

2.2 REFLECTIVE ROOFING

(ADOPTED 19 DECEMBER 2006)

1. INTRODUCTION

There has been increasing awareness of the need for energy efficiency in housing in recent years, with the *Residential Design Codes* now recognising that reflective roofs can be effective in reducing the heat absorbed during summer months. However, the Codes also point out that highly reflective roofing such as zinalume may sometimes cause glare and discomfort to neighbours and that it may sometimes be appropriate to use materials or finishes which are light but less reflective.

The use of light coloured roofing is encouraged under the Building Code of Australia which now includes energy efficiency requirements taking into account the heat absorptance of the roofing material. Finishes such as Zinalume ® steel are preferable to darker colours in terms of heat gain, and contribute significantly towards improved energy efficiency of buildings. According to information provided by the manufacturer, zinalume re-radiates only around 5% of incident radiation compared with almost 10% for light coloured colorbond and more than 20% for red roofing (colorbond or tiles).¹

Reflective roofing in the form of galvanized (iron) steel has been used for a considerable period of time in Western Australia, although its relatively fast oxidation meant that reflection did not remain an issue for very long. By comparison, Zinalume ® steel which was introduced in the 1970s, while less reflective than new galvanized steel, generally weathers more slowly, and retains a lighter shade than weathered galvanized steel. Both Zinalume ® steel and light-coloured pre-painted steel such as Colorbond ® are popular roofing materials in the City, and are a distinguishing design characteristic of some areas.

While Zinalume ® is the most reflective of the commonly available sheet roofing finishes, significant *specular* or mirror-like reflection can also occur with new high-gloss painted finishes and glazed tiles. However, for some painted finishes, the process of weathering will normally result in a reduction in reflectivity, over time. This policy is to be applied only to those situations in which specular reflection is likely to be a cause of nuisance over a considerable period of time.

2. NUISANCE REFLECTION

Reflective roofing does not always result in nuisance glare, and the circumstances in which significant adverse impacts occur are actually quite limited. This is borne out by the small number of complaints received, but may also be confirmed by analysing the conditions under which reflective glare is likely to become a significant issue.

All high-gloss roofing will result in *specular* reflection at some times of the day for some months of the year, but the impact of such reflection will vary according to:

- Time of day and season when reflection occurs
- Position of the observer relative to the reflective roofing
- Frequency and duration of reflection
- Extent of roofing from which reflection is received
- Nature of area affected by reflection
- Size and orientation of opening affected by reflection
- Significance attributed to any outlook from opening

¹ Energy Efficient Steel Roofs in www.bluescopesteel.com.au

- Light levels within the area or room affected by reflection
- Attitude of the observer to sunlight at the relevant time of year
- Presence of any intervening landscaping which could filter or screen
- Presence and/or use of any screening of openings, e.g. blinds, curtains

The following diagrams illustrate the variation in the sun's position throughout the day at Mid Summer and Mid Winter.

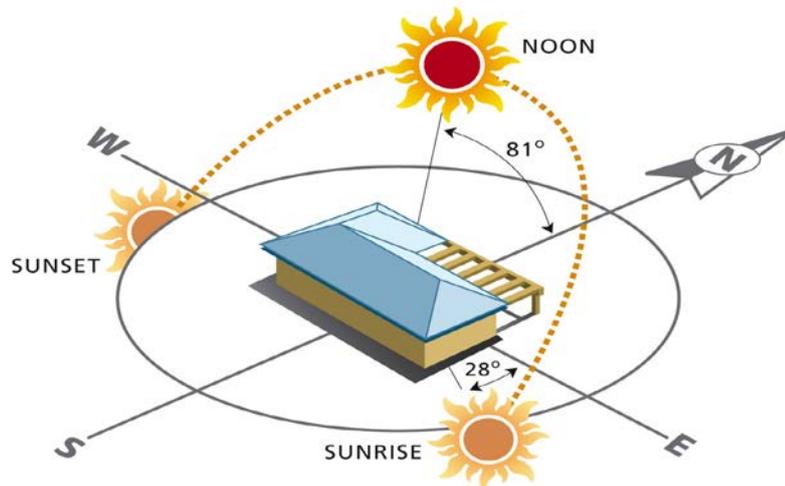


Figure 1a: Movement of sun during mid Summer (21 December)

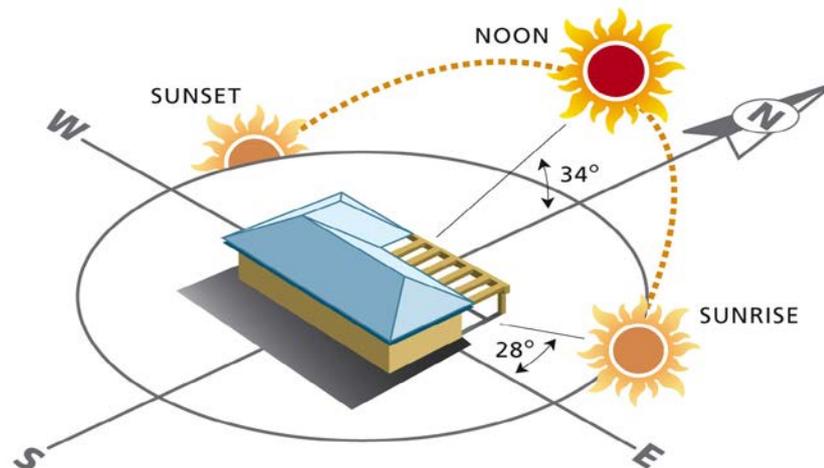


Figure 1b: Movement of sun during mid Winter (21 June)

Based on a general assessment of sun angles and in consideration of a range of design issues, the following general conclusions can be drawn about the likelihood of nuisance associated with specular reflection:

Specular reflection is less likely to be a nuisance:

1. where it occurs during early morning or late afternoon periods when the sun is low in the sky. This is because the rate of vertical change of the sun's angle is greatest, the duration of the reflective event is limited, and control measures to limit *direct* sunlight during such periods, will also be effective in limiting nuisance reflection during these times.

2. where the property is situated to the north of a reflective roof, i.e. between 80 degrees east and 80 degrees west. This is because the only times when the sun will be reflected from the south towards the north from the plane of a roof, is during early morning and late afternoon periods, when the sun is relatively low in the sky. Refer to 1 above.
3. where the direction from which the reflected light is received is significantly above or below the horizontal.
4. where the horizontal angle of the reflected light is relatively oblique, i.e. the reflected light comes from the side rather than from in front of the opening.
5. where the incident sunlight does not align with the fall of the roof, and the reflected light is dispersed by the profile of the roofing material.
6. where the number of days in the year during which reflection is received is limited.
7. where the effective area of the reflective roof is relatively small as perceived by the observer. The effective perceived area of a roof section will depend on its dimensions, orientation and distance from the observer.
8. where the receiving opening is to a room other than a living area (kitchen, dining, family, lounge) or where the opening is not a *major opening* to such a room.
9. where there is intervening landscaping which effectively filters or screens reflected light from the roof concerned.
10. where the roofing material has weathered, although the rate of such weathering will vary depending on the particular material and finish, and on the conditions in which it is situated.

3. OBJECTIVE

The objective of this policy is to:

- define the circumstances in which reflective glare needs to be taken into consideration, and where consultation with potentially affected property owners is required; and
- provide an objective basis for assessment of nuisance glare in the event of objection being received from potentially affected property owners.

4. DEFINITIONS

Direct reflection

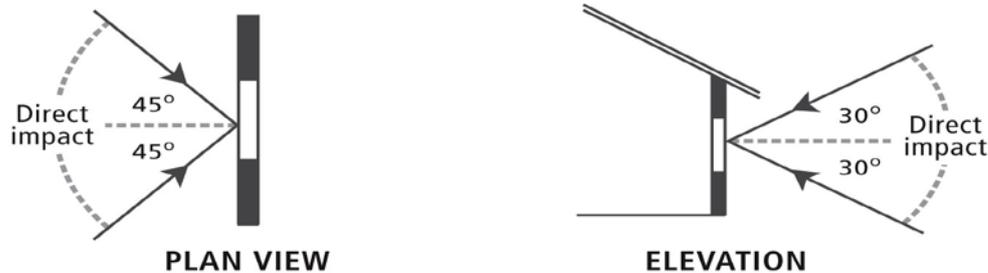
For the purposes of assessment under this policy, the angle of reflection from a roof is to be based on the pitch of the roof in the case of sheet roofing or the pitch of the tiles in the case of a tiled roof. Direct reflection is to be assumed to be in the direction of the fall of the roof as defined by the direction of corrugations or longitudinal profiling, in the case of sheet roofing, or the run of the tiles in the case of tiled roofing. Subject to these assumptions, the angle of incidence of sunlight is equal to the angle of reflection, with no allowance made for dispersion due to profiling or surface irregularities.

Directly impacted upon

For the purposes of this policy, the term 'directly impacted upon' is to be distinguished from an oblique impact, and refers to reflected sunlight which is incident on an opening with an angle of incidence of less than 45° in the horizontal plane, or $\pm 30^\circ$ in the vertical plane. These angles correspond to those applied under Element 8 of the R-Codes for determining the effective angle of view for the purpose of privacy.

Field of view

For the purposes of this policy, the field of view is deemed to be limited in accordance with the limits of *direct impact* as described in the previous definition and associated diagram.



Highly reflective

The following materials and/or finishes are deemed to be highly reflective for the purposes of this policy:

- Zinc or Zinc-Aluminium alloy coated steel or polished metal, e.g. Zinalume[®], galvanized (iron) steel, stainless steel, aluminium, copper (where sealed against oxidation)
- Glazed tiles (irrespective of colour)
- Glass or Perspex
- High-Gloss painted finishes, unless heavily textured (whether tile or metal)
- High gloss coated finishes other than paint, e.g. enamel

Non-Highly reflective

The following materials and/or finishes are not deemed to be highly reflective for the purposes of this policy:

- Concrete or clay tiles other than glazed or high-gloss finishes
- Painted or pre-painted finishes other than high-gloss, e.g. Colorbond[®] steel

N.B. The inclusion of a material or finish in the above list does not guarantee it will

necessarily be free from reflective glare. However, it is not practical to control all potential

impacts on adjacent property, and the extent of reflective glare associated with the foregoing

finishes when new can be expected to diminish over time due to weathering processes.

Major opening

Has the same meaning as defined in the *Residential Design Codes*.

5. ASSESSMENT CRITERIA

5.1 Preliminary assessment (Level 1)

The following criteria are to be applied to determine if a proposed development involving new or replacement roofing is to be regarded as acceptable in terms of the potential impact of reflective glare on adjacent property, or if it requires more detailed assessment of reflectivity:

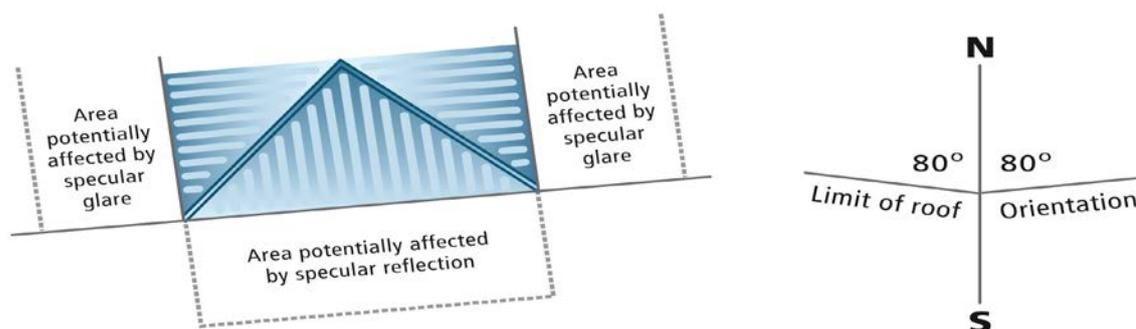
1.1 The material and/or finish of the proposed roof or roof section is defined as not being '*highly reflective*' (see below for definition); Yes No

1.2 The proposed development does not include any roof or roof section of the nature referred to in 1.1 above, which is facing between 80° east and 80° west²;

Yes No

1.3 There is no potentially affected *recipient* property directly in line and within 35 metres of a roof or roof section facing between 80° east and 80° west.

Yes No



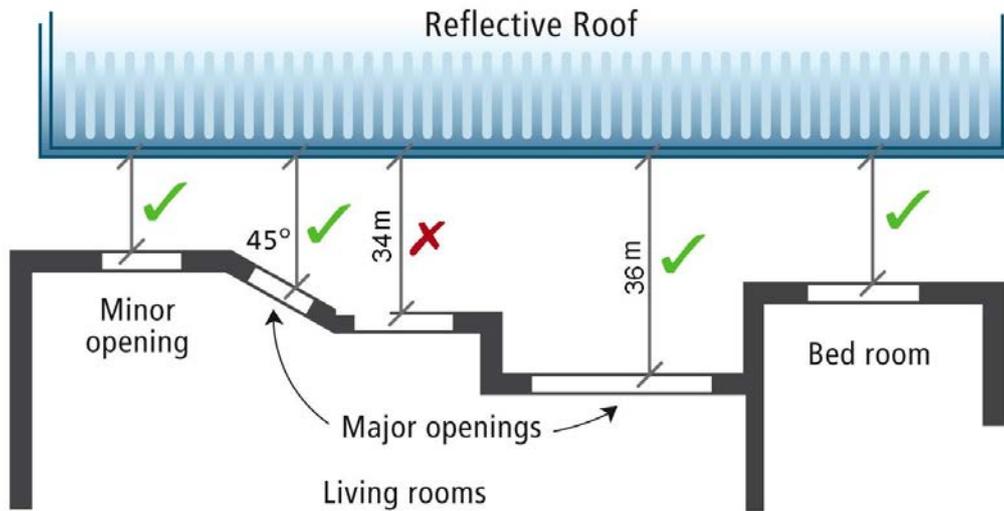
Where the proposed development satisfies at least one of the foregoing criteria, the issue of reflectivity will not be further investigated as part of the development assessment. In the event that adjacent property owners may still consider reflection to be a problem, amelioration of any perceived impact will be the responsibility of the recipient unless otherwise agreed by the applicant.

5.2 Detailed assessment (Level 2)

The following additional criteria will apply in those circumstances where the preliminary assessment referred to above indicates there is potential for reflective glare to adversely affect an adjacent property, i.e. where the proposal fails to satisfy at least one of the foregoing criteria.

² The basis for an 80° east or west cut-off is that for the corresponding solar azimuth or bearing of 110° west or east respectively, the solar elevation does not exceed 30°, which has been identified as the minimum elevation at which reflected sunlight would be at significant variance from the line of direct sunlight. It is assumed that such controls as may be required for direct sunlight in these circumstances would also be effective in controlling reflected sunlight.

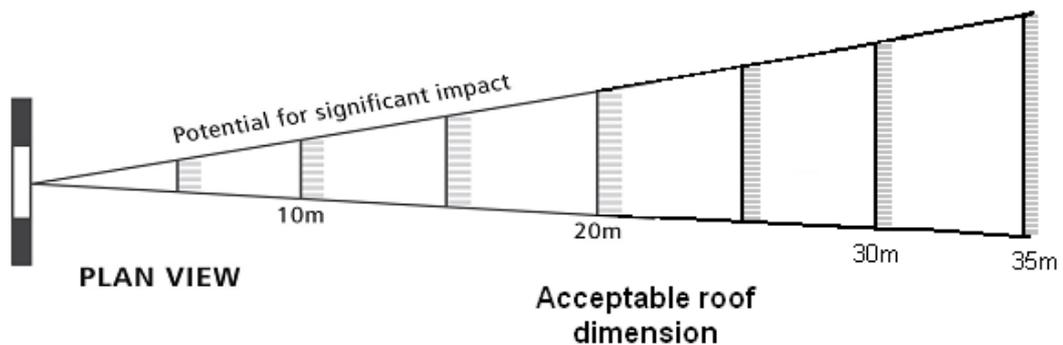
- 2.1 No major openings to living rooms (including kitchen and dining areas) within 35 metres of the source of reflection, are *directly impacted upon* by reflected sunlight from the proposed roof or roof section; Yes [] No []



- 2.2 The section of roof from which reflection is received does not exceed the following horizontal dimensions for the relevant separation distance to the affected living room: Yes [] No []

Separation distance	5 m	10 m	15 m	20 m	25m	30	35
Horizontal Dimension of roof	1.3 m	2.6 m	3.9 m	5.3 m	6.5m	7.8m	9.1m

Notes: The above table is based on a 15° angular field of view.



Where the City is satisfied that at least one of the foregoing criteria is met, the proposed development is to be deemed not to involve any significant adverse impact on adjacent property, and therefore to be acceptable in terms of this policy. It is the responsibility of the applicant to address the foregoing criteria, although the City reserves the right to review and/or verify any calculations where it considers this necessary.

Where the proposed development fails to meet at least one of the above criteria, it is to be deemed to have a significant adverse impact on the relevant adjacent property. Unless agreement can be reached with the owner of the affected property, there is to be a presumption against approval of the proposed development without some form of amelioration. (See below.)

Where, in the rare event, in the opinion of the City, there is doubt about whether a proposed development meets the foregoing criteria, a condition of planning approval is to be imposed to ensure that ameliorative measures are put in place in the event that the completed development is found not to comply with this policy. The terms of such a condition is to be generally in accordance with the following:

Condition: If, following receipt of a written complaint within 12 months of the development having been completed, reflective glare from the roofing of the development is found not to satisfy the criteria included in Reflective Roofing Policy 3.16, the owner will be required to put in place ameliorative measures to the satisfaction of the City, to ensure compliance with that policy.

Note: No ameliorative action will be required unless a complaint is made to the City in writing by an affected resident or owner within 12 months of the development which is subject of complaint having been completed.

5.3 Consultation

Consultation with adjacent property owners is not required where any one of the criteria identified above under *Preliminary Assessment* have been met, i.e. where reflective glare is not deemed to be a major issue.

Where none of the criteria identified above under *Preliminary Assessment* have been met, formal consultation with potentially affected property owners should be undertaken, either before or in association with the *Detailed Assessment*.

Consultation is intended to provide an opportunity to comment by potentially affected property owners, and to gain information about the potential impact of reflective glare on the property concerned. It also provides an opportunity to canvass proposals for the amelioration of impacts associated with reflection, where such action is considered appropriate.

In the event that there is no objection from potentially affected property owners, it will not generally be necessary to proceed with detailed assessment, and the proposed roofing will be regarded as being acceptable in terms of this policy.

In the event that objections are received from adjacent property owners, the Council is to take into consideration any concerns raised in its assessment and determination of the application concerned, including (in the event of approval) the imposition of any conditions of approval directed towards amelioration of reflective glare.

6.0 AMELIORATION OF IMPACTS

In the event there is found to be a significant adverse impact due to reflectivity, the impact is to be ameliorated before development is approved. Where reflective glare is determined to be unacceptable with reference to this policy, the responsibility for amelioration and the cost of ameliorative measures is to be borne solely by the developing owner unless otherwise agreed with the affected property owner.

The following are some of the options available, although others may be identified in the course of consultation and/or mediation:

A: Prevention

1. Change the roofing material to one with a less reflective finish, e.g. colorbond or low-gloss paint finish, matt finish tiles.
2. Change the design of the roof so as to avoid or reduce the amount of reflection to the affected property, e.g. alter pitch, re-orient, interpose gable(s), parapet wall section.
3. Application of an anti-glare treatment to the roof.

B: Protection

4. Physical screening such as shade sails or shade cloth, so as to intercept or reduce the level of reflection. Care needs to be taken to ensure that such screening does not unduly detract from the visual amenity of the area or cause unacceptable levels of shading of adjacent property. These considerations will generally limit the height of any vertical screening elements, such as those erected above existing fence-lines. Where physical screening is proposed on the affected property, such measures are to be subject to the agreement of the affected property owner.
5. Landscape screening either in the form of advanced growth trees or trellis plants. Care needs to be taken in the location and species of trees likely to shade north-facing living areas, so as not to unduly affect solar access during winter months. Where plantings are proposed on the applicant's site assurances need to be provided that the screening will be retained and maintained. Where landscape screening is proposed on the affected property, such measures are to be subject to the agreement of the affected property owner.
6. Some form of blinds to control the penetration of reflective glare, either horizontal or vertical depending on the angle of reflection and the preference of the affected property owner. Where such measures are proposed they are to be subject to the agreement of the affected owner.
7. Some form of protective coating to affected windows to reduce the level of penetration of reflective glare. Where such measures are proposed they are to be subject to the agreement of the affected owner.