine if the plume would have an average velocity above 4.3 m/s at the height of an airspace protection surface for consistency with current legislation.

3.1.4 If the screening tool indicates there will be no infringement at an average velocity above 4.3 m/s, CASA will conclude that no mitigation is required. If the screening tool indicates the possibility of an infringement at an average velocity greater than 4.3 m/s, CASA will use the MITRE EPA model.

3.1.5 CASA will use the following inputs to run the MITRE EPA model:

- Information about the proposed facility obtained from Form 1247
- environmental data from the meteorological module of TAPM
- aircraft specific parameters if the LUPA requests advice tailored to the operations at the aerodrome. This approach would be useful at aerodromes where there is a limited range of aircraft types e.g., a mining aerodrome restricted to charter Boeing 737 fly-in fly-out (FIFO) operations.

3.1.6 The MITRE EPA model will calculate the probability of the defined aircraft types experiencing moderate turbulence across the vertical and horizontal envelope.

**Example 1 - Gas engines located along the extended centreline, below the approach and take-off climb surfaces; 1,000 m from the runway threshold**

3.1.7 In the following example, the proposal is for the use of gas engines at a location 1,000 m from the threshold of a runway. The airport has advised that the critical aircraft is a turbo prop RPT aircraft, the De Havilland Canada Dash 8-400.

3.1.8 The information on the proposed facility from Form 1247 is:

- stack height: 10 m
- stack diameter: 0.3 m
- number of stacks: 3
- stack separation: 5 m
- exit velocity: 30 m/s
- exit temperature.: 180 degrees C.

3.1.9 In this example, the screening tool indicates that the plume rise would infringe the approach and take off surfaces at an average velocity exceeding 4.3 m/s. CASA will then refine the assessment using the MITRE EPA model.

3.1.10 Figure 1 presents the output depicting the probability of moderate turbulence for the critical aircraft at this location, which is a Dash 8-400.

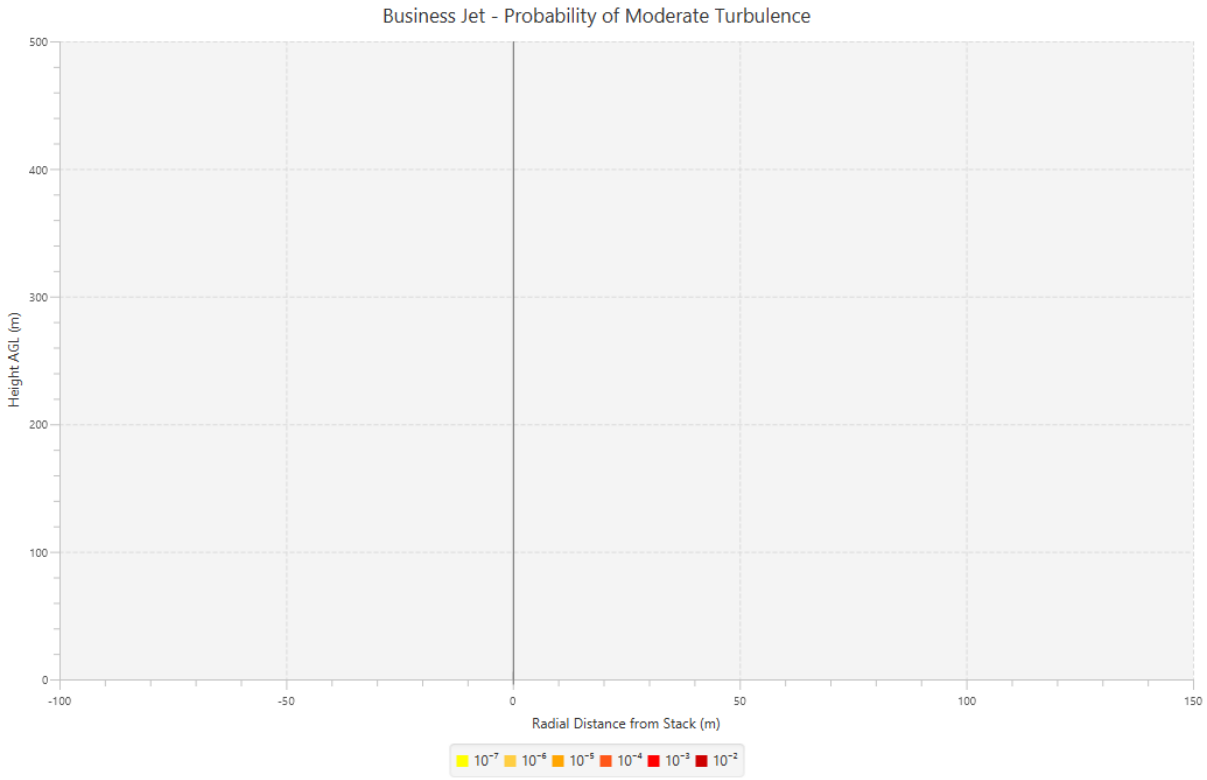


**Figure 1 Probability of Dash 8-400 RPT aircraft (equivalent to a Business Jet) encountering moderate turbulence in the vicinity of the plume rise**

3.1.11 The output shows that there will be no infringement of the OLS by the plume rise from the proposal capable of creating moderate turbulence for a Dash 8-400 aircraft. CASA will therefore conclude that the proposal is acceptable.

**Example 2 - Cogeneration plant, located below the inner horizontal surface, 3000 m abeam of the runway threshold**

3.1.12 In the following example, the proposal is for the use of a cogeneration plant at a location 3000 abeam of the threshold of a runway. The airport has advised that the critical aircraft is a turbo prop RPT aircraft, the De Havilland Canada Dash 8-400.

3.1.13 The information on the proposed facility from Form 1247 is:

- stack height: 70 m
- stack diameter: 2 m
- number of stacks: 1
- exit velocity: 18.5 m/s
- exit temperature: 140 degrees C.

3.1.14 In this example, the screening tool indicates that the plume rise would infringe the inner horizontal surface at an average velocity exceeding 4.3 m/s. CASA will then refine the assessment using the MITRE EPA model.

3.1.15 Figure 2 presents the output depicting the probability of moderate turbulence for the critical aircraft at this location, which is a Dash 8-400.

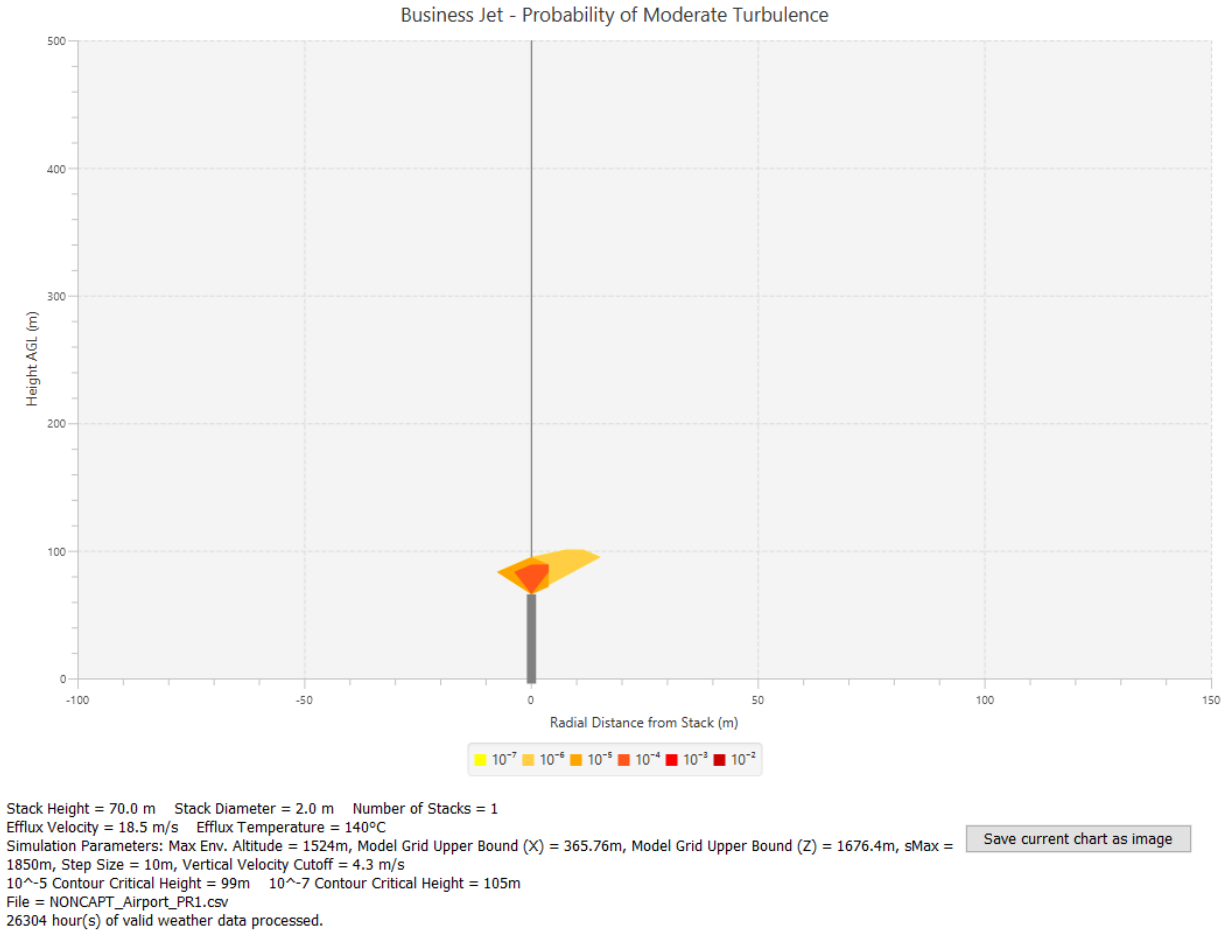


**Figure 2 Probability of Dash 8-400 RPT aircraft (equivalent to a Business Jet) encountering moderate turbulence in the vicinity of the plume rise**

3.1.16 The output indicates that the maximum height at which there is a 1 x 10 $^{-5}$ probability for this aircraft type to encounter moderate turbulence is approximately 100 m (330 FT) AGL.

3.1.17 A Dash 8-400 aircraft in the vicinity of this plume will be operating at or above 1500 FT AGL. CASA will therefore conclude that the proposal is acceptable.

**Example 3 - Power generation units, located under the inner horizontal surface, 3000 m from the runway threshold, at a bearing of 45 degrees.**

3.1.18 In the following example, the proposal is for the use of power generation units at a location 3,000 m at a bearing of 45 degrees from the threshold of a runway. The airport has advised that the critical aircraft is a Cessna 172.

3.1.19 The information on the proposed facility from Form 1247 is:

- stack height: 15 m
- stack diameter: 2.0 m
- number of stacks: 3
- stack separation: 20 m

- exit velocity: 40 m/s
- exit temperature: 500 degrees C.

3.1.20 In this example, the screening tool indicates that the plume rise would infringe the inner horizontal surface at an average velocity exceeding 4.3 m/s. CASA will then refine the assessment using the MITRE EPA model.

3.1.21 Figure 3 presents the output depicting the probability of moderate turbulence for the critical aircraft at this location, which is a Cessna 172.

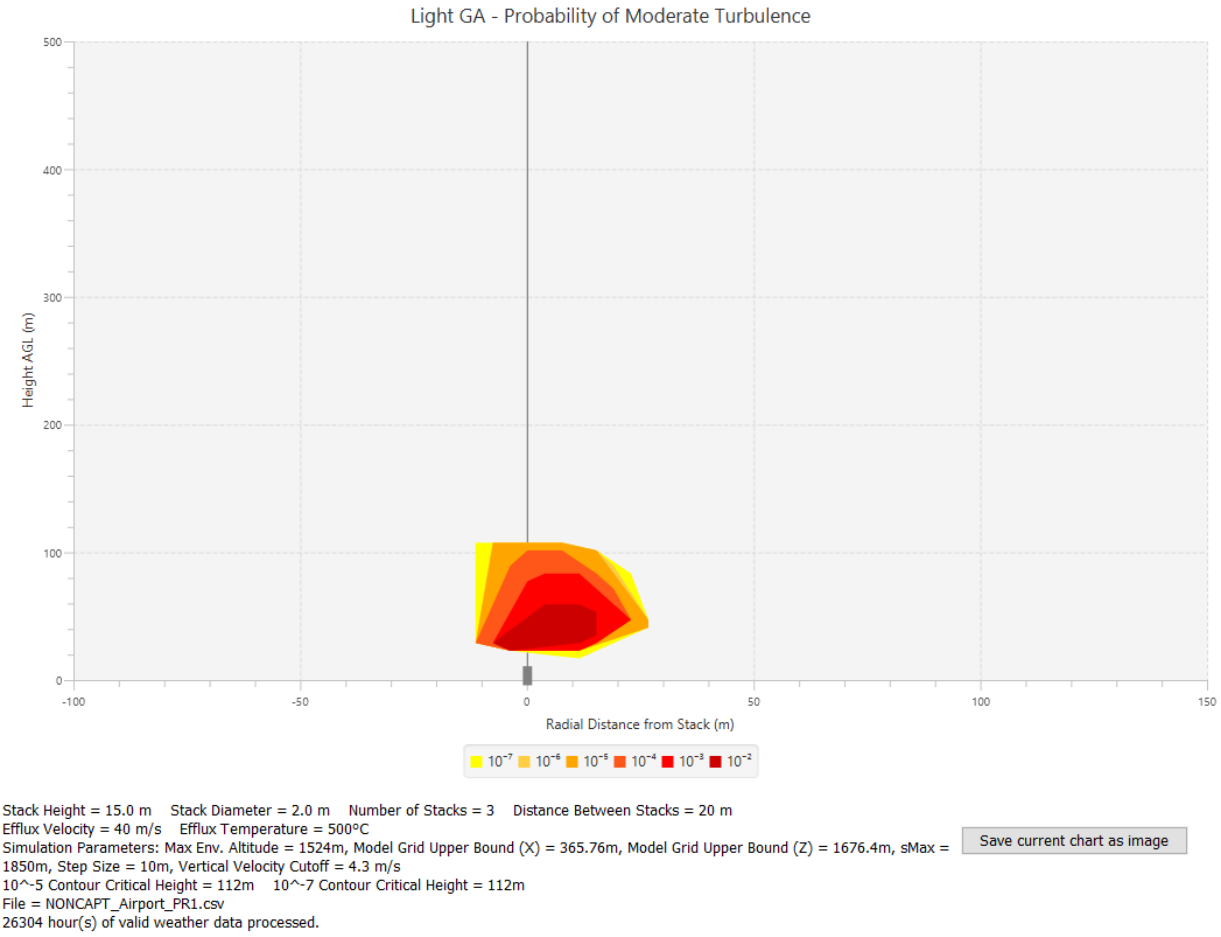


**Figure 3 Probability of a light GA aircraft encountering moderate turbulence in the vicinity of the plume rise.**

3.1.22 The output indicates that the maximum height at which there is a 1 x $10^{-5}$ probability for this aircraft type to encounter moderate turbulence is approximately 115 m (375 FT) AGL.

3.1.23 A Cessna 172 aircraft in the vicinity of this plume will be operating at or above 500 FT AGL. CASA will therefore conclude that the proposal is acceptable with the mitigation of a plume rise symbol and a training/education campaign with local operators.

**Example 4 - Road tunnel ventilation stacks, located under the inner horizontal surface, 700 m abeam a point 1500 m along the extended centreline from the runway threshold**

3.1.24 In the following example, the proposal is for the use of road tunnel ventilation stacks at a location 700 m abeam a point 1500 m along the extended centreline from the threshold of a runway. The airport has advised that the critical aircraft is a Dash 8 -400.

3.1.25 The information on the proposed facility from Form 1247 is:

- stack height: 20 m
- stack diameter: 5.5 m
- number of stacks: 3
- stack separation: 6.5 m
- exit velocity: 7.5 m/s
- exit temperature: 35 degrees C.

3.1.26 In this example, the screening tool indicates that the plume rise would infringe the inner horizontal surface at an average velocity exceeding 4.3 m/s. CASA will then refine the assessment using the MITRE EPA model.

3.1.27 Figure 4 presents the output depicting the probability of moderate turbulence for the critical aircraft at this location, which is a Dash 8 -400.

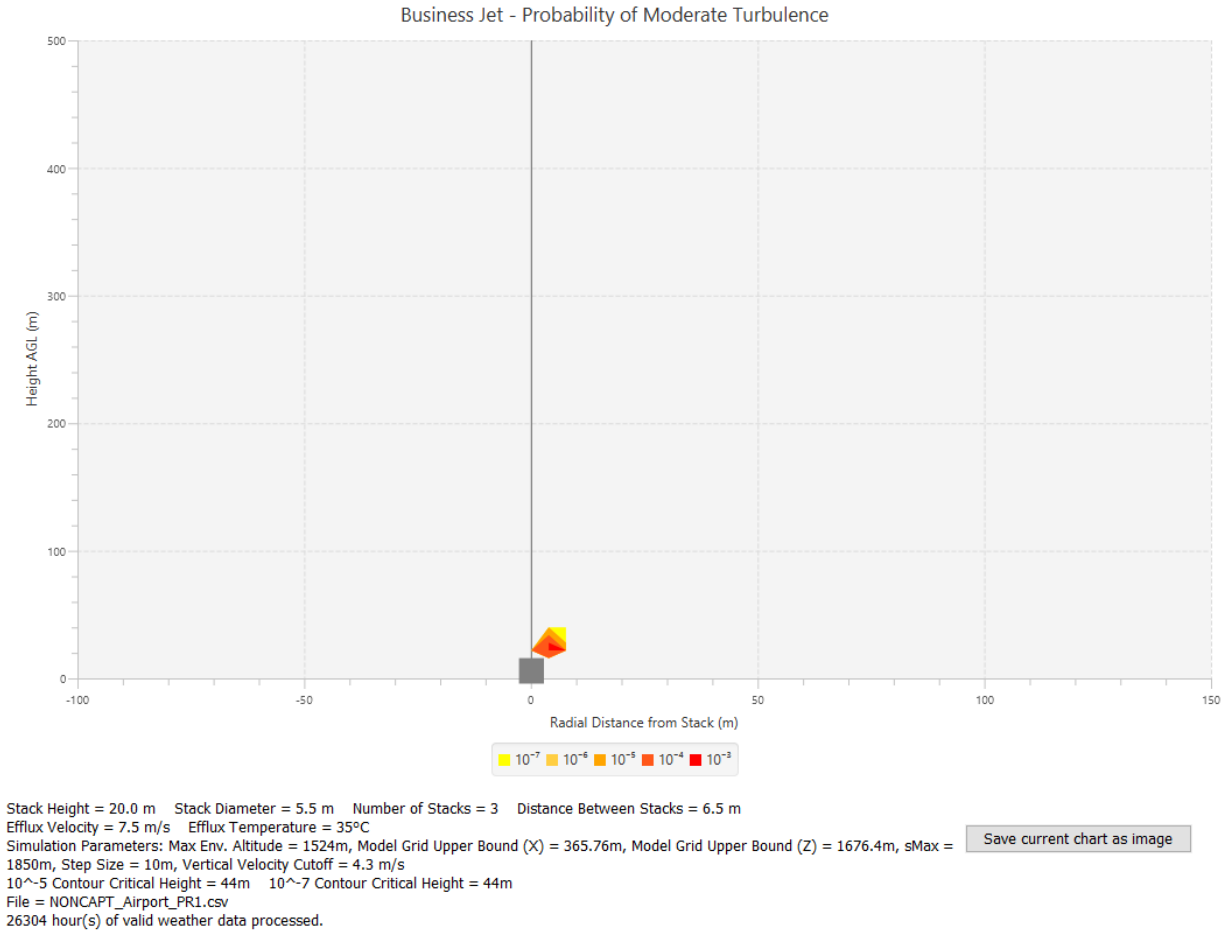


**Figure 4 Probability of a Dash 8 -400 aircraft encountering moderate turbulence in the vicinity of the plume rise.**

3.1.28 The output shows that there will be no infringement of the OLS, which is at a height of 45 m AGL at this location. CASA will therefore conclude that the proposal is acceptable.

### Example 5 - Open cycle Gas Turbine power plant, located under the conical surface, 5500 m along the extended centreline

3.1.29 In the following example, the proposal is for the use of an open cycle gas turbine power plant at a location 5,500 m from the threshold of the runway is located 5500 m from the threshold of the runway. The aerodrome is a mine site aerodrome with FIFO Boeing 737-800 operations.

3.1.30 The information on the proposed facility from Form 1247 is:

- stack height: 35 m
- stack diameter: 6.0 m
- number of stacks: 1
- exit velocity: 40 m/s
- exit temperature: 550 degrees C.

3.1.31 In this example, the screening tool indicates that the plume rise would infringe the conical surface at an average velocity exceeding 4.3 m/s. CASA will then refine the assessment using the MITRE EPA model.

3.1.32 Figure 5 presents the output depicting the probability of moderate turbulence for the critical aircraft at this location, which is a Boeing 737-800.

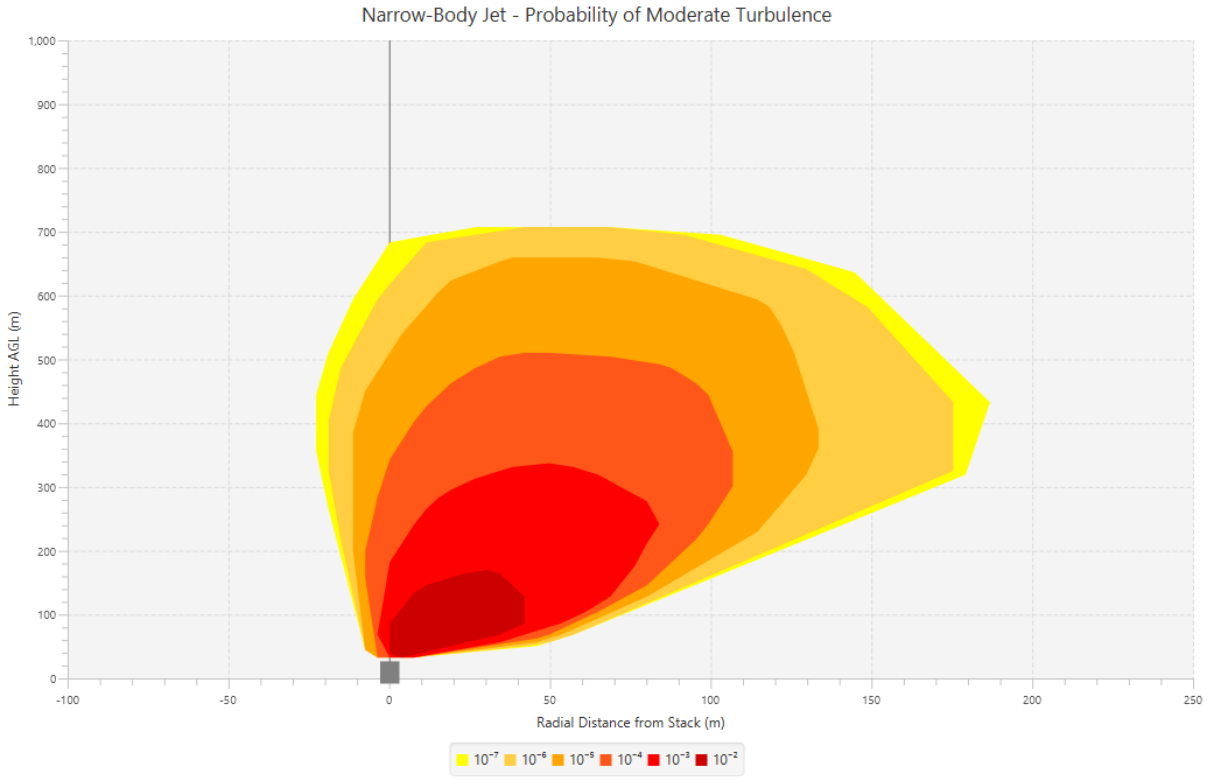


**Figure 5 - Probability of a narrow body jet aircraft similar to Boeing 737-800 encountering moderate turbulence in the vicinity of the plume rise.**

3.1.33 The output indicates that the maximum height at which there is a 1 x $10^{-5}$ probability for this aircraft type to encounter moderate turbulence is approximately 670 m (2200 FT) AGL.

3.1.34 The plume is located 5500 m from the threshold of the runway. Aircraft will be flying over the plume at approximately 305 m (1000 FT)

CASA will conclude that the risk to aircraft operations is not acceptable.

# Appendix A

# Plume rise assessment process

## A.1 Plume rise assessment process

A.1.1 The flowchart is an overview of the assessment process.

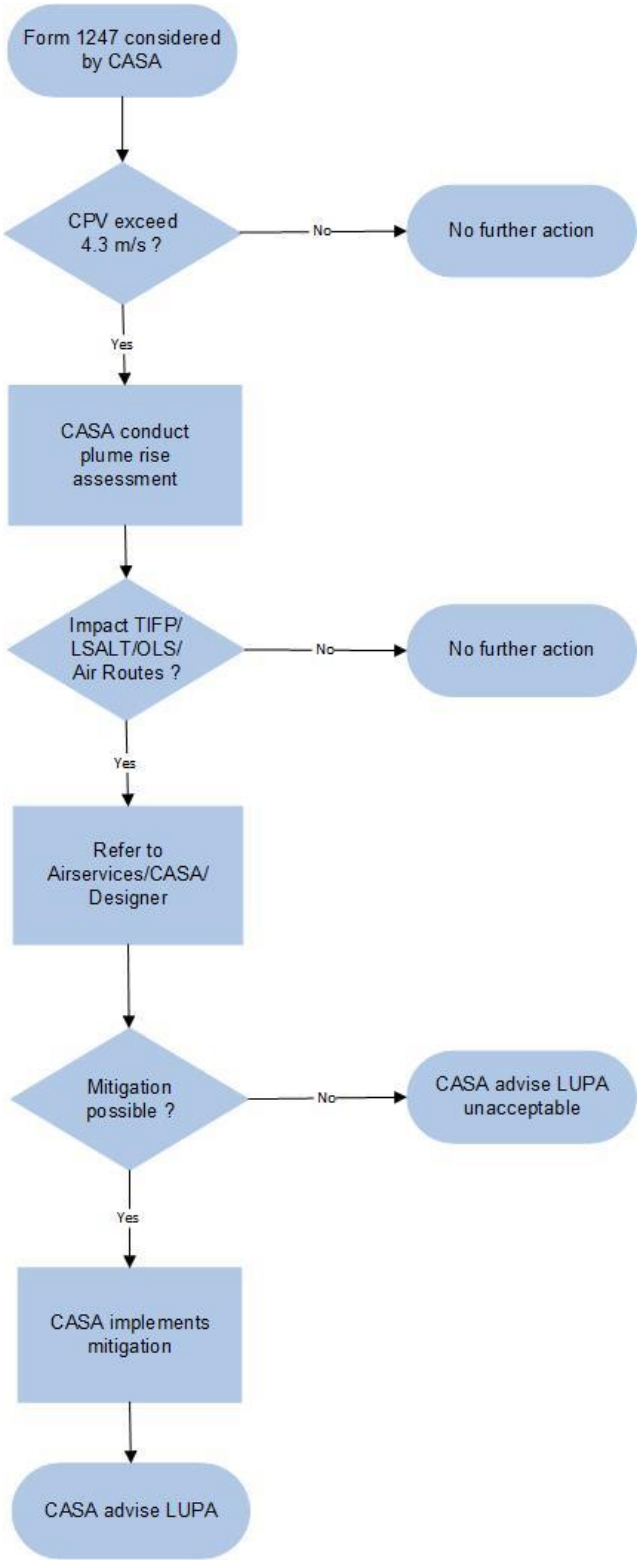


**Figure 1 Plume rise assessment process**