Appendix 8. Wind

This Appendix details the requirements for wind tunnel tests and describes the form and content of the wind reports, as required by standard 13.6.3.5.3.

1. Aims of the Wind Tunnel Test

The aims of a wind tunnel test are:

1.1 to quantify the effect of a building proposal on the surrounding pedestrian level wind environment by measuring and comparing the existing and proposed wind conditions, and

1.2 where wind conditions deteriorate as a result of the proposed building, to test alternative designs to it, and

1.3 to provide documentary evidence, of the proposed building's positive effect on the wind environment, emphasising measures taken to improve the wind environment, and demonstrating, where required, that every reasonable alternative design has been explored and that the proposed building is the best practical aerodynamic design arising from the other options that have been tested.

2. Form of the Wind Tunnel Test

Wind tunnel studies must meet the following conditions:

2.1 Wind studies should comply with the requirements of Australasian Wind Engineering Society Quality Assurance Manual, *Wind Engineering Studies of Buildings, AWES-QAM-1-2001*, except where the rules and requirements of the Wellington City District Plan supersede them.

2.2 The model scale used in the wind tunnel test must not produce models that are smaller than those obtained using a 1:500 scale.

2.3 The atmospheric boundary-layer simulation should be equivalent to Category 3 or Category 4 terrain, as defined in the Australia/New Zealand Loading Standard, AS/NZS 1170.2:2002.

2.4 Where there is no site wind speed data of sufficient quality, the reference wind speeds shall be derived using wind data from Wellington Airport, with the following corrections;

winds at a height of 10 m at Wellington Airport have equivalent mean speed to winds at a height of 150 m above Wellington City, and

wind directions over Wellington City are the same as those at Wellington Airport, except that the northerly wind directions (i.e. 0°-80° & 280°-360°) are rotated to the west by 10° (e.g. 360° at the airport becomes 350° over the city).

2.5 Wind speeds shall be measured for the reference wind directions (degrees clockwise with respect to true North) 150°, 170°, 190°, 210°, 320°, 340°, 360° and 020°.

2.6 The gust speeds shall be calculated as:

$$\text{gust} = v + 3.7\sigma,$$

where v = the annual maximum hourly mean wind speed for all wind directions combined, and

σ = the corresponding standard deviation of the wind speed.

This overall gust speed will be used to assess the compliance with the safety criteria given in standard 13.6.3.5.2 (a).

2.7 The number of hours that a 1-hour mean wind speed of 2.5 m/s and 3.5 m/s are equalled or exceeded in a year shall be calculated in order to assess compliance with creep criteria given in standard 13.6.3.5.2 (b). Where applicable, the hours that a 1-hour mean wind speed of 2.5 m/s is equalled or exceeded in a year shall be calculated in order to assess compliance with comfort criteria given in standard 13.6.3.5.2 (c).

2.8 All wind speeds shall be measured at a full-scale height of 2 metres.

2.9 The percentage change in hours shall be calculated by dividing the change in the number of hours by 8760 (i.e. the total hours in one year)

2.10 Flow visualisation tests that show the spatial extent of windy areas throughout public areas that surrounding the development shall be made for the existing situation and for the proposed development. Flow visualisation testing will include at least six different wind speeds, and be undertaken for at least two representative northerly wind directions and two representative southerly wind directions.

2.11 Where the standards set in 13.6.3.5.2 cannot be met, such as when the criteria are already exceeded in the surrounding area with the existing building, additional wind tunnel testing should be undertaken to quantify the effects of alternative building designs and/or modifications. Clear evidence should be gathered to show that the proposed building is the best practical aerodynamic design with respect to achieving these standards. The recording and measurement of wind speeds for this investigation of alternatives need only be for those areas around the proposed building, and for those wind directions, where problems have been identified. However, sufficient measurements must be taken to quantify all the changes with the alternative designs.

3. Form of Wind Tunnel Test Report

A wind tunnel test report must contain:

3.1 A description of the atmospheric boundary layer simulation that is used in the wind tunnel. This will include plots of the mean wind speed profile and turbulence intensity profile.

3.2 A description of the reference wind speeds that have been used to derive the wind speeds listed in the wind report. Any assumptions and limitations of the reference wind speed analysis and a description of the meteorological data used must be provided.

3.3 A calibration section, which contains images of the flow visualisation tests when applied to an isolated building model, subjected to the same wind tunnel test conditions as those used in the wind study. The building model shall be a square prism, 15 metres square in plan and 60 metres high, at the scale used in the test. Images of the flow visualisation test shall be taken for at least six different reference wind speeds. The final wind speed should correspond to an area of influence, that is identified by the flow visualisation, that is equal to 80 % of a diameter of 50 metres (at the scale of the model), centred on the back face of the

model. The intermediate speeds will be chosen to divide this maximum speed into equal parts.

3.4 An analysis of the errors limits and the precision that is achievable in the wind speeds and their frequency of occurrence that are listed in the body of the report. The relationship of the model (wind tunnel) to full-scale Wellington conditions, as far as it is known, should also be documented through reference to externally refereed papers or reports.

3.5 A diagram that clearly shows and identifies the locations/areas that were measured during testing

3.6 A table of the gust wind speeds for each wind direction and for each of the locations measured during testing. This will include listings for both the existing situation and for the proposed development.

3.7 A table of hours that the mean wind speeds of 2.5 m/s and 3.5 m/s are equalled or exceeded each year, for each of the locations measured during testing.

3.8 Records/diagrams of the flow visualisation tests.

3.9 A description of the effects of the proposed development on wind conditions in the surrounding area.

3.10 An analysis of the 3-dimensional wind flows around the proposed building indicating the way in which its effect on the air flow affects pedestrian-level winds. This should clarify:

3.10.1 the cause(s) of any observed problems;

3.10.2 the ways in which the problems might be avoided; and

3.10.3 the ways in which these wind problems might be mitigated.

At its simplest this might mean stating (for example):

- that the root cause is the downwash caused by the building being very much bigger in scale than its neighbours;
- that reducing the size of the proposed building would remove this root cause;
- that large canopies around the building could provide shelter from the downwash in the immediate vicinity of the entry ways, although this may result in the carparking area beyond the canopy being made uncomfortable.

3.11 Where the standards set in 13.6.3.5.2 cannot be met, such as when the criteria are already exceeded in the surrounding area with the existing building, an assessment of alternative designs and modifications including the results of additional wind tunnel testing that quantify the wind effects shall be provided. Clear evidence should be provided that the proposed building is the best practical aerodynamic design with respect to achieving these standards. Existing wind speeds and hours of occurrence shall be reported only at the locations / wind directions where alternative designs have been tested.

4. Form of Wind Assessment Report

A wind assessment report is not based on the results of a wind tunnel test and so ultimately relies on the expert knowledge and opinion of the qualified wind specialist. However, it must contain the following:

4.1 A description of the existing wind conditions, including sources and limitations of information used in the assessment.

4.2 A description of the likely interaction of the existing buildings with the wind that leads to the existing wind conditions.

4.3 A review of the design of the development, and its appropriateness for a windy environment. The WCC Wind Design Guide should be used as a basis for a design evaluation checklist for this review.

4.4 A description of the expected influence of the proposed development on pedestrian level wind speeds in areas open to the public. The WCC Wind Design Guide should be used as the basis for a design evaluation checklist for this review. The review should also examine the role of amelioration measures, including large setbacks of upper levels from the street façade, deep balconies and full-width verandahs.

4.5 A discussion of the building design, including the effectiveness of ameliorative measures or major design changes that are recommended. It is intended that the wind assessment should provide clear evidence that the proposed building is the best practical aerodynamic design with respect to achieving the wind standards.

4.6 A statement at the conclusion of the report that, in the professional opinion of the expert, the proposal is highly likely to comply with standard 13.6.3.5.2.