NATIONAL AIRPORTS SAFEGUARDING FRAMEWORK

MANAGING THE RISK OF BUILDING GENERATED WINDSHEAR AND TURBULENCE AT AIRPORTS

REVISION DATE	VERSION NUMBER	CHANGES MADE	APPROVED BY
Feb 2012	2.2.1	Document Creation	NASAG
Apr 2012	2.2.2	Drafting changes post consultation process	SCOTI
Jul 2012	2.2.3	Version control table added. Page numbers added.	S. Stone, GM Aviation Environment, DOIT.
Jun 2013	2.2.4	Minor formatting and editing amendments.	S. Stone, GM Aviation Environment, DOIT.

Purpose of Guideline

1. To provide guidance to Commonwealth, state/territory and local government decision makers and airport operators to manage the risk of building generated windshear (i.e. changes in wind speed and/or direction between two points) and building generated turbulence (i.e. rapid irregular changes in wind speed and/or direction at a fixed point) at airports.

Why it is important

2. The *Principles for a National Airports Safeguarding Framework* acknowledge the importance of airports to national, state/territory and local economies, transport networks and social capital.

3. This Guideline is designed to assist land use planners and airport operators in their planning and development processes to reduce the risk of building generated windshear and turbulence near runways at airports.

4. The building generated windshear / turbulence issue becomes safety critical when a significant obstacle, such as a building, is located in the path of a crosswind to an operational runway. The wind flow will be diverted around and over the buildings causing the crosswind speed to vary along the runway.

5. Australian Transport Safety Bureau (ATSB) data indicates that there have been at least two serious incidents in Australia caused by building induced windshear, which resulted in passenger injuries or damage to the aircraft and triggered safety investigations. In both of these cases the buildings were located on-airport.

How it should be used

6. Some states/territories already have planning guidelines or policies in place and this document provides guidance for their review. For those without policies in place, this guideline (in addition to the associated Safeguarding Framework) provides input to new policies.

7. This guideline can be applied by airports, planners and regulators when evaluating building proposals on airports, or by planners in consultation with airport operators for proposals in the immediate vicinity of airports.

8. While off-airport buildings are an important consideration, the Civil Aviation Safety Authority (CASA) advises that the risk of wind effects from buildings located off-airport should not be overstated.

9. This guideline is not intended to be applied retrospectively to existing buildings. However:
    - if a new building is proposed then the existing surrounding buildings need to be considered in the assessment of the proposed building; and
    - if a new runway or a modification to an existing runway is proposed, the existing surrounding buildings that fall within the assessment trigger area for the new or modified runway need to be considered in the assessment of the new or modified runway.

Roles and Responsibilities

10. There is a need for a risk-based approach where all the parties listed below recognise the risk of building-induced windshear/turbulence and share the responsibility for risk management.

Australian Government (Department of Infrastructure and Regional Development (DIRD))

11. On-airport planning at Australia's leased federal airports is under Australian Government control and administered under the *Airports Act 1996* (the Airports Act).

12. This responsibility is exercised by the Minister responsible for the Airports Act through the approval of Airport Master Plans (MPs) and Major Development Plans (MDPs). The Department provides advice to the Minister to inform the assessment of MPs and MDPs. In forming its advice to the Minister, DIRD will also consult with CASA on safety issues.

Civil Aviation Safety Authority (CASA)

13. CASA is Australia's safety regulator for civil air operations and the operation of Australian aircraft overseas.

14. For on-airport planning at Australia's leased federal airports, CASA has a role in providing windshear and turbulence advice to the Minister for all MDPs and any proposed buildings that penetrate the 1:35 surface. In forming their advice, CASA will consider the size, shape and location of a proposed structure and apply this guideline and any other matters it considers relevant.

15. CASA does not have regulatory powers to prevent construction based on windshear and/or turbulence risk. If a proposed structure is on a leased federal airport, CASA will provide advice to the Minister on the windshear/turbulence risk to inform the Minister's consideration and approval of the MDP.

16. For structures that are not on leased federal airports, CASA can provide safety advice if requested, but the decision to approve or not approve the structure would lie with the local planning/approval authority.

17. If requested by state/territory/local governments, approval authorities/decision makers, non-federally-leased airports, or proponents of developments, CASA may provide safety advice on proposed structures or on the findings of expert's assessment reports produced under Guideline B.

18. CASA may also be able to provide advice on operational mitigation measures that may result in a building being acceptable (i.e. runway closures when wind is coming from a certain direction). Developers and airport operators should work together to develop such measures and CASA would then advise the approval authority/decision maker whether it considers the arrangement to be acceptable.

State/territory and local governments

19. State, territory and local governments are primarily responsible for off-airport land use planning in the vicinity of the leased federal airports, as well as on-airport planning and off-airport planning at all other airports.

20. For this guideline to be effective, it is important that each jurisdiction considers how best to implement the guideline within their planning schemes so that off-airport development proposals can be assessed in a consistent manner to those on-airport. This is particularly important for the non-federally-leased airports.

21. This guideline does not prescribe in detail how state/territory and local governments should implement it into their planning schemes. That is a matter for individual jurisdictions and it is appropriate that jurisdictions have some flexibility in implementation given the variability in planning approaches.

22. Jurisdictions could apply this Guideline by overlaying the assessment trigger area and 1:35 surface (described in paragraphs 43-48) in state/territory or local planning documentation.

23. For example, the planning documentation could specify that developments within the assessment trigger area, which penetrate the 1:35 surface, need to consider windshear and turbulence risk. In some cases, the proponent of the development may be able to put forward a simple safety case that satisfies the approval authority/decision maker (e.g. easterly winds only occur 10 per cent of the time and the runway is not operational at these times, so a building to the east of the runway is safe). The approval authority/decision maker may seek CASA advice on such safety cases before deciding to approve or not approve the development. In other cases, if the approval authority/decision maker and/or CASA are not satisfied by the safety case, the proponent of the development may wish to engage a suitably qualified wind engineering specialist to assess the proposed structure and advise whether it passes the windshear and turbulence criteria described in paragraphs 49-53. Again, the approval authority/decision maker may seek CASA advice on engineering assessments before deciding to approve or not approve a development.

24. Structures that are outside the assessment trigger area and/or do not penetrate the 1:35 surface, do not pose a windshear or turbulence risk and may be approved without further consideration of windshear and/or turbulence.

Airport Operators

25. At the leased federal airports, airports are responsible for preparing master plans and major development plans for the Minister's approval. The safety and amenity related guidelines (including this Guideline B) of the National Airports Safeguarding Framework form part of the Minister's consideration.

26. On-airport planning at non-federally-leased airports is undertaken by the airport operator – either a private owner/operator or, in some cases, the local council which owns and operates the airport. These airports are responsible for complying with relevant state/local planning regimes (including any safeguarding guidelines).

27. At non-federally-leased airports this guideline is useful in providing airport operators with some guidance to avoid building structures that may cause building-generated windshear/turbulence near airport runways.

Pilots / Airlines

28. Pilots have the ultimate responsibility for choosing whether to land an aircraft in the prevailing wind conditions.

29. Pilots and airlines have a role to inform airports and planners about potential risks and management strategies.

Qualified Wind Engineers / Other Suitably Qualified Wind Professionals

30. When a proposed development penetrates the 1:35 surface, within the assessment trigger area, a qualified wind engineer or other suitably qualified wind professional may be required to assess the proposed structure using wind tunnel testing or computational fluid dynamics (CFD) in order to satisfy the approval authority/decision maker (and CASA if their advice is sought) that the structure is acceptable.

31. The purpose of wind tunnel or CFD testing is to assess when and in what circumstances the 6-knot (3.1 m/s), 7-knot (3.6 m/s) and 4-knot (2.1 m/s) windshear and turbulence criteria (outlined in paragraphs 49-53) are expected to be exceeded.

32. The assessment report should provide enough information (e.g. whether the criteria will be exceeded, what wind strength and direction would cause each criteria to be exceeded, how often this can be expected to happen) to allow planners to decide whether the proposed structure is acceptable, whether the risks can be mitigated through operational procedures at the airport, or whether the proposed structure should be refused.

33. CASA has suggested a preferred format for presenting assessment output data. This specifies that the gust speed required to exceed each criteria should be given at 100m horizontal intervals along the runway centreline and at 5m vertical intervals up to a height of 60m. More information and a suggested table for presenting this data is provided in the Guidance Material at Attachment A.

Australasian Wind Engineering Society (AWES)

34. The AWES is a non-profit organisation whose membership comprises the academic and industrial wind engineering communities with the objective of promoting and advancing the practice of wind engineering and industrial aerodynamics.

35. The AWES has produced a Quality Assurance Manual (QAM) which provides guidance to practicing professionals on the conduct of wind tunnel testing for buildings and structures. The QAM assists users in specifying wind tunnel tests and ensuring the basic testing requirements are met. Minimum requirements for wind tunnel testing in simulated boundary layers are clearly specified and commentary is provided on the basis of these minimum requirements.

36. Wind tunnel tests conducted in accordance with the QAM are generally recognised as industry best practice. However, it is noted that building generated windshear and turbulence are specific cases, requiring specific tests that are not currently covered in the QAM. This Guideline therefore does not mandate the use of the AWES QAM.

37. It is not necessary for building proponents, airports or approval authorities/decision makers to consult the QAM for their role in the assessment methodology outlined on page 9.

Establishing a practicable standard to control the risk of building generated windshear and turbulence at airports near runways

38. Australia has international obligations as a contracting state to the Convention on Civil Aviation to regulate aviation safety.

39. The Australian Government is committed to developing guidance on the impact of turbulence and windshear generated by buildings in the vicinity of runways. This Guideline was updated in 2017 to reflect advances in the science and understanding of engineering and align guidance material with world's best practice.

40. The science of building generated windshear and turbulence is extremely technical and complex. This Guideline aims to better inform the siting and construction of on-airport buildings, and buildings in the immediate vicinity of airports, to mitigate the risk of building-generated windshear and turbulence without imposing unnecessary resource burdens on affected industries or regulators.

41. Noting the complexity of the issues, this Guideline and the guidance material at Attachment A presents a simplified depiction of wind flows behind obstacles such as buildings and contains a synopsis of the technical issues surrounding building-induced wind effects.

42. This Guideline and the guidance material at Attachment A set out:
    - empirically determined criteria for windshear and turbulence respectively;
    - generic guidance on mitigating risks from proposed buildings;
    - a methodology for assessment of proposed buildings;
    - options, where required, for subsequent detailed modelling of wind effects; and
    - options to mitigate wind effects of existing buildings, where required.

Key Considerations for Managing the Risk of Building Generated Windshear and Turbulence at Airports

Mitigation of risk by building siting and location

43. Research conducted by the Aeronautical Research Laboratory of the Netherlands (NLR) indicates that safety risk is highest below 200ft (61m) above the runway. This research was conducted in response safety incidents at Amsterdam airport caused by building induced wind effects.

44. Buildings that could pose a safety risk are those located within a rectangular 'assessment trigger area' around the runway ends (see Figure 1, below):
    a. 1200m or closer perpendicular from the runway centreline (or extended runway centreline[1]);
    b. 900m or closer in front of runway threshold (towards the landside of the airport); and
    c. 500m or closer from the runway threshold along the runway.

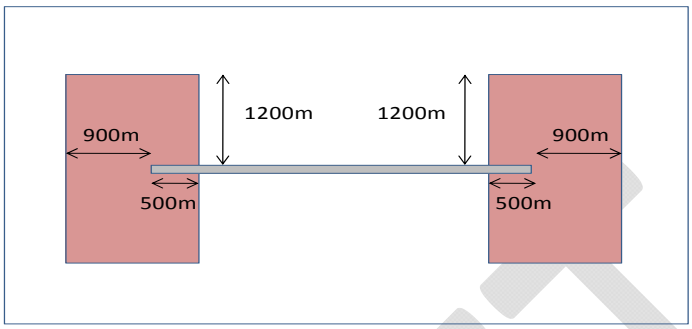

Figure 1: Assessment trigger area around runways, within which buildings should be assessed

Mitigation of risk by use of a height limitation surface

45. For buildings within the assessment trigger area, the first step is to consider the height of the building to determine its acceptability. The rule adopted in Australia is based on one developed in the Netherlands. This proposes that buildings should not penetrate a 1:35 surface extending perpendicular from the runway centreline (or extended runway centreline within the assessment trigger area). As the 1:35 surface extends from the runway centreline, when considering buildings against the 1:35 surface the building height should be measured above runway level.
46. In other words, the distance from the runway centreline to the closest point of the building should be more than 35 times the height (above runway level) of the building. Thus, a building with a height of 10 metres would be acceptable if it is located more than 350 metres perpendicular from the runway centreline (or extended runway centreline) and a building with a height of 20 metres would need to be located more than 700 metres from the runway centreline (or extended runway centreline).
47. The 1:35 surface can be applied to rule out buildings that will clearly not pose a risk. This will therefore be the first test that will be applied when approval authorities/decision makers are presented with a building to assess within the trigger area. This approach will enable the vast majority of developments at regional airports to be assessed very quickly. The 1:35 surface is very conservative and any building that does not penetrate the surface is not expected to create unsafe wind effects.
48. Plan and elevation views illustrating the concept of the 1:35 surface are provided in Figure 2. The footprint of the 1:35 surface is the same as the assessment trigger area (i.e. 1200m either side of the runway centreline, 500m along the length of the runway and 900m landside of the runway threshold). Figure 2 also illustrates the concept of the 'extended runway centreline'.

[1] The extended runway centreline is a hypothetical extension of the runway centreline beyond the runway threshold (as illustrated in Figure 2).

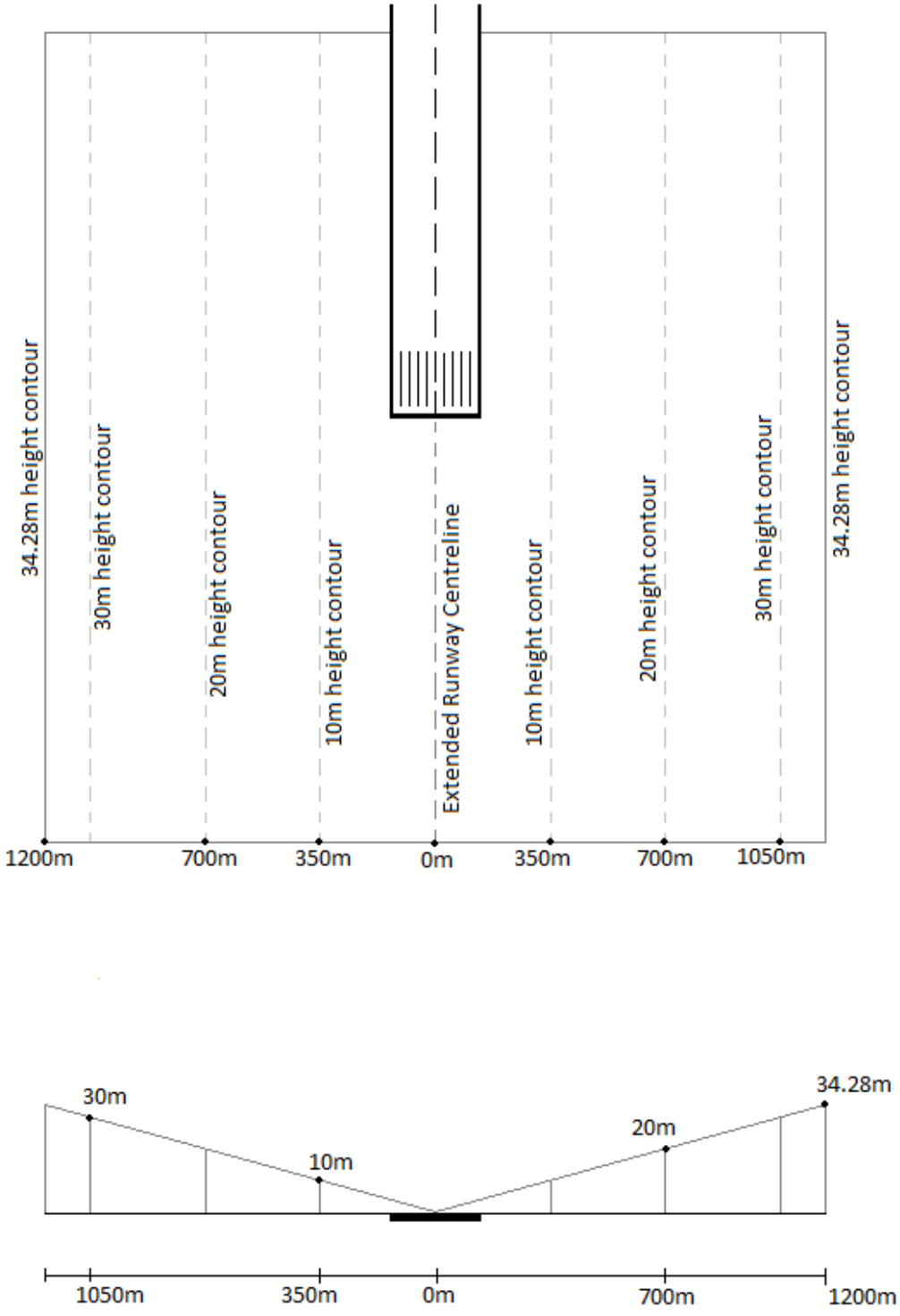

Figure 2: (Top) Plan view of the 1:35 surface within the assessment trigger area. (Bottom) Elevation view of the 1:35 surface, looking down the runway centreline. Illustrative purposes only – not to scale.

Windshear and Turbulence Criteria – Mitigation of risk for buildings that penetrate the 1:35 surface

49. For buildings that penetrate the 1:35 surface, an alternative approach is required as the basis of regulatory controls. This approach is:

    - The adoption of along-wind and across-wind windshear criteria; and
    - The adoption of a turbulence criterion.

50. The mean wind speed deficit due to wind disturbing structures is defined as the difference between the mean undisturbed wind field (with no structures present) and the mean disturbed wind field (downwind of the structure).

51. The variation in mean wind speed due to wind disturbing structures must remain below:

    - 7 knots (3.6 m/s) parallel to the runway centreline (or extended runway centreline) at heights below 61m AGL. Any speed deficit change of 7 knots or greater must take place over a distance of at least 100m. The "7 knot along-wind windshear criterion".
    - 6 knots (3.1 m/s) perpendicular to the runway centreline (or extended runway centreline) at heights below 61m AGL. Any speed deficit change of 6 knots or greater must take place over a distance of at least 100m. The "6 knot across-wind windshear criterion".

52. The standard deviation of wind speed must remain below 4 knots (2.1 m/s) at heights below 61m AGL. The "4 knot turbulence criterion".

53. These criteria, which will apply in Australia, are based on the research of the NLR and considered by many experts to be world's best practice.

Assessment Methodology

Using this Guideline

54. At airports, a combination of strong winds and large buildings near runways can create runway wind effects that could affect aviation safety.

55. This guideline sets out a short summary of steps to follow when assessing this risk from proposed buildings located near the threshold of runways. It should be used in conjunction with the Background and Guidance Material for Planners, Airport Operators and Wind Specialists provided at Attachment A, and with the 2012 report published by SLR Consulting, *Guidance Material for Building-Induced Wake Effects at Airports*, available on the Department's website.

56. The steps detailed below allow a simple risk based analysis of building induced windshear and turbulence risks in many circumstances. In some circumstances, if a proposed building fails the initial simple checks, a detailed risk assessment and potential mitigation case, taking account of historic wind conditions at the relevant airport, may be sufficient to satisfy the approval authority/decision maker that the building is acceptable. In further cases, physical wind tunnel modelling or computational fluid dynamics modelling may be necessary.

57. The below steps are also presented as a decision tree in Figure 3.

Step 1

58. Does the entire structure lie outside of the assessment trigger area at each runway end? (See Figure 1) i.e. no part of the structure is within the rectangle:

    a. 1200m perpendicular from the runway centreline (or extended runway centreline);
    b. 900 m beyond the runway threshold towards the landside of airport; and
    c. 500 m from the runway threshold along the runway.

59. If the structure is outside the assessment trigger area it is acceptable and no further assessment is required. If any part of the structure is within the assessment trigger area, go to Step 2.

Step 2

60. Does the structure sit entirely below the 1:35 surface? i.e. is the horizontal distance, perpendicular from the runway centreline (or extended runway centreline) to the building, more than 35 times the proposed height of the building?

61. If yes, the building is acceptable and no further assessment is required. If no, go to Step 3.

Step 3

62. If the structure is within the assessment trigger area and penetrates the 1:35 surface then windshear and turbulence effects must be considered and the building proponent must satisfy the approval authority/decision maker that the building will not create an unacceptable risk to aircraft operations.

63. The proponent may wish to put forward a risk assessment/safety case/risk mitigation measures for consideration of the approval authority/decision maker. The safety case may consider prevailing wind directions and wind speeds, runway operating modes, shielding provided by surrounding buildings, etc. If the proposed structure is a single, stand-alone building of regular shape (square or rectangular), the proponent may also wish to conduct the simple building-induced wind speed deficit (BWD) assessment using Table 1 on Page 6 of Attachment A.

64. This desktop windshear assessment will only test a building for windshear (and not turbulence). It was originally included in Guideline B when the turbulence criterion was not used in Australia. With the inclusion of the turbulence criterion, the desktop test can no longer be used by itself to prove that a structure passes or fails all of the criteria of Guideline B.

65. However, the desktop BWD assessment may be used as part of a safety case to show that the building satisfies the windshear criteria. If the BWD assessment shows that the structure meets each of the 6-knot and 7-knot windshear criteria, professional modelling under Step 4 may only be required to test the turbulence criterion.

66. The approval authority/decision maker may wish to seek advice from CASA when considering the proponent's safety case and deciding whether the building creates an unacceptable risk to aircraft operations.

67. If the approval authority/decision maker is satisfied that the building is acceptable, no further assessment is required. If not, go to step 4.

Step 4

68. If the approval authority/decision maker is not satisfied that the proposed building is acceptable based on the proponent's risk analysis and safety case, the proponent may wish to commission a wind engineer, or other suitably qualified professional, to conduct quantitative modelling. It is important to note that multiple buildings and buildings with complex shapes that penetrate the 1:35 surface must be subject to quantitative modelling.

69. The objective of the quantitative modelling should be to provide definitive results on whether the building will meet the 6-knot (3.1 m/s) and 7-knot (3.6 m/s) building-induced windshear criteria and the 4-knot (2.1 m/s) building-induced turbulence criterion.

70. The choice between wind tunnel and CFD modelling is a matter for the qualified professional to decide, with input from the building proponent, based on a number of factors including building geometry, surrounding geography and structures, and costs.

71. If the professional assessment indicates that the building passes each of the windshear and turbulence criteria, no further assessment is required and the approval authority/decision maker may approve the proposal (CASA is available to provide advice on expert wind assessments if required). If not, go to step 5.

Step 5

72. If the professional assessment above indicates that the building will fail one or more of the windshear or turbulence criteria, the approval authority/decision maker, in discussions with CASA and the airport/building proponent, should consider the likely frequency of occurrence. For example, if historic records indicate that the criteria will be failed only a few times a year and aircraft will be able to use alternative runways, it is possible the building could be accepted and the risks managed through operational procedures.

73. Discussion and consultation between the proponent of the structure, CASA and the airport users/stakeholders is required to assess the operational risks and for the approval authority/decision maker to make an informed judgement on whether the proposed structure is acceptable. Structures may be deemed acceptable if appropriate mitigation options are included i.e. runway operating restrictions during strong wind events that may trigger the windshear and turbulence criteria.

74. If the risk is determined to be unacceptable, the building proposal should be modified by the proponent or refused by the approval authority/decision maker, to ensure the safety of aviation operations at the airport.

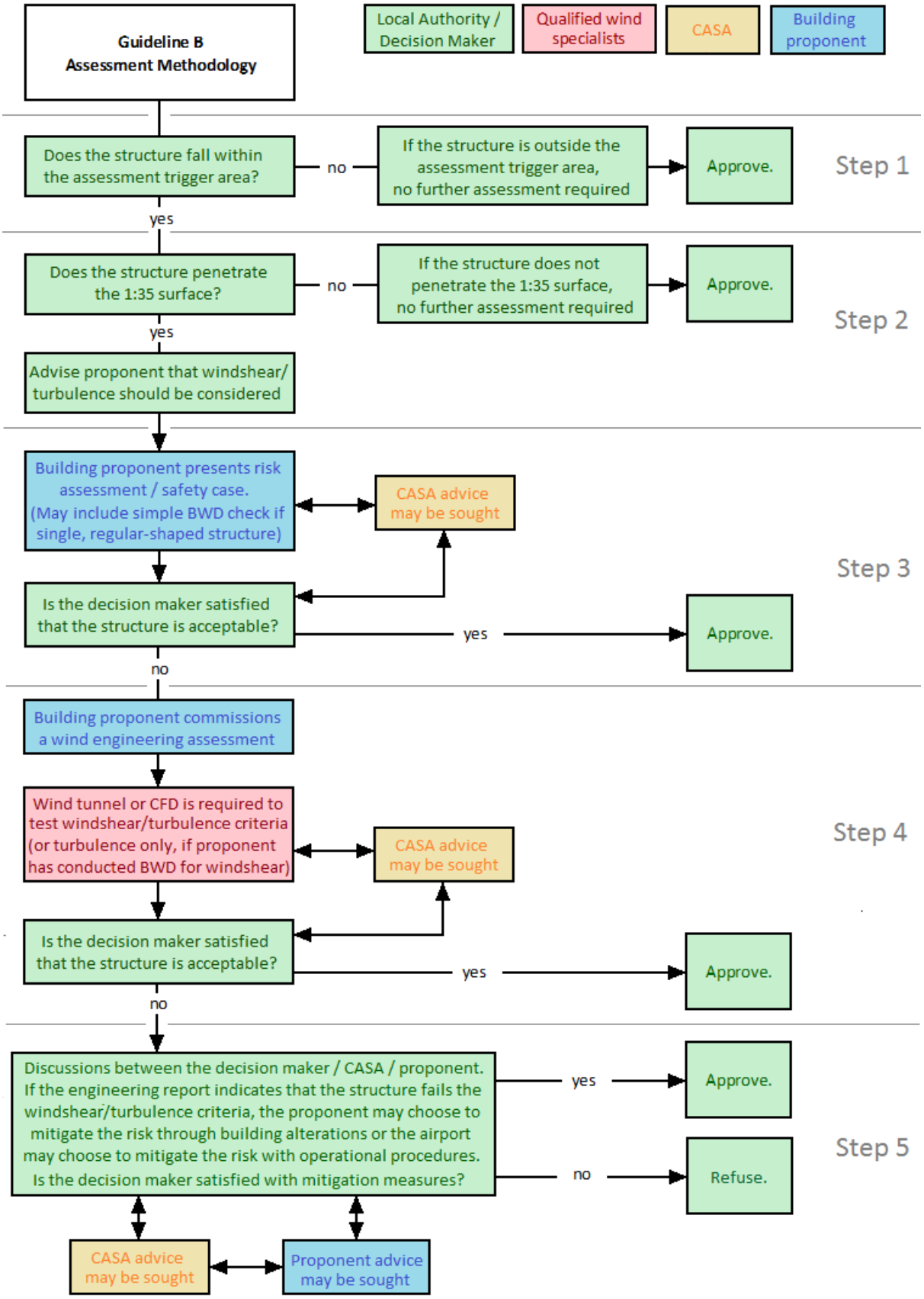

Figure 3: Assessment methodology